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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

ILLINOIS POWER RESOURCES GENERATING, LLC,	)	
Petitioner,	)	
v.	)	
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY,	)	PCB 2024-048
Respondent.	)	

NOTICE OF FILING

To: See Attached Service List (Via Electronic Filing)

PLEASE TAKE NOTICE that the undersigned filed today with the Office of the Clerk of the Illinois Pollution Control Board by electronic filing the following NOTICE OF FILING, CERTIFICATE OF SERVICE, CERTIFICATE OF RECORD ON APPEAL, and RECORD ON APPEAL, copies of which are attached hereto and hereby served upon you.

Respectfully submitted,

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

By: /s/Mallory Meade

Mallory Meade, #6345981
Assistant Attorney General
Environmental Bureau
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Dated: June 20, 2024

SERVICE LIST

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on June 20, 2024, before 5:00 PM, she caused to be served by electronic mail, a true and correct copy of the following instruments entitled Notice of Filing and Motion for Extension of Time to File the Record to:

Joshua R. More
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This email transmission contains 3,649 pages.

/s/ Mallory Meade
Assistant Attorney General
Environmental Bureau

Under penalties as provided by law pursuant to Section 1-109 of the Code of Civil Procedure, the undersigned certifies that the statements set forth in this Certificate of Service are true and correct, except as to matters therein stated to be on information and belief and as to such matters the undersigned certifies as aforesaid that she verily believes the same to be true.

/s/ Mallory Meade
Assistant Attorney General
Environmental Bureau

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

ILLINOIS POWER RESOURCES GENERATING, LLC,	)	
Petitioner,	)	
v.	)	
	)	PCB 2024-048
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY,	)	
Respondent.	)	

CERTIFICATE OF RECORD ON APPEAL

Respondent, ILLINOIS ENVIRONMENTAL PROTECTION AGENCY ("Illinois EPA"), in accordance with the procedural rules of the Illinois Pollution Control Board ("Illinois PCB") as set forth in 35 Ill. Adm. Code 105.212 and 105.116, files as its Record in this cause the Illinois EPA's record of non-concurrence with the Duck Creek Power Plant GMF Pond Alternative Source Demonstration ("ASD") which is attached and consists of the following documents:

PAGES	DOCUMENT		DATE
R000002 - R000011	1	Drever, James I. The Geochemistry of Natural Waters: Surface and Groundwater Environments. Prentice Hall. Third Edition.	1997
R000013 - R000022	2	Faybishenko, Boris, Paul A. Witherspoon and Sally M. Benson Editors. Dynamics of Fluids in Fractured Rock. American Geophysical Union.	2000

R000024 - R000031	3	Eby, G. Nelson. Principles of Environmental Geochemistry. Brooks/Cole, Cengage Learning.	2004
R000033 - R000062	4	United States Environmental Protection Agency (USEPA). SW-846 Test Method 1314: Liquid-Solid Partitioning as a Function of Liquid-Solid Ratio for Constituents in Solid Materials Using An Up-Flow Percolation Column Procedure.	July, 2017
R000064 - R000100	5	United States Environmental Protection Agency (USEPA). SW-846 Test Method 1315: Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure	July, 2017
R000102 - R000121	6	SW-846 Test Method 1316: Liquid-Solid Partitioning as a Function of Liquid-to-Solid Ratio in Solid Materials Using a Parallel Batch Procedure.	July, 2017
R000123 - R000152	7	United States Environmental Protection Agency (USEPA) Region I. Low Stress (Low Flow) Purging And Sampling Procedure For The Collection Of Groundwater Samples From Monitoring Wells.	September 19, 2017
R000154 - R000421	8	Fetter, C.W., Thomas Boving, and David Kreamer. Contaminant Hydrogeology. Waveland Press. Third Edition.	2018
R000423 - R000562	9	Illinois Pollution Control Board (IPCB). Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments; 35	April 21, 2021

		Illinois Administrative Code Part 845.	
R000564 - R001746	10	Copy of Illinois Power Resource Generating, LLC's Operating Permit Application for the Duck Creek Power Plant GMF Pond and submittal letter	October 25, 2021
R001748 - R003103	11	Copy of Illinois Power Resource Generating, LLC's Construction Permit Application for the Duck Creek Power Plant GMF Pond	January 28, 2022
R003105 - R003106	12	Email chain with top email from Stefanie Diers titled "Re: Joppa AS" and dated November 2, 2023 7:52 AM	November 2, 2023
R003108 - R003527	13	Copy of Illinois Power Resource Generating, LLC's Alternative Source Demonstration Submittal for the Duck Creem Power Plant GMF Pond	November 13, 2023
R003529	14	Email chain with top email from EPA.BOW.GWS.CCR titled "RE: Duck Creek Power Plant ASD submittal notice" and dated November 13, 2023 3:31 PM	November 10-13, 2023
R003531 - R003532	15	Email chain with top email from Brian Voelker titles "[External] RE: Duck Creek/Hennepin Power Plant ASD submittal notice" and dated November 14, 2023 9:49:13 AM	November 10-14, 2023
R003534 - R003536	16	Email Chain from with top email from Brian Voelker titled "[External] RE: Duck Creek/Hennepin Power Plant ASD submittal notice" and dated November 14, 2023 11:07:40 AM	November 10-14

R003538	17	Email from Lauren Hunt titled "Joppa ASD letter" dated November 16, 2023 9:02:52 AM	November 16, 2023
R003540 - R003541	18	Draft letter of nonconcurrence for Joppa Power Plant East ASH Pond Alternative Source Determination [attachment to email of November 16, 2023, Document 18)	November 16, 2023
R003543	19	Email from Lauren Hunt titled "Joppa ASD Non Concurrence Letter" dated November 16, 2023 9:08:12 AM	November 16, 2023
R003545	20	Email from Lauren Hunt titled "Duck Creek ASD Response Letter" dated November 16, 2023 10:15 AM	November 16, 2023
R003547	21	Meeting invitation from Lauren Hunt titled "Matt to hand in Duck Creek ASD	November 16, 2023
R003549	22	Meeting invitation from Lauren Hunt titled "Matt and Justin to hand in ASD Letters"	November 16, 2023
R003551 - R003552	23	Draft letter of nonconcurrence for Joppa Power Plant East ASD Pond Alternative Source Determination [attachment to email of November 16, 2023, Document ??)	November 16, 2023
R003554	24	Meeting invitation from Lauren Hunt titled "Mail Duck Creek ASD Letter"	November 16, 2023
R003556	25	Email from Josia Seif titled "3rd Qtr., 2023, Duck Creek - Gypsum Management Facility (2022-EO-67783) dated November 28, 2023 12:58:33 PM	November 28, 2023
R003558	26	Email from Jenny Cassel titled "[External] Comments	November 28, 2023

		of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek" dated November 28, 2023 2:08:46 PM	
R003560 - R003563	27	Letter from Jenny Cassel titled “Public Comments on Alternative Source Demonstrations for Hennepin West Ash Pont System and Duck Creek surface impoundments” [attachment to email from November 28, 2023, Document 27]	November 28, 2023
R003565	28	Email chain with top email from Lynn Dunaway titled "FW: VN Response: Electric Energy, Inc (Joppa East) - W-2023-50186" dated November 30, 2023 3:04:37 PM	November 30, 2023
R003567 - R003574	29	Letter from Bina Joshi titled "Response to Violation Notice W-2023-50186 (Settlement Confidential Communication)" [attachment to email from November 30, 2023, Document 29]	November 30, 2023
R003576	30	Email from Matthew Garee titled "Duck Creek ASD Draft" dated November 30, 2023 4:02:04 PM	November 30, 2023
R003578	31	Draft letter of nonconcurrence for the Duck Creek Power Plant GMF Pond Alternative Source Demonstration Submittal [attachment to email from November 30, 2023, Document 31]	November 30, 2023
R003580	32	Email chain with top email from Rhys Fullers titled "[External] RE: IL0055620 - Duck Creek Modification"	June 8, 2023- December 4, 2023

		dated December 4, 2023 9:20:20 AM	
R003582 - R003583	33	Email chain with top email from Mark Liska titled "RE: IL0055620 - Duck Creek Modification" dated December 4, 2023 9:44:30 AM	December 4, 2023
R003585 - R003594	34	Letter from Darin LeCrone dated November 8, 2023 [attachment to email from December 4, 2023, Document 34]	December 4, 2023
R003596 - R003597	35	Email chain with top email from Rhys Fuller titled "[External] RE: IL0055620 – Duck Creek Modification" dated December 4, 2023 9:52:41 AM	December 4, 2023
R003599	36	Email chain with top email from Jenny Cassel titled "[External] RE: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek" dated December 5, 2023 1:40:25 PM	December 5, 2023
R003601	37	Copy of the letter of nonconcurrence regarding the Newton Power Plant Primary Ash Pond Alternative Source Demonstration Submittal [attachment to email dated December 5, 2023, Document 39]	December 5, 2023
R003603 - R003604	38	Email chain with top email from Jenny Cassel titled "[External] RE: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and	December 5, 2023

		Duck Creek" dated December 5, 2023 2:07:27 PM	
R003606	39	Email from Lauren Hunt titled "Draft ASD Duck NonConcurrence letter Dec 2023.docx" dated December 5, 2023 3:00 PM	December 5, 2023
R003608 - R003609	40	Letter from Michael Summers titled "Duck Creek Power Plant GMF Pond Alternative Source Demonstration Submittal" [attachment to December 5, 2023 email, Document 40]	December 5, 2023
R003611	41	Email chain with top email from Lauren Hunt titled "RE: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx" dated December 5, 2023 3:45 PM	December 5, 2023
R003613	42	Email from Lauren Hunt titled Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx" dated December 5, 2023 3:47 PM	December 5, 2023
R003615	43	Email chain with top email from Lynn Dunaway titled “RE: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx” dated December 5, 2023 4:41:54 PM	December 5, 2023
R003617	44	Email from Matthew J. Garee titled “Duck Creek ASD” dated December 6, 2023 9:42:33 AM	December 6, 2023

R003619 - R003620	45	Letter from Michael Summers titled “Duck Creek Power Plant GMF Pond Alternative Source Demonstration Submittal” [attachment to December 6, 2023 email, Document 50]	December 6, 2023
R003622	46	Email chain with top email from Michael Summers titled “RE: Duck Creek ASD” dated December 6, 2023 9:53:14 AM	December 6, 2023
R003624 - R003625	47	Email chain with top email from Lynn Dunaway titled “RE: Duck Creek ASD” dated December 6, 2023 9:53:40 AM	December 6, 2023
R003627	48	Email from Sherri L. Richardson titled “Alternative Source Demonstration Submittal” dated December 6, 2023 1:14:15 PM	December 6, 2023
R003629	49	Letter from Michael Summers titled "Duck Creek Power Plant GMF Pond Alternative Source Demonstration Submittal" [attachment to email from December 6, 2024, Document 54]	December 6, 2023
R003631	50	Email from Matthew J. Garee titled “Duck Creek ASD Non-concurrence letter” dated December 6, 2023 1:50:00 PM	December 6, 2023
R003633	51	Letter from Michael Summers titled "Duck Creek Power Plant GMF Pond Alternative Source Demonstration Submittal" [attachment to email from	December 6, 2023

		December 6, 2024, Document 56]	
R003635	52	Canceled meeting invitation from Lauren Hunt titled "Canceled: Mail Duck Creek ASD Letter”	December 6, 2023

I, Lauren Hunt, of the Illinois EPA, hereby certify that the documents of the Record on Appeal filed in the above referenced matter and summarized in the above Index are complete to the best of my knowledge, information, and belief.

BY: s/ Lauren Hunt
Lauren Hunt
Environmental Protection Geologist II
Illinois Environmental Protection Agency

Respectfully submitted,

KWAME RAOUL,
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State of Illinois,

MATTHEW J. DUNN, Chief
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Litigation Division

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Dated: June 20, 2024

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Document 1

R000002

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by organisms (nitrogen, phosphorus, sometimes carbon, potassium, and silica), biological processes are often the dominant control in surface waters. For elements utilized in only trace amounts (e.g., Mn, Cu, Ni, Mo, and Se), uptake by organisms in open waters such as lakes probably affects dissolved concentrations significantly only in environments where concentrations are low in general. In environments where concentrations are high as, for example, in polluted waters, the amounts taken up by organisms are likely to be small compared to the amounts in solution or to the amounts removed by adsorption processes.

In terrestrial systems uptake by plants can have a major influence on both heavy metals and organic compounds. One method of water treatment is to route a contaminated water through an artificially constructed wetland—a swamp with abundant plants (e.g., Wieder, 1993). Contaminants are removed by direct plant uptake, by adsorption on solid organic matter, and by precipitation as sulfides where the environment is anaerobic. One problem with artificial wetlands is that their lifetime is generally finite (a decade or so), and then the material that makes up the wetland must be disposed of.

HAVIOR OF SPECIFIC ELEMENTS

Several specific elements are discussed here to provide an overview of their behavior and to illustrate patterns of behavior that are common to many other elements.

Copper, Zinc, Cadmium, and Lead

These elements have several features in common. The dominant species in solution is a divalent cation (free or complexed). Under oxidizing conditions, they are soluble under acid conditions and their solubilities at higher pH are limited by the solubility of a carbonate or oxide/hydroxide (Figs. 9-12 to 9-16; these and subsequent figures have been simplified by omission of some possible complexes in solution involving sulfate, sulfide species, carbonate species, and OH^-. These omissions do not significantly change the diagrams for the conditions commonly encountered in fresh waters). Under reducing conditions, in the presence of sulfur all form relatively insoluble sulfides. In the absence of sulfur, copper is insoluble as the native metal (Fig. 9-16). The others behave as they do in oxidizing environments: they are relatively soluble at low pH and insoluble as carbonates/oxides/hydroxides at high pH. Copper, zinc, and cadmium form anionic species at high pH. It is rare, however, for pH values in nature to be sufficiently high for such species to be important. The response of these elements to a change in redox conditions is determined less by redox reactions involving the elements themselves than by changes occurring in sulfur species, and in Fe and Mn oxyhydroxides, which are important substrates for adsorption.

All members of the group are complexed by natural organic matter. Some binding constants for complexing of the M^{2+} ion with humic substances are shown in Table 9-2. These constants give a general indication of the strength of interaction between the metal and dissolved organic matter. The constant for calcium is included for comparison. In general, copper is the most strongly complexed member of the group and is very commonly influenced by organic complexation. Lead is next, followed by zinc and cadmium. Complexing of zinc and cadmium by organic solutes is, generally speaking, important only where concentrations of dissolved organic carbon are relatively high.

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All members of the group are potentially affected by adsorption on iron and manganese oxyhydroxides (Fig. 9-17), and Cd is potentially affected by adsorption on calcite. As discussed in Chapter 5, adsorption is pH dependent. Lead adsorbs at the lowest pH, followed by Cu, Zn, and Cd. The curves shown in Fig. 9-17 illustrate the results of experiments conducted under a specific set of conditions and should not be overgeneralized.

The expected behavior of these metals in the environment can be summarized as follows: under oxidizing conditions at low pH, they are all soluble and mobile. As the pH rises, their concentrations tend to decrease, first because of adsorption (particularly for Pb and Cu), and then because of the limited solubility of carbonates and oxides/hydroxides. Under reducing conditions, if sulfur is present, all should be immobilized as sulfides. If sulfur is absent, for Zn, Cd, and Pb the solubility control will be the same as under oxidizing conditions; Cu should be insoluble at all pH values. Adsorption is generally less important under reducing conditions because the most important substrates for adsorption, Fe and Mn oxyhydroxides, tend themselves to dissolve.

Arsenic and Selenium

Arsenic and selenium differ strongly from the previous examples in that both elements undergo important changes in oxidation state themselves, and both occur in solution as anions or as neutral species rather than as cations. *pe*-pH diagrams are shown in Figs. 9-18 and 9-19. Under oxidizing conditions, the dominant form of arsenic is the +V oxidation state, which is present as arsenic acid and its anions (arsenate), corresponding closely to phosphoric acid and phosphate species. For selenium, the dominant form under oxidizing conditions is selenate, which is closely analogous to sulfate. As conditions become reducing, As(V) is reduced to As(III)—arsenious acid and arsenite anions. When sulfate reduction occurs, As precipitates as a sulfide; if sulfur is absent, it remains in solution as arsenious acid or an arsenite. Elemental arsenic should be a stable species under highly reducing conditions, but it does not occur commonly in nature. For selenium, selenite species (analogous to sulfite) occur at intermediate redox levels, followed by elemental selenium and hydrogen selenide (analogous to hydrogen sulfide) species under strongly reducing conditions. Both

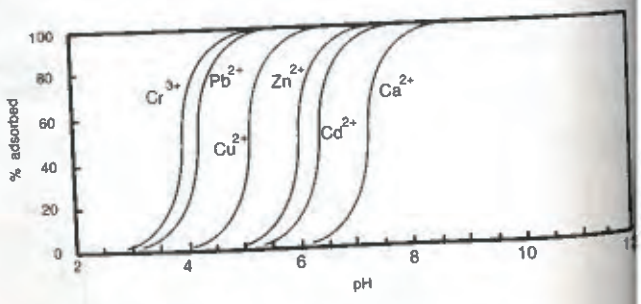

FIGURE 9-17 Adsorption of Cu^{2+}, Cd^{2+}, Zn^{2+}, Pb^{2+}, Cr^{3+}, and Ca^{2+} (for comparison) on hydrous ferric oxide as a function of pH. Each metal shows an adsorption "edge"; at pH values below the edge, the ion is not adsorbed or very weakly adsorbed. At pH values above the edge, the ion is strongly adsorbed. Conditions correspond to a high ratio of hydrous ferric oxide to adsorbing cation and an ionic strength of 0.1 m. The edges move towards higher pH as the ratio adsorbing cation:hydrous ferric oxide increases. From data in Dzombak and Morel (1990).

R000004

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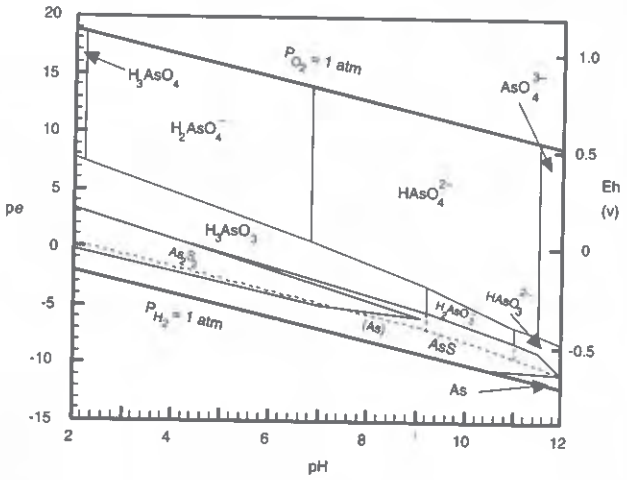

FIGURE 9-18 Simplified pe–pH diagram for the system As–O–H_2O at 25°C and one atm. Total activity of sulfur species = 10^{-2}. Light lines are boundaries involving dissolved species only. Dashed line is field of solid elemental arsenic in the absence of sulfur. Solubility is defined as a dissolved As species activity of 10^{-6}.

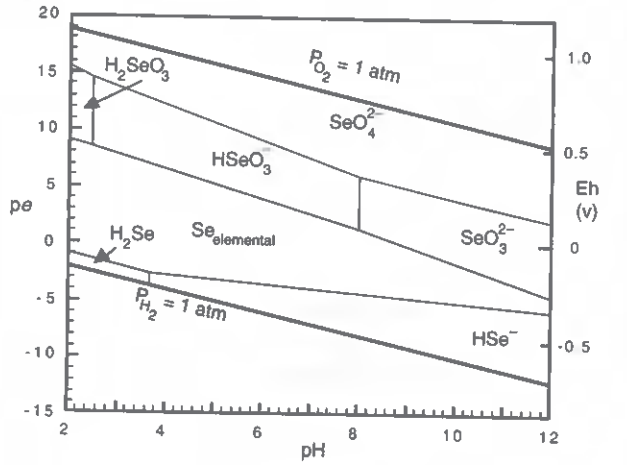

FIGURE 9-19 Simplified pe–pH diagram for the system Se–O–H_2O at 25°C and one atmosphere. Solubility is defined as a dissolved Se activity of 10^{-6}. Data are from Cowan (1988).

arsenic and selenium may be incorporated into iron sulfides under reducing conditions. The kinetics of redox transformations involving arsenic and selenium are slow, so disequilibrium is common (Kent et al., 1994; Runnells and Lindberg, 1990).

Arsenate species form inner-sphere complexes at the iron oxyhydroxide surface and are strongly adsorbed at near-neutral pH (Fig. 9-20). At high pH the strong negative charge on the oxide surface decreases adsorption of anions. As(III) apparently does not form inner-sphere complexes at the oxide surface. It is not strongly adsorbed at any pH value. For selenium, the adsorption picture is reversed. The oxidized form is only weakly adsorbed (similar to sulfate), whereas Se(IV) is strongly adsorbed under near-neutral conditions.

Organoarsenic compounds occur in nature but do not appear to be particularly important in the overall cycle of arsenic. Organic forms of selenium are more important, particularly in plants that accumulate selenium. Certain plants, notably vetches of the genus *Astragalus*, can accumulate high concentrations of selenium and may cause toxicity problems for livestock.

R000005

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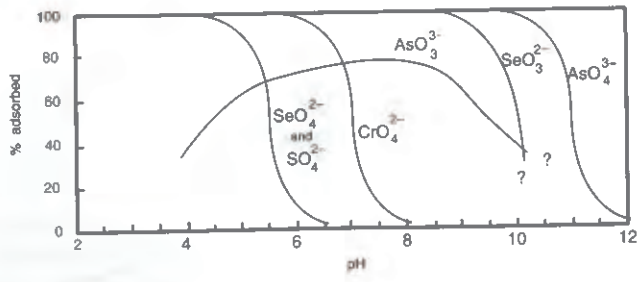

FIGURE 9-20 Adsorption of arsenate, arsenite, selenate, selenite, chromate, and sulfate (for comparison) on hydrous ferric oxide as a function of pH. Most of the anions show an adsorption "edge"; at pH values above the edge (for anions), the ion is not adsorbed or very weakly adsorbed. At pH values below the edge, the ion is strongly adsorbed. The anomalous behavior of arsenite is related to the fact that AsO_3^{3-} is fully protonated to H_3AsO_3 below pH 9 (Fig. 9-18); the symbol AsO_3^{3-} is used for all As in the +III oxidation state. Conditions correspond to a high ratio of hydrous ferric oxide to adsorbing cation and an ionic strength of 0.1 m. The edges move towards lower pH as the ratio adsorbing anion:hydrous ferric oxide increases. From data in Dzombak and Morel (1990).

Chromium

Chromium (Fig. 9-21) shows some similarities to both of the groups of elements discusse above. Under highly oxidizing conditions, the hexavalent form (chromate) is stable as a anion. It is not strongly adsorbed (adsorption edge at about pH 7, Fig. 9-20) and is therefor mobile in the environment. Under intermediate and reducing conditions, Cr(III) is the stabl oxidation state. It is insoluble in the neutral and alkaline pH ranges. It is soluble (largely a $Cr(OH)^{2+}$) under acid conditions. In general, Cr(III) species are strongly adsorbed (Fig. 9-17 Where dissolved chromium pollution occurs, the problem form is generally Cr(VI).

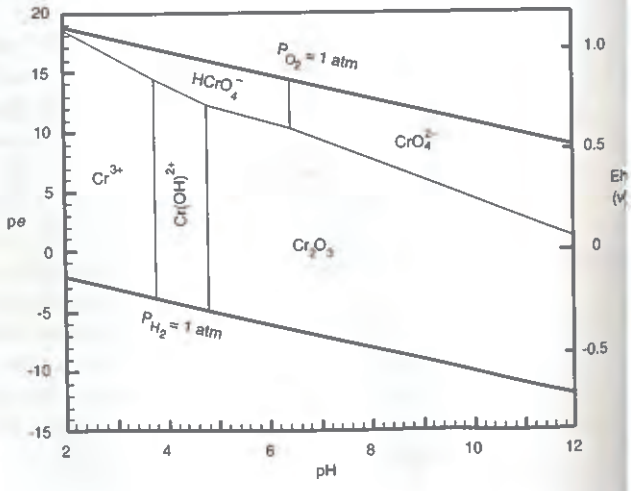

FIGURE 9-21 pe–pH diagram for the system Cr–O–H_2O at 25°C and one atm. Solubility is defined as a dissolved Cr activity of 10^{-6}. Data from Brookins (1988).

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ılfate (for comparison)
'edge"; at pH values above
below the edge, the ion
SO_3^- is fully protonated
xidation state. Conditions
trength of 0.1 m. The edges
From data in Dzombak and

ps of elements discussed
hromate) is stable as an
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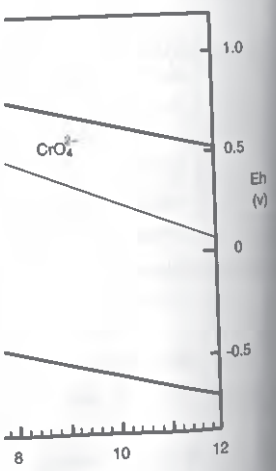
ngly adsorbed (Fig. 9-17).
enerally Cr(VI).



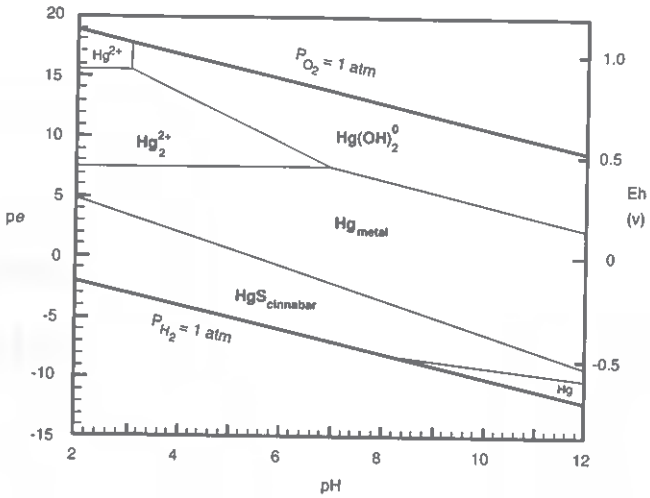


FIGURE 9-22 pe–pH diagram for the system Hg–S–O–H_2O at 25°C and one atm. Solubility is defined as a dissolved Hg activity of 10^{-6}. Total activity of sulfur species = 10^{-2}. The diagram is the same in the absence of S species, with the HgS (cinnabar) field replaced by Hg (metal). In the presence of chloride, the Hg_2^{2+} may be replaced by the insoluble mercurous chloride (calomel). Data are consistent with Allison et al. (1991).

Mercury

The chemistry of mercury in the environment is highly complex. The thermodynamically stable forms are shown in Fig. 9-22. The common soluble form is the oxidized (mercuric) Hg^{2+} ion and its hydrolysis product $Hg(OH)_2^0$, with the reduced (mercurous) Hg_2^{2+} ion being less important. Elemental mercury has a large stability field. The elemental form is volatile and slightly soluble in water. The global cycle of mercury is dominated by vapor-phase transport of Hg^0 through the atmosphere (Mason et al., 1994). Mercury is transformed by microorganisms into organic forms, notably monomethyl mercury (CH_3Hg) and dimethyl mercury [$(CH_3)_2Hg$]. These organic forms, in addition to being highly toxic, are volatile and tend to accumulate in the food chain. High concentrations of Hg in fish, which are common in polluted waters, generally result from accumulation of organomercury species. Pollutant Hg in sediments is partly transformed to organomercury species and partly to the sulfide.

Most of the metals discussed above—Cu, Zn, Cd, Pb, As, Hg, and, to a lesser extent, Se—are transformed to sulfides in anaerobic sediments. So long as conditions remain anaerobic and sulfur is available, they are relatively immobile. However, any disturbance, such as dredging, that brings the sediment into contact with oxygen will cause oxidation of the sulfides and release of the metals into solution. Cleaning up or moving contaminated sediments is a difficult problem because it may lead to oxidation and mobilization of these metals.

SUMMARY

1. To understand the behavior of any trace element in natural waters, it is essential to know the chemical form of the element in the water of interest. Anomalously high concentrations are often related to the presence of stable complexes in solution.
2. The solubility of phases containing the element as a major constituent (commonly an oxide/hydroxide, carbonate, or sulfide) provides a general upper limit to the concentration of a specific element.

R000007

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This is exactly the expression we had for a non-adsorbed solute (Eq. 16–9), but with D/R substituted for D (which could be either a dispersion coefficient or a diffusion coefficient). Thus spreading by diffusion or dispersion is retarded in an analogous manner to advection. Provided dispersion is much greater than diffusion, the geometry of movement and spreading of an adsorbed solute as it moves through an aquifer will be exactly the same as that of an unadsorbed solute, but the time taken to reach a particular position and "width" will be a factor of R longer.

Adsorption affects only non-steady-state diffusion. At steady state (e.g., a constant concentration gradient between a constant source and a constant sink), there is no net uptake or release by adsorption, so adsorption has no effect on diffusion. The diffusional flux will be given by Fick's first law with no correction for adsorption.

The above discussion applies only to the limiting case of rapid, reversible, linear adsorption. Because of its mathematical convenience, the retardation equation based on the linear K_d is often used as an approximation even where these conditions do not hold. It should also be remembered that, in general, the numerical value of K_d is specific to the solute, the substrate, and the composition of the groundwater. It is not readily transferred from one experiment or situation to another.

Example 3

Suppose the pollutant in Example 2 above is adsorbed by the sediment, and the adsorption can be described by a constant K_d of 5 *l*/kg. How long will it now take for the pollutant to reach a depth of 50 cm?

If we assume a grain density of 2.6 g/cm^3, the redardation factor, R, is

$$\left(1 + \frac{0.3}{0.7} \times 2.6 \times 5\right) = 6.57$$

The times calculated in Example 2 will be multiplied by this number. The time for 1 percent of the initial concentration to reach 50 cm will thus be 10.97 y rather than 1.67 y. Note that, for a given K_d, the retardation factor increases as the porosity decreases as a result of the factor $(1 - \phi)/\phi$. If, in this example, the porosity had been 10 percent rather than 70 percent, the retardation factor would have been 118 rather than 6.57.

REACTION PATH MODELING

Reaction path calculations, or *mass-transfer* codes, give us the successive compositions of a solution as a mineral (or several minerals) reacts with a solution or as some other process, such as evaporation of the solution, proceeds. The mass of each solid phase or gas produced or consumed is calculated. Such codes do not, in general, contain any kinetic information: They calculate changes as a function of the amount of reaction that has taken place but do not say anything about how long the reaction should take. The most widely available and widely used codes are PHREEQE (Parkhurst et al., 1980), EQ3/6 (Wolery, 1979), SOLMINEQ.88 (Kharaka et al., 1988), and MINTEQA2 (Allison et al., 1991). PHRQPITZ (Plummer et al., 1988) is a version of PHREEQE modified to include Pitzer's equations for calculations at high ionic strength (see Chapter 2); PHREEQC (Parkhurst, 1995) is an updated version of PHREEQE that includes inverse modeling analogous to NETPATH (see Chapter 12 and later in this chapter). Each of these codes was developed for a slightly different purpose, which

gives them advantages and disadvantages for particular applications. PHREEQE is a relatively versatile code that can model many different types of reaction at a fixed temperature. However, the database supplied is fairly limited, particularly for trace elements, so the user may have to enter all the information for particular elements/reactions him/herself. It is not a particularly easy code for a beginner to use. MINTEQA2 is in a sense the reverse: it has an extensive database and is quite "user friendly," but the range of calculations it can perform is more limited. EQ3/6 is a large, complex, and versatile program, currently geared towards simulations associated with radioactive waste disposal. It can simulate reactions with changing temperature as well as reactions at a fixed temperature. SOLMINEQ.88 was designed particularly to simulate processes associated with petroleum basins, which implies moderately elevated temperatures and the presence of several organic species.

As an example of a reaction path calculation, let us consider the case of a mineral reacting with water. The general approach is:

1. A small increment of the mineral is dissolved.
2. A speciation-saturation program (Chapter 2) tests if the solution is supersaturated with respect to any solid phase. (The speciation–saturation program is part of the mass-transfer code. Thus each of these codes can be used for speciation–saturation calculations.)
3. If the solution is supersaturated with respect to any phase (or to specific phases specified by the user), an amount of that phase is precipitated sufficient to bring the solution into equilibrium with that phase. If the solution becomes undersaturated with respect to a previously precipitated phase, that phase redissolves to establish equilibrium.
4. An iteration procedure ensures that the solution is in equilibrium with all solid reaction products before another increment of the original mineral is dissolved.

The procedure for simulating evaporation is the same, except that increments of water are removed instead of increments of mineral being added. The calculated composition of a solution reacting with K-feldspar is shown in Figs. 16-10 and 16-11.

Although mass-transfer programs in the strict sense calculate only the path that the solution composition will follow and do not contain any rate expressions to relate reaction progress to time, it is possible to combine a mass-transfer model with a kinetic model to predict solution composition as a function of time. Examples include KINDIS (Madé et al., 1990) and PHREEQM (Appelo and Postma, 1993). There is some question as to whether our understanding of kinetics at low temperatures is sufficient for this approach to be realistic.

Example 4

A mining company proposes to dig a pit, which will be left to form a lake at the end of mining operations. The composition of the groundwater that will flow into the pit is shown in Table 16-2. The bedrock is altered granite containing calcite as the only reactive mineral. Use MINTEQA2 to predict the composition of the final lake.

In order to solve this problem, we need to make some simplifying assumptions. Some of these are:

1. A chemical equilibrium model is a suitable approximation.
2. The final lake will be in equilibrium with atmospheric oxygen and CO_2.

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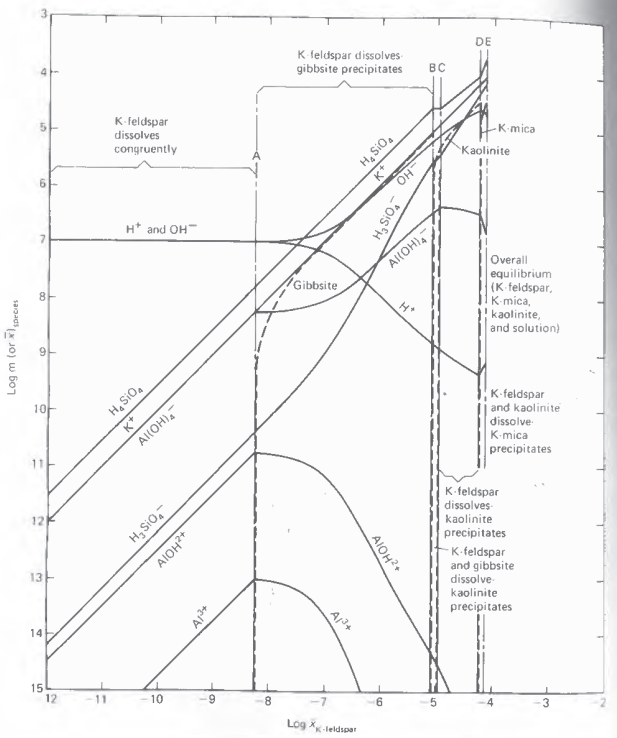
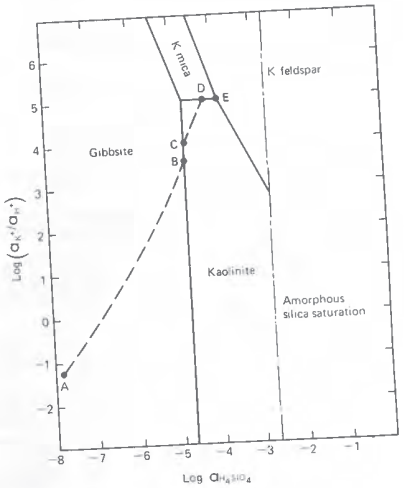


FIGURE 16-10 Concentration (m) of species in the aqueous phase (solid lines) and amounts (mol/kg H_2O) of minerals produced and destroyed (dashed lines) as K-feldspar reacts with water at 25°C and 1 atm pressure. The abscissa represents the number of moles of K-feldspar destroyed per kg H_2O. The letters correspond to the points on the reaction path shown in Fig. 16-11 (Helgeson et al., 1969).

3. Reactions involving silicates can be ignored. The justification for this assumption is that the groundwater has been in contact with the silicate minerals surrounding the pit for a long time and should be close to equilibrium or at least steady state.
4. Our time span and flow rate are such that evaporation and dilution by rainfall can be neglected. In reality these would be incorporated into the model. They are omitted here for the sake of simplicity.

FIGURE 16-11 Path of solution composition (ABCDE) as K-feldspar reacts with water, plotted on a mineral stability diagram (after Helgeson et al., 1969).



The first step is to use MINTEQA2 as a speciation-saturation program only, with the water of Table 16-2 as the input. This has two purposes: (1) To see which phases are supersaturated and hence are likely to precipitate, and (2) To convert the alkalinity input into total concentration of carbonate species and concentration of the component H^+. MINTEQA2 requires the input to be in this form for further calculations. At this stage we also have to decide on an oxidation state for the Fe in the analysis. We can either input it as Fe^{2+} (which is probably the actual form), or we can input it as the oxidized species, Fe^{3+}, with the justification that the final water will be in equilibrium with atmospheric oxygen. If iron is input as Fe^{3+}, MINTEQA2 does not have to perform any redox calculations, as all the inputs are in their oxidized form. There are often advantages to minimizing the number of different reactions that the reaction path code has to consider simultaneously. The concentration of Fe is sufficiently low that the choice of oxidation state does not affect the cation–anion balance significantly. Part of the output from this first run is shown in Table 16-3.

TABLE 16-2 Composition of Inflow Water for Example 4

Na	64.2	ppm	As	0.05	ppm
K	17	ppm	Cu	0.014	ppm
Ca	151.4	ppm	Zn	1.1	ppm
Mg	54.6	ppm			
Cl	23.8	ppm	pH	7.51	
SO_4	104	ppm			
Alkalinity	12.54	meq/l	T	20°C	

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We can see from Table 16-3 that the water is supersaturated with respect to various phases, including calcite, dolomite, magnesite, and a range of compounds containing ferric iron (ferrihydrite, goethite, hematite, jarosite, etc.) the high saturation indices for these phases is a consequence of our decision to specify the total Fe as Fe^{3+}. The next step is to choose which phases will precipitate. We shall choose ferrihydrite as the iron compound, as it is the phase most likely to precipitate. We shall also choose calcite as a phase likely to precipitate in a natural system, but we shall not allow dolomite (or other Mg-carbonate phases) to precipitate because the kinetics of precipitation of these phases are generally slow (Chapter 3). Note that no phases containing the trace elements Cu, Zn, or As are supersaturated.

With these choices, we can now perform a second MINTEQA2 run in which we:

1. Do not specify the input pH, instead allowing MINTEQA2 to calculate the pH.
2. Specify equilibrium with a CO_2 gas phase at a pressure of 3.16×10^{-4} atm (atmospheric CO_2 pressure). We could also list O_2 at a fixed pressure of 0.2 atm, but this is unnecessary if our input does not contain any reduced species.
3. Specify calcite and ferrihydrite as *possible solids*. A possible solid is one that is allowed to precipitate if the solution is supersaturated with respect to it. Phases that are not listed in this way (or in an analogous way) will not be considered in the calculations.

Part of the output from this run is shown in Table 16-4. The solution is in equilibrium with calcite and ferrihydrite, and has a final pH of 8.88. This output would constitute our prediction for the major ions in solution. Note that the solution is still supersaturated with respect to ferric (hydr)oxides more stable than ferrihydrite (Chapter 7), and with respect to Mg-containing carbonates. 99.9 percent of the iron has been precipitated as ferrihydrite, and 98.6 percent of the calcium as calcite. The presence or absence of calcite in the bedrock would make no difference to the calculation, as calcite is precipitating and not dissolving. The main reason why so much calcite precipitated is the drop in P_{CO_2} from a value of $10^{-1.7}$ in the inflow water to $10^{-3.5}$ in the equilibrated pit lake.

So far, the only process we have considered is precipitation of supersaturated phases. Adsorption is also likely to be a significant control on trace element concentrations, particularly As, Cu, and Zn in our example (Table 16-2). As discussed in Chapter 5, adsorption can also be modeled by use of MINTEQA2. This calculation is performed after the major element chemistry has been calculated. It is necessary to specify the amount and properties of the adsorption substrate, which requires further assumptions. The details of these calculations are not presented here. A reasonable set of assumptions would be that ferrihydrite is the adsorbing phase, the amount present is equal to the amount precipitated in the previous modeling step, and its properties are the same as those of ferrihydrite used in laboratory experiments by Dzombak and Morel (1990). The Dzombak and Morel numbers are supplied as a data file with MINTEQA2. Calculations based on these assumptions indicate that adsorption should greatly reduce the concentrations of arsenic, copper, and zinc.

Application to Contaminant Transport in Groundwater

It has become recognized in recent years that human activities are introducing contaminants into groundwater systems on an enormous scale. Examples include leaching from municipal landfills, hazardous waste burial sites, mine tailings, and various spills, both deliberate and accidental. Agriculture itself often causes contamination of groundwater by fertilizers (notably nitrate) and pesticides. A great deal of effort is currently being put into modeling the

TABLE 16-4 Output from the MINTEQA2 Equilibration Calculation for Example 4 (The output file has been greatly condensed.)

```
_____ PART 1 of OUTPUT FILE _____
Example 4: Equilibration with atmosphere and solid phases

-----------------------------------------------------------------------
Temperature (Celsius):  20.00
Units of concentration: MG/L
Ionic strength to be computed.
If specified, carbonate concentration represents total inorganic carbon.
Do not automatically terminate if charge imbalance exceeds 30%
Precipitation is allowed only for those solids specified as ALLOWED
  in the input file (if any).
The maximum number of iterations is:  40
The method used to compute activity coefficients is: Davies equation
Intermediate output file
-----------------------------------------------------------------------

INPUT DATA BEFORE TYPE MODIFICATIONS
  ID      NAME        ACTIVITY GUESS    LOG GUESS   ANAL TOTAL
 330   H+1            1.000E-07          -7.000     1.370E+01
  61   H3AsO4         3.548E-07          -6.450     5.000E-02
 150   Ca+2           3.802E-03          -2.420     1.514E+02
 180   Cl-1           6.761E-04          -3.170     2.380E+01
 231   Cu+2           2.188E-07          -6.660     1.400E-02
 281   Fe+3           2.291E-05          -4.640     1.270E+00
 460   Mg+2           2.239E-03          -2.650     5.460E+01
 410   K+1            4.365E-04          -3.360     1.700E+01
 500   Na+1           2.818E-03          -2.550     6.420E+01
 732   SO4-2          1.072E-03          -2.970     1.040E+02
 950   Zn+2           1.698E-05          -4.770     1.100E+00
 140   CO3-2          9.333E-05          -4.030     7.859E+02
   2   H2O            1.000E+00           .000      0.000E-01

  Charge Balance: UNSPECIATED
    Sum of CATIONS=  2.900E-02 Sum of ANIONS =  2.906E-02
    PERCENT DIFFERENCE =  1.065E-01  (ANIONS - CATIONS)/(ANIONS + CATIONS)

Type V - POSSIBLE SOLIDS
  ID      NAME        CALC MOL     LOG MOL   NEW LOGK     DH
5015001  CALCITE      1.937E+02     2.287      8.446     2.585
2028100  FERRIHYDRITE 6.817E+02     2.834     -4.891      .000

_____ PART 5 of OUTPUT FILE _____

-------EQUILIBRATED MASS DISTRIBUTION-------
                    DISSOLVED              SORBED              PRECIPITATED
IDX   NAME       MOL/KG     PERCENT    MOL/KG     PERCENT   MOL/KG     PER-
CENT
330   H+1        4.365E-03   100.0     0.000E-01     .0     0.000E-01     .0
 61   H3AsO4     3.527E-07   100.0     0.000E-01     .0     0.000E-01     .0
950   Zn+2       1.685E-05   100.0     0.000E-01     .0     0.000E-01     .0
180   Cl-1       6.721E-04   100.0     0.000E-01     .0     0.000E-01     .0
231   Cu+2       2.206E-07   100.0     0.000E-01     .0     0.000E-01     .0
732   SO4-2      1.084E-03   100.0     0.000E-01     .0     0.000E-01     .0
460   Mg+2       2.248E-03   100.0     0.000E-01     .0     0.000E-01     .0
```

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```
410  K+1            4.353E-04   100.0   0.000E-01      .0   0.000E-01      .0
500  Na+1           2.796E-03   100.0   0.000E-01      .0   0.000E-01      .0
281  Fe+3           1.853E-08      .1   0.000E-01      .0   2.275E-05    99.9
150  Ca+2           5.213E-05     1.4   0.000E-01      .0   3.730E-03    98.6
140  CO3-2          4.727E-03    55.9   0.000E-01      .0   3.730E-03    44.1
  2  H2O            9.297E-06   100.0   0.000E-01      .0   0.000E-01      .0

     Charge Balance: SPECIATED
       Sum of CATIONS =  7.178E-03 Sum of ANIONS   7.239E-03
       PERCENT DIFFERENCE =  4.291E-01  (ANIONS - CATIONS)/(ANIONS + CATIONS)
     EQUILIBRIUM IONIC STRENGTH (m) =   1.029E-02
     EQUILIBRIUM pH                 =   8.879
```

```
_____PART 6 of OUTPUT FILE _____
Saturation indices and stoichiometry of all minerals
    ID #     NAME       Sat. Index        Stoichiometry in [brackets]
 5015000 ARAGONITE         -.154    [  1.000] 150  [  1.000] 140
 5015001 CALCITE            .000    [  1.000] 150  [  1.000] 140
 5015002 DOLOMITE          1.654    [  1.000] 150  [  1.000] 460  [  2.000] 140
 2028100 FERRIHYDRITE      0.000    [ -3.000] 330  [  1.000] 281  [  3.000]   2
 2028102 GOETHITE          4.210    [ -3.000] 330  [  1.000] 281  [  2.000]   2
 6015001 GYPSUM           -2.897    [  1.000] 150  [  1.000] 732  [  2.000]   2
 3028100 HEMATITE         13.405    [ -6.000] 330  [  2.000] 281  [  3.000]   2
 5015003 HUNTITE            .812    [  3.000] 460  [  1.000] 150  [  4.000] 140
 6041002 JAROSITE K       -7.386    [ -6.000] 330  [  1.000] 410  [  3.000] 281
                                    [  2.000] 732  [  6.000]   2
 3028101 MAGHEMITE         3.397    [ -6.000] 330  [  2.000] 281  [  3.000]   2
 5046002 MAGNESITE         1.156    [  1.000] 460  [  1.000] 140
 2023101 TENORITE          -.815    [ -2.000] 330  [  1.000] 231  [  1.000]   2
 5095000 SMITHSONITE       -.861    [  1.000] 950  [  1.000] 140
 5095001 ZNCO3, 1H2O       -.546    [  1.000] 950  [  1.000] 140  [  1.000]   2
 2095005 ZNO(ACTIVE)       -.449    [ -2.000] 330  [  1.000] 950  [  1.000]   2
 2095006 ZINCITE           -.552    [ -2.000] 330  [  1.000] 950  [  1.000]   2
 5023101 MALACHITE        -2.691    [  2.000] 231  [  2.000]   2  [  1.000] 140
                                    [ -2.000] 330
 3028102 LEPIDOCROCIT      3.520    [ -3.000] 330  [  1.000] 281  [  2.000]   2
```

behavior of contaminants in the subsurface, both for predicting the fate of and designing remediation strategies for existing contaminants and for designing and locating disposal sites for future waste, particularly high-level radioactive waste.

Before any detailed geochemical modeling can be attempted, the hydrology of the area in question, particularly groundwater flow paths and velocities, must be established. This is by no means a trivial requirement; the information required for an adequate hydrologic model may be greater than that required for a chemical model, and the mathematical formulation of the hydrologic model may be extremely complex.

For modeling purposes, it is often convenient to divide the region to be studied into a source, a mixing zone (*near field,* in the terminology of radioactive waste disposal), and a relatively undisturbed aquifer or aquifers (*far field*). This is illustrated conceptually in Fig. 16-12 for a mill tailings pile. A real example of modeling applied to a uranium mill tailings pile is given by White et al. (1984) and Narasimhan et al. (1986). The source is the downward movement of solutions from the tailings pile. These solutions are oxygenated and highly acidic from the processing used in the mill and contain high concentrations of iron and several trace elements such as uranium, molybdenum, and selenium.

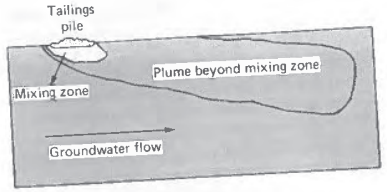

FIGURE 16-12 Schematic illustration of migration of contaminants from a uranium mill tailings pile.

Groundwaters are typically mildly alkaline and may be oxidizing or reducing. When the acid tailings solution enters the aquifer, it reacts chemically with the groundwater and with the minerals of the aquifer. Calcite dissolves, gypsum may precipitate, and iron and aluminum hydroxides precipitate, coprecipitating trace metals with them. Chemical reactions such as these can be modeled successfully by a program such as PHREEQE, MINTEQ, or EQ3/6. The mixing zone, where the major chemical reactions take place, is commonly a relatively small volume, and the hydrology of such a small volume can be modeled in a relatively simple way.

Beyond the mixing zone, the groundwater is more or less in equilibrium with the minerals of the aquifer. Dissolution and precipitation are no longer major processes, and modeling focuses on hydrology/water movement plus hydrodynamic dispersion and on relatively simple chemical processes such as adsorption, radioactive decay, and, for some organic compounds, biodegradation.

An additional problem with modeling of contaminant transport is the question of how to treat uncertainty. One can never know with certainty the porosity, permeability, and dispersivity, for example, at all points in an aquifer. One can make estimates for the regions in which data are missing and, using them, calculate, for example, a travel time for a particular solute between two locations. For problems such as disposal of high-level radioactive waste, it is important to know the uncertainty associated with the travel time as well as the "best estimate." Increasingly, *stochastic modeling* is being used to assess uncertainty. Instead of single values being assigned to the properties of each location in the aquifer, a statistical distribution of properties is assigned, and the model generates a statistical distribution of travel times or whatever other output is required.

CHEMICAL EVOLUTION OF GROUNDWATER

The reaction path modeling discussed above has been "forward" modeling in that we posed the problem in the form: "Suppose we have water A and allow it to react with minerals B and C, what will be the final composition of the water?" For understanding the chemical composition of groundwater, we are generally presented by the "inverse" problem (Plummer, 1992): we know the composition of the final water, the problem is to deduce the reactions that gave rise to it. One approach is simply to solve the forward problem repeatedly, changing the identity and amount of the minerals reacting until a "match" is achieved. Alternatively, one can use the code NETPATH (Plummer et al., 1991) or PHREEQC (Parkhurst, 1995) to solve the inverse problem directly. The use of NETPATH to solve a mass balance problem was discussed in Chapter 12. The input is an initial water composition, a final water composition, and

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a list of phases that may dissolve, precipitate, or both. The output is a list of all the possible reactions involving the listed minerals that satisfy the mass balance constraints. NETPATH also considers isotopic balance for ^{13}C, ^{14}C, ^{34}S, D, T, ^{18}O and ^{87}Sr, and includes WATEQ4F as a subroutine to test whether the reactions deduced from mass balance are chemically reasonable. It would not be reasonable, for example, to postulate that gypsum precipitates from a solution that is undersaturated with respect to gypsum.

An excellent example of this type of modeling is the study by Plummer et al. (1990) of the chemical evolution of groundwater in the Madison aquifer as it moves several hundred km eastward from recharge areas in Montana and Wyoming. The chemical evolution of the water was consistent with dissolution of gypsum and dolomite, precipitation of calcite, and oxidation of organic matter. That set of reactions explained not only the major element chemistry, but also the isotopes of carbon and sulfur.

A major problem with NETPATH-type modeling, particularly of silicate weathering reactions, is that solutions are rarely unique. Several different sets of minerals can usually be found that satisfy the constraints. Also, depending on the number of solid phases chosen, there may be no solution or an indeterminately large number of solutions. The code is thus a tool to be used in conjunction with geologic insight and judgment: it does not provide simple, unique answers. The inclusion of isotopes may greatly constrain the number of possible answers, provided sufficient isotopic data are available.

REVIEW QUESTIONS

1. Suppose you had a 1 mm wide fracture in an igneous rock, and the concentration of a contaminant in the fracture were kept at a constant value (say by rapid flushing). How long would it take for a mass of contaminant equal to the mass present in the fracture at any instant to diffuse into the rock matrix? Assume a porosity for the matrix of 0.01 and an effective diffusion coefficient of $1 \times 10^{-7} cm^2 s^{-1}$.
2. Suppose you assume instead (Problem 1) that the fluid in the fracture were not moving. Estimate how long it would take for half the material in the fracture to diffuse into the rock matrix. How long would it take if the fracture width were 0.1 mm?

   Note: The analytical solution to this problem is by no means simple. You could (a) make an educated guess based on example 1 above; (b) construct a simple numerical model; or (c) (if you have the background) construct a finite difference model.
3. The following analyses (from Plummer et al., 1990) represent two wells from the Madison aquifer in Montana that lie approximately along a flowline. The aquifer contains limestone, dolomite, and occasional evaporites. Use NETPATH to come up with a set (or more than one set) of reactions that could account for the difference. Do you think the reactions are plausible?

	T(°C)	*pH*	*Ca*	*Mg*	*Na*	*K*	*Cl*	SO_4	ΣCO_2
Well 1	11	7.58	1.87	1.15	0.10	0.02	0.05	1.46	3.31
Well 2	32	7.08	6.50	3.96	3.44	0.31	1.89	10.32	3.72

4. In Example 4 above, suppose the pit lake were to stratify, forming an anoxic hypolimnion (Chapter 8). Predict the chemical composition of the anoxic waters. Make your assumptions clear, and discuss how reasonable these assumptions are.

SUGGESTED READING

ALABARÈDE, F. (1995). *Introduction to Geochemical Modeling.* Cambridge, England: Cambridge University Press.

ANDERSON, M. P. (1979). Using models to simulate the movement of contaminants through groundwater flow systems. *CREC Critical Reviews in Environmental Control* (pp. 97–156). Boca Raton, FL: CREC Press.

ANDERSON, M. P., and W. W. WOESSNER. (1992). *Applied Groundwater Modeling: Simulation of Flow and Advective Transport.* San Diego, CA: Academic Press, Inc.

APPELO, C. A. J., and D. POSTMA. (1993). *Geochemistry, Groundwater, and Pollution.* Rotterdam, Germany: Balkema.

FETTER, C. W. (1994). *Applied Hydrogeology,* (3rd ed.). New York: Macmillan.

FREEZE, R. A., and J. A. CHERRY. (1979). *Groundwater.* Englewood Cliffs, NJ: Prentice-Hall. Chapters 7 (Chemical Evolution of Natural Groundwater) and 9 (Groundwater Contamination).

LICHTNER, P. C.; C. I. STEEFEL; and E. H. OELKERS, (Eds.) (1996). Reactive transport in porous media. *Reviews in Mineralogy,* (v. 34). Washington, DC: Mineralogical Society of America.

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Document 2

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Predicting Hydrology of Fractured Rock Masses from Geology

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Fracture network connectivity often dominates movement rate, flow volume, and mass transport through rock masses. These networks influence the effectiveness of petroleum reservoir development, safe disposal of nuclear waste, delineation of water supply or establishment of well-head protection plans, recovery from geothermal reservoirs, solution mining, construction of underground openings, and the remediation of contaminated rock. Well tests can provide a great deal of useful information on the hydraulic properties of fracture systems, but they are often expensive or logistically infeasible. These tests also may not provide an accurate description of the hydrologic properties of the rock volume under consideration. Methods to model fractured rock can be improved by quantifying the relation between geologic parameters and the hydrologically conductive fractures. This study illustrates the application of four statistical and pattern recognition methods—evaluation of correlation coefficients, contingency table analysis, multivariate regression, and neural net analysis. The data for the study consist of borehole and well-test information from eight boreholes used for characterizing a proposed low-level radioactive waste repository in Wake County, North Carolina. The analyses show that high localized flow rates are related to the presence of increased fracture intensity, and that this intensity is controlled by a complex interplay of structural geology and lithology. Some of the initial hypotheses concerning the relation of geology to hydrology were not substantiated by the data, leading to a refined conceptual model that differed in significant ways from the initial model. Although the techniques used are of general applicability, the precise nature of the correlation between geology and hydrology is site dependent.

1. INTRODUCTION

1.1 Overview

Fractures are geologic features that form networks capable of transporting fluids through rock over long distances. The rate of movement, the volume of flow, the amount of mass transport through the system interconnected fractures affect petroleum reser development, safe disposal of nuclear waste, delineatio water supply or establishment of well-head protec plans, recovery from geothermal reservoirs, the efficie of solution mining, the construction of undergro openings, and the remediation of contaminated rock.

It is common for engineers and hydrologists to emp hydrologic testing to directly characterize fracture netw flow parameters. However, well tests are often expen

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or logistically infeasible. For example, the number and spatial reach of wells drilled from an offshore oil platform are very much restricted. This may cause direct hydrologic test results to be very sparse for the volume of rock under consideration. It also presents a problem because hydrologic heterogeneity is often quite significant, so that and, therefore, a few tests may not provide an accurate description of the hydrologic properties of the large volume of rock under consideration. Such a situation makes it necessary to infer parameters from the well or boreholes to a much larger volume of rock.

There are two broad approaches to modeling flow and transport in fractured rock [*National Research Council,* 1996]: the Discrete Fracture Network (DFN) approach and the Stochastic Continuum (SC) approach. Both methods have advantages and disadvantages.

DFN models require the specification of the geometry, location, and hydraulic properties of the fractures that play a significant role in the rock permeability.

SC models need permeability and porosity values that reflect the local matrix and fracture systems' effective properties at the scale and shape of the numerical grid. SC models incorporate geology to delineate large-scale statistically homogeneous regions, often referred to as *domains* or *zones*. Parameter values within these domains can be assigned according to statistical distributions or conditioned to geologic parameters. Often, the relation between mappable geology and values of effective permeability is not well understood. Parameter assignment within each domain is carried out using a spatial statistical model or an inversion that matches known well test results, but is constrained elsewhere to statistical parameters only [*Zimmerman et al., 1998*]. Better geologic conditioning of the parameter values within zones and better definition of zones can greatly improve model accuracy [*La Pointe et al.,* 1996; *National Research Council,* 1996].

Over the past decade, DFN models [*Hudson and La Pointe,* 1980; *Long et al.,* 1982; *Dershowitz,* 1984; *Endo et al., 1984; Robinson,* 1984; *Smith and Schwartz, 1984*] have evolved to successfully address problems of regional fracture network connectivity [*Cacas et al.,* 1990a,b; *Dershowitz et al.,* 1992; *Swaby and Rawnsley,* 1996]. The models represent fractures as polygons with flow and transport properties. However, the specification of these models relies upon accurately describing the geologic context of the subset of fractures that contribute to large-scale flow. This subset of fractures constitutes the network of *conductive* fractures. As detailed surveys of wellbores prove, only a portion, often less than 10% [*National Research Council,* 1996] play a role in flow at the scale of contaminant dispersal, energy production, or containment of nuclear waste. It is the intensity, geometry, and fluid-flow properties of this conductive subset that control the important behavior of fracture-dominated flow systems.

Thus, better understanding of the geologic habitat of conductive fractures could lead to improved DFN modeling, as well as a better understanding of why some fractures play a significant role in regional flow, while others play a limited, or insignificant role.

The attractiveness of geologically conditioning DFN or SC models rests on the presumption that hydrology relates to geology. By understanding the geologic characteristics that are associated with hydrologic variability, it is possible to describe the conductive fracture network or assign values of permeability (or other properties) at unsampled locations based upon the geologic characteristics.

The geologic approach is very appealing, since it is much more flexible in handling hydrologic variability as a result of variability in underlying geology than any zonal statistical model. This is because the geologic approach need not conform to overly simplistic statistical models. Moreover, a demonstrated connection between mappable geology and flow modeling is important in many licensing applications for proposed waste repositories or other facilities. Another advantage is that the geology is often known with reasonably high accuracy and resolution throughout the site.

However, the attempt to relate flow in fractured rock masses to underlying geology has proven challenging, particularly in fracture-dominated flow systems. Fracture network connectivity often controls flow and transport. This means that local geologic conditions might be affected by the properties of individual fractures and may not correlate to the larger-scale fracture network connectivity.

The current study attempts to understand the geologic habitat of fractures that play an important role in regional flow and mass transport. The focus of the study is a preliminary site investigation of a proposed low-level nuclear waste repository in Wake County, North Carolina. Licensing of the site requires modeling of possible movement of radionuclides through the rock and soil.

The goal of this work was to investigate the interrelation of hydrologic behavior and geologic characteristics by using multivariate analysis or other techniques, as appropriate, to help prepare the initial site conceptual model and support the development of the preliminary groundwater flow simulations. The identification of key geologic parameters was also important. These parameters needed to be measured in a manner sufficient for subsequent hydrologic modeling and so as to identify how data collection protocols might be altered in order to obtain the necessary data.

The problem of relating geology to hydrology is one of pattern recognition. Powerful and sophisticated tools to recognize patterns and correctly classify new data into proper groups are in common use in many disciplines. These tools differ in mathematical assumptions and outcomes, but all share the ability to classify data into categories. Section 1.4 below describes the methodology employed in this study in greater detail.

1.2 Data

A thorough data set was obtained for this study from geochemical surveys, hydrophysical logging, packer tests, and geologic logging. The data came from a series of eight wells, aligned from west to east. The line formed by these wells transects a prominent fault north-striking a normal fault (Figure 1). Wells W206 through W208 lie to the east of the fault in the footwall of the normal fault. Wells W201 through W205 lie in the hanging wall. As shown in Figure 1, well W205 cuts through the fault plane. Each of these boreholes was carefully logged to record both the lithologic characteristics and the attributes of any fractures present. Subsequently, the core and the borehole imagery was interpreted to create a data set in which fractures were identified, and their measured depths, orientations, apertures, and types recorded. Lithologic information was also recorded. This included grain-size classification, ranging from conglomerate to claystone, as well as the orientation and measured depth of contacts separating strata of contrasting lithology.

Hydrophysical anomalies were identified as part of the testing and logging program carried out in the eight wells. Such anomalies were determined as follows. First, a borehole was filled with deionized water and a logging tool to measure electrical conductivity is placed in the borehole. Next, the nonconductive deionized water was slowly pumped out, which allowed the conductive groundwater to flow through fractures or other permeable pathways into the borehole and be sensed by the logging tool. Continuous recording of the conductivity made it possible to identify locations and rate of groundwater flow into the borehole. The term "strength," as used in this study, refers to the magnitude of the conductivity change between the nonconductive, deionized water and the inflowing groundwater. The magnitude of the anomaly is a function of flow rate, and is used as a surrogate for fracture transmissivity or local wellbore permeability. The tool used in this study has a 1 ft (0.3 m) resolution. Together with image logs, it is possible to relate hydrophysical anomalies to fractures or other geologic features within the 1 ft intervals. Figure 2 summarizes the interpreted lithology, and shows the location and geometric aperture of detected fractures, as well as the location and magnitude of flow for hydrophysical anomalies. Figure 3 and Table 1 show the directly measured and derived geologic parameters used in this study. Parameters related to the four nearest fractures were included to account for the 1 ft resolution of the hydrophysical logs, and for any small misregistration among the hydrophysical logs, the borehole imagery, and the core.

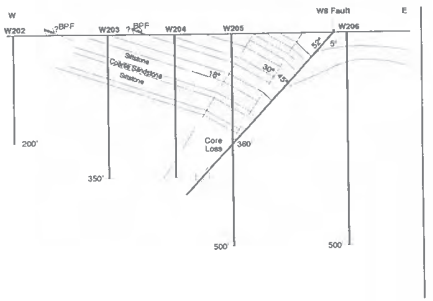

Figure 1. Geologic cross section along trench GM-1. Trench is oriented along an east-west axis. The normal fault, denoted as W8, strikes approximately north-south.

1.3 Initial Hypotheses

A preliminary focus of efforts at the Wake County site was to clarify the role of jointing and faulting in the site-scale hydrology. It was thought that fracture intensity at the site might be related to depth, weathering, structural deformation, and structural position. Thus, the study focused on evaluating some initial hypotheses concerning the relations between site geology and conductive flow features. These hypotheses are:

1. Hydrophysical anomalies are caused by fracture flow.
2. Fracture intensity is greater in the hanging-wall deformation zone.
3. Proximity to contacts between strongly contrasting lithological units leads to an increase in fracturing.
4. Fracture intensity relates to lithology.
5. Fracture intensity changes with depth/elevation because of weathering or lithostatic effects.
6. None of the above.

1.4 Methodology

A number of statistical and pattern-recognition techniques were applied to the data in order to investigate possible relations between geologic parameters and fracture flow. These studies were designed not only to test existing hypotheses, but also to uncover other unsuspected relations between geologic parameters and the

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Table 1. Directly measured and derived geologic parameters.

Directly Measured Parameters	Symbol	Dimensions
Fracture Parameters		
Measured depth to fracture	MDF	Feet
Fracture dip and dip direction	DIP,DPDIR	Degrees
Fracture type: Shear or bedding	TYPE	
Fracture Aperture	AP	Inches
Lithologic Parameters		
Lithologic classification, based on grain size, gradated from 1 to 9 (1 being coarsest; 9 being finest): Conglomerate (Cnglom) = 1 Very coarse sandstone (VCrsSS) = 2 Coarse sandstone (CrsSS) = 3 Medium sandstone (MedSS)= 4 Fine sandstone (FineSS)= 5 Very fine sandstone (VFineSS)= 6 Siltstone (SiltS) = 7 Mudstone (MudStone) = 8 Claystone (Claystone) = 9	LITH	Grain size
Measured depth to contact between lithologic units	MDCON	Feet
Orientation of contact between lithologic units	CONDIP, CONDPDIR	Degrees
Layer (lithologic unit) thickness , distance measured vertically	UTHICK	Feet
Dip of contact above anomaly	DIP_A	Degrees
Dip of contact below anomaly	DIP_B	Degrees

hydrophysical anomalies. The following statistical techniques were used:

1. Evaluation of correlation coefficients among all parameters.
2. Contingency table analysis.
3. Multivariate regression.
4. Neural net analysis.

Correlation coefficients are very useful in examining the first-order relations between continuous variables such as the strength of the hydrophysical anomaly and its proximity to the boundary of a contrasting lithologic unit, or between the depth of a fracture and its aperture. These coefficients are also important in gaining an understanding of which variables may be redundant. Identifying redundant variables is important when data are sparse. When there are more variables—degrees of freedom—than hydrophysical anomalies, it is possible to predict the anomalies with a good degree of accuracy without actually determining any significant relations among the parameters.

Two-way contingency table analysis is a method for looking at the correlation among class or ordinal variables. It is also useful for examining relations between a parameter-like lithologic unit and a hydrophysical anomaly.

Contingency table analysis and correlation coefficients examine relations between pairs of variables. Multiple regression takes into account the combined relations among many variables. Multiple regression assumes that the dependent variable is a linear combination of independent (uncorrelated) variables.

Neural nets are the most complex of the methods used to investigate the relations among dependent variables and hydrophysical anomalies. This approach does not assume a simple or hypothesized model among the variables, nor does it require linear independence. Unlike multiple regression, it can also include class or ordinal variables such as lithologic type. Since the variable of interest, i.e., the hydrophysical anomaly flux rate, is a continuous variable, a Generalized Regression Neural Network

Table 1(continued).

Derived Parameters		
Distance from hydrophysical anomaly to four nearest fractures	D1, D2, D3, D4	Feet
Apertures of four fractures nearest to a hydrophysical anomaly	W1, W2, W3, W4	Inches
Lithology of four nearest fractures (ranging from conglomerate to mudstone, 1 to 8)	L1, L2, L3, L4	Grain size
Depth of four nearest fractures	MD1, MD2, MD3, MD4	Feet
Lithology contrast between layer containing hydrophysical anomaly lithology and layer above; grain-size class of layer above used for computation	LCA	Dimensionless
Lithology contrast between layer containing hydrophysical anomaly lithology and layer below; grain-size class of layer above below for computation	LCB	Dimensionless
Absolute contrast above; computed as ABS(LCA)	ALCA	Dimensionless
Absolute contrast below; computed as ABS(LCB)	ALCB	Dimensionless
Total contrast between lithological unit containing anomaly and units above and below; computed as LCA+LCB	TC	Dimensionless
Total absolute contrast between lithological unit containing anomaly and units above and below; computed as ALCA+ALCB	ATC	Dimensionless
Distance from anomaly to nearest upper contact; computed as distance perpendicular to contact interface	CDA	Feet
Distance from anomaly to nearest lower contact; computed as distance perpendicular to contact interface	CDB	Feet
Minimum distance to contact; computed as MIN(CDA, CDB	CMIN	Feet
Grain size contrast with nearest unit	C_NEAR	Dimensionless
Apparent distance to upper contact	APCDA	Feet
Apparent distance to upper contact	TDIST_MIN	Feet
Apparent distance to lower contact	APCDB	Feet
Angular difference between upper and lower contact; computed as DIP_B - DIP_A	UNCONF	Degrees
Absolute value of UNCONF	ABS(UNCF)	Degrees
Bed thickness	THICK	Feet

(GRNN), was employed. This type of network architecture has proven very useful for this type of application [*Ward*, 1996].

2. RESULTS

2.1 Correlation Coefficients

Table 2 shows the correlation coefficients for all of the independent variables with hydrophysical anomaly strength. This strength has been expressed in two ways: the arithmetic strength, which is the actual measured value, and the base-ten logarithm of the measured strength. The logarithmic transformation of a variable reduces the impact of extreme values, which may be outliers or spurious measurements.

Correlation coefficients vary between −1.0 (perfect anticorrelation) and +1.0 (perfect correlation). The statistically significant correlations at the 95% level in Table 2 are those in which the absolute value of the

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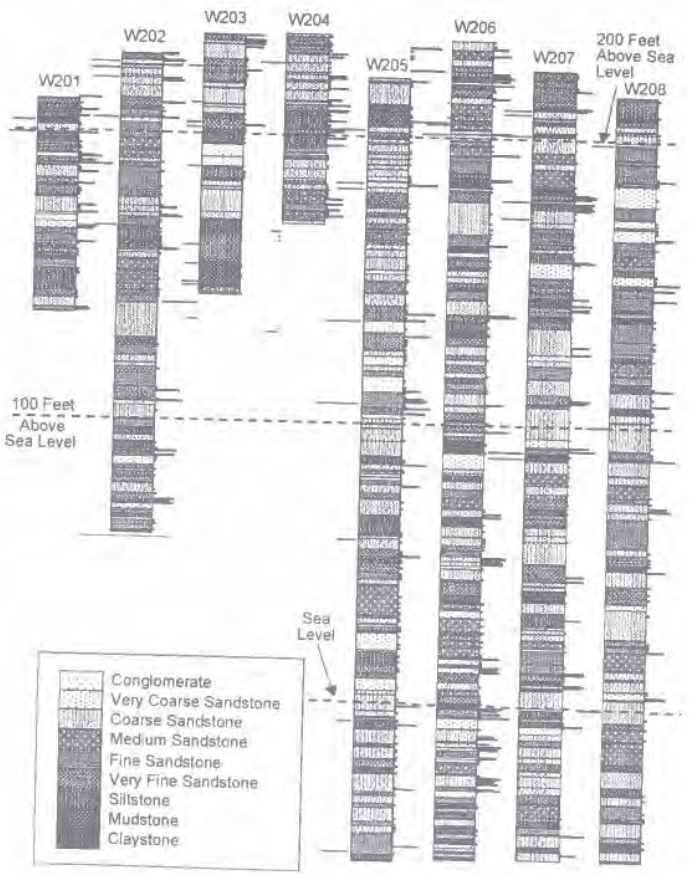

Figure 2. Summary of lithology, fractures, and hydrophysical anomalies. For each borehole, the location of hydrophysical anomalies and fractures are shown by horizontal lines. The length of the line to the left of the borehole is proportional to the logarithm of the hydrophysical anomaly magnitude, while the length of the line to the right of the borehole is proportional to the logarithm of the fracture aperture. In both cases the lines represent relative, not absolute lengths.

correlation coefficient is greater than or equal to 0.35.

This table shows that the anomaly strength and the log of the anomaly strength are positively correlated with the fracture width (aperture), the lithology of the unit in which the hydrophysical anomaly occurs, and the surrounding lithologic units, their contrast, and the dip of the contact between lithologic units. The positive correlation with lithology means that finer-grained lithological units have stronger anomalies. The positive correlation with the absolute total contrast (ATC) implies that stronger anomalies tend to be in lithologies, unlike the units immediately above and below. The correlation with contact dip may reflect structural disruption in the hanging wall of the fault, but other explanations may also be possible. The log of the anomaly strength is negatively correlated with the distance to the nearest fractures (in other words, the closer the fractures to the anomaly and the more there are of them, the stronger the anomaly).

Table 2. Correlation coefficients for flow anomaly and $\log_{10}$(anomaly) with geological parameters. Absolute values of the coefficient equal to 0.35 or greater are significant at the 95% level.

Variable	Anomaly	Log_{10}(anomaly)
W2	0.36	0.53
ALCA	0.31	0.48
ATC	0.20	0.47
W3	0.40	0.40
LITH	0.08	0.31
CONDIPB	0.47	0.27
CNEAR	−0.02	0.27
ALCB	0 00	0.23
W1	0.00	0.19
W4	0.03	0.18
LCB	0.15	0.16
LCA	0.25	0.15
LITHA	0.38	0.14
LITHB	−0 11	0.13
MDF	0.19	0.08
CONDIPA	0.23	0.01
APCDB	−0.01	0.00
CDB	−0.04	−0.02
CDA	0.17	−0.12
APCDA	0.19	−0.13
CMIN	0.08	−0.25
D1	−0.12	−0.34
D4	−0.15	−0.39
D3	−0.18	−0.40
D2	−0.18	−0.45

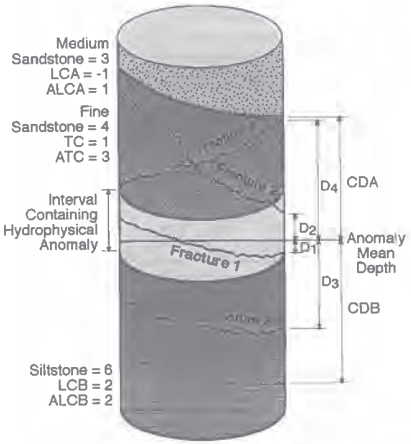

Figure 3. Derived parameters used in the statistical analyses Table 1 provides additional explanation of these and other parameters.

2.2 Contingency Tables

Contingency tables were computed for various combinations of variables. This type of analysis is useful for determining whether a variable of interest shows up with unusually high or low frequency in some other variable class. For example, do siltstones have an unusually high frequency of fractures or hydrophysical anomalies that is out of proportion to their stratigraphic percentage?

Tables 3, 4, and 5 provide overall lithology and fracture intensity data for the eight wells. Table 3 shows how lithology varies among the eight wells. This Table illustrates that fine-grained lithological layers, particularly siltstone, increase eastward from W201 to W205, where such layers reach upwards of 45% of the total amount. They decrease abruptly in the three wells to the east of W205.

Tables 4 and 5 summarize the fracture intensity by lithology and well. These tables show that fractures in the western wells (W201 through W203) tend to reside in the coarse sandstone, while in the wells nearer to the fault, the fractures tend to occur in the siltstones. However, the

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Table 3. Lithology statistics by well.

	Total Thickness (inches) of Lithological Layers Within Wells									
	Lithology									
Well No.	1 Cnglom	2 VCrsSS	3 CrsSS	4 MedSS	5 FineSS	6 VFineSS	7 SiltSt	8 MudStone	9 ClayStone	Total
W201		50.25	146.74	218.29	108.29	74.42	177.11	79.44		854.54
W202			188.71	432.06	420.76	209.13	550.51	147.26		1948.43
W203		72.8	175.94	351.29	9.41	34.18	354.3	88.82		1086.74
W204		4.43	117.38	107.36	63.42	74.03	326.4	29.17		722.19
W205	30.71	220.76	479.08	1388.54	590.14	299.59	3403.86	648.01	70.87	7131.56
W206	66.35	186.64	304.61	912.62	484.35	611.72	1286.1	349.94	46.55	4248.88
W207	266.82	194.12	349.49	814.3	434.02	546.04	1814.42	402.63		4821.84
W208	110.12	67.26	189.86	474.12	1822.33	759.82	1584.26	429	43.26	5480.03
Total	474	796.26	1951.81	4698.58	3932.72	2608.93	9496.96	2174.27	160.68	26294.21
	Percent of Thickness of Lithological Layers Within Wells									
	Cnglom	VCrsSS	CrsSS	MedSS	FineSS	VFineSS	SiltSt	MudStone	ClayStone	
W201		5.88	17.17	25.54	12.67	8.71	20.73	9.30		
W202			9.69	22.17	21.59	10.73	28.25	7.56		
W203		6.70	16.19	32.33	0.87	3.15	32.60	8.17		
W204		0.61	16.25	14.87	8.78	10.25	45.20	4.04		
W205	0.43	3.10	6.72	19.47	8.28	4.20	47.73	9.09	0.99	
W206	1.56	4.39	7.17	21.48	11.40	14.40	30.27	8.24	1.10	
W207	5.53	4.03	7.25	16.89	9.00	11.32	37.63	8.35		
W208	2.01	1.23	3.46	8.65	33.25	13.87	28.91	7.83	0.79	

greater number of fractures in siltstones near the faults may be due to a higher proportion of siltstone in these wells than in the western wells (Table 3), rather than a greater fracture intensity in siltstones near the faults.

Two series of questions have been formulated to specifically address fracture variability and hydrophysical anomalies among the wells. The first series of questions focuses on the fracturing itself. The correlation between hydrophysical anomaly strength and the number of fractures and their closeness to the anomaly indicates that

Table 4. Total number of fractures by lithology within wells, independent of aperture.

	Total No. of Fractures by Lithology within Wells									
	Lithology									
Well No.	1 Cnglom	2 VCrsSS	3 CrsSS	4 MedSS	5 FineSS	6 VFineSS	7 SiltSt	8 MudStone	9 ClayStone	Total
W201		7	6	32	5	3	16	16		85
W202			22	30	9	2	19	10		92
W203		1	4	36	0	1	10	1		53
W204		0	16	19	11	16	37	2		101
W205	3	36	57	124	60	22	203	82	5	592
W206	2	10	24	54	19	17	82	54	7	269
W207	13	13	27	66	34	14	55	41		263
W208	5	3	7	37	46	40	69	43	13	263
Total	23	70	163	398	184	115	491	249	25	1718
	Percent of Total Fractures by Lithology within Wells									
	Cnglom	VCrsSS	CrsSS	MedSS	FineSS	VFineSS	SiltSt	MudStone	ClayStone	
W201		8.24	7.06	37.65	5.88	3.53	18.82	18.82		
W202			23.91	32.61	9.78	2.17	20.65	10.87		
W203		1.89	7.55	67.92	0.00	1.89	18.87	1.89		
W204		0.00	15.84	18.81	10.89	15.84	36.63	1.98		
W205	0.51	6.08	9.63	20.95	10.14	3.72	34.29	13.85	0.84	
W206	0.74	3.72	8.92	20.07	7.06	6.32	30.48	20.07	2.60	
W207	4.94	4.94	10.27	25.10	12.93	5.32	20.91	15.59		
W208	1.90	1.14	2.66	14.07	17.49	15.21	26.24	16.35	4.94	

Table 5. Total number of fractures by lithology within wells for apertures > 0.03 in.

	Total No. of Fractures > 0.03 in. by Lithology within Wells									
	Lithology									
Well No.	1 Cnglom	2 VCrsSS	3 CrsSS	4 MedSS	5 FineSS	6 VFineSS	7 SiltSt	8 MudStone	9 ClayStone	Total
W201		2	2	4	2	0	2	6		18
W202			4	8	1	0	10	1		24
W203		0	0	5	0	0	4	0		9
W204		0	4	5	2	2	8	0		21
W205	0	3	3	9	6	1	27	9	1	59
W206	0	3	3	11	5	3	20	22	4	71
W207	4	3	7	20	9	2	7	18		70
W208	0	1	0	6	7	7	9	7	1	38
Total	4	12	23	68	32	15	87	63	6	310
	Percent of Total Fractures > 0.03 in. by Lithology within Wells									
	Cnglom	VCrsSS	CrsSS	MedSS	FineSS	VFineSS	SiltSt	MudStone	ClayStone	
W201		11.11	11.11	22.22	11.11	0.00	11.11	33.33		
W202			16.67	33.33	4.17	0.00	41.67	4.17		
W203		0.00	0.00	55.56	0.00	0.00	44.44	0.00		
W204		0.00	19.05	23.81	9.52	9.52	38.10	0.00		
W205	0.00	5.08	5.08	15.25	10.17	1.69	45.76	15.25	1.69	
W206	0.00	4.23	4.23	15.49	7.04	4.23	28.17	30.99	5.63	
W207	5.71	4.29	10.00	28.57	12.86	2.86	10.00	25.71		
W208	0.00	2.63	0.00	15.79	18.42	18.42	23.68	18.42	2.63	

the existence of multiple fractures could mean the presence of a strong hydrophysical anomaly.

If fractures are correlated with hydrophysical anomalies, then it is important to determine how fractures vary throughout the site, and what factors influence variations in fracture intensity. Tables 6 through 9 address the following four questions regarding fracture intensity and whether it varies among the wells or lithologic groups:

1. Are fractures distributed uniformly within all logged lithologic layers? If this is true, then it may imply that fracturing is relatively independent of lithological controls or structural position.
2. Are fractures distributed uniformly within each lithological layer in each well? If so, then fracture intensity may be controlled by lithology, and be relatively unaffected by structural position.
3. Are fractures with an aperture of >0.03 in. (0.76 cm) distributed uniformly within all lithologic layers? This question is similar to the first, except the emphasis here is on fractures with the largest geometric apertures. Such fractures may represent only a small subset of the most conductive fractures in a well, which may account for most of the flow.
4. Are fractures with an aperture of >0.03 in. distributed uniformly within each lithological layer within each well? This question is similar to the second, except it focuses on the fractures with the largest geometric apertures, which might in turn represent the most conductive fractures.

Table 6 shows that the p-value (the probability of observing the calculated Chi-Square statistic given that the null hypothesis is true) is essentially 0.0, implying that fracture intensity is not uniform among the wells. Wells W204, W205, and W208 are the most anomalous in terms of fracture intensity, as shown by their high Chi-Square values. Table 7 demonstrates that the frequency of fracture variation from well to well is influenced by lithology. The high Chi-Square value for siltstone and mudstone in well W205 shows that the fracture frequency is anomalous in these fine-grained lithologies in the well. The higher values for the coarser-grained layers in wells W202 and W203 confirm that fracturing is anomalous in these units. The p-values show that fracture intensity varies with lithology within individual wells. Tables 8 and 9 show similar results for fractures with apertures greater than 0.03 in. In summary, these tables indicate that fracture intensity varies among wells, and this variation is due not only to differences in the proportion of different lithologies. For example, siltstones in well W205 have a different frequency than siltstones in well W202.

With regards to the hydrophysical anomalies themselves, several questions arise:

1. Does the strength of the conductivity anomaly or number of anomalies vary by well?
2. Does the strength of an anomaly depend upon being located in a particular lithology?
3. Is the strength of an anomaly influenced by the thickness of the unit in which it occurs?
4. Is the strength of an anomaly influenced by the

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Table 6. Evaluation of the degree to which fractures are distributed uniformly among the wells, using Chi Square criteria.

Well	Total Thickness of Layer (inches)	Total No. of Fractures	Expected No. of Fractures	Chi Square	p-value
W201	854.54	85	55.8	15.24	
W202	1948.43	92	127.3	9.79	
W203	1086.74	53	71.0	4.57	
W204	722.19	101	47.2	61.37	
W205	7131.56	592	466.0	34.09	
W206	4248.88	269	277.6	0.27	
W207	4821.84	263	315.0	8.60	
W208	5480.03	263	358.1	25.23	
Total	26294.21	1718	1718.0	159.16	4.82E-31

proximity to a contact with another lithologic unit?

5. Is the strength of an anomaly correlated to a sharp contrast in the lithologies of units immediately above and below the unit?

Figure 4 shows the percent of hydrophysical anomalies by lithology within each well. There is insufficient information to carry out meaningful contingency table analyses on these data, but the figure clearly illustrates that the anomalies occur in different lithologies in a manner that is not in proportion to the relative net thickness of the lithologic layers in the wells

Figure 5 illustrates the relation of the thickness of a unit containing a hydrophysical anomaly to the thickness of all units found in the eight wells. There is no obvious visual difference.

The hypothesis that lithologic contrasts are related to anomalies was tested by comparing the anomaly strength to:

1. The absolute strength of the contrast (parameter ATC).
2. The contrast with the nearest adjacent lithology (parameter C_NEAR).
3. The distance to the nearest adjacent lithology.
4. Whether anomalies are predisposed to occur more closely to lithologic unit contacts.

Figure 6 shows the relation between both total contrast (TC) and ATC with the strength of the anomaly. The figure illustrates that there is a weak trend between increasing ATC and anomaly strength, but none between TC and anomaly strength. Figure 6 also compares anomaly strength to the contrast of the unit above (ALCA) and the unit below (ALCB). There is no obvious visual trend between these parameters and anomaly strength.

In addition, Figure 6 shows two parameters relating the anomaly strength to the contrast between the unit containing the anomaly (C_NEAR) and the distance to the nearest adjacent unit (CMIN). These data suggest no obvious trend.

The data shown in Figure 6 were tested to determine if hydrogeologic anomalies tend to be within 1 ft of the nearest contact. Does this imply that hydrophysical anomalies tend to occur close to lithology changes? This proposition was tested by selecting a random point in each unit penetrated by the eight wells and then computing the distance to the nearest contact. Figure 7 summarizes the result. Visually these two distributions appear very similar. A Chi-Square test does not reject this hypothesis, showing with an approximate 86% significance that these distributions are the same. This implies that anomalies do not appear to be preferentially located near major changes in lithology, although lithology contrasts have some importance.

The location and relative strength of each hydrophysical anomaly identified in the eight boreholes are indicated in Figure 2 by a line on the left-hand side of the borehole log. The length denotes the log of the flow rate. The figure indicates that the strongest hydrophysical anomalies are in W205, which intersects the fault.

Table 7. Evaluation of the degree to which fractures are distributed uniformly with lithologic layer in individual wells.

Expected Number of Fractures											
Well No.	1 Cnglom	2 VCrsSS	3 CrsSS	4 MedSS	5 FineSS	6 VFineSS	7 SiltSt	8 MudStone	9 ClayStone	Total	
W201		5.00	14.60	21.71	10.77	7.40	17.62	7.90		85	
W202			8.91	20.40	19.87	9.87	25.99	6.95		92	
W203		3.55	8.58	17.13	0.46	1.67	17.28	4.33		53	
W204		0.62	16.42	15.01	8.87	10.35	45.65	4.08		101	
W205	2.55	18.33	39.77	115.26	48.99	24.87	282.56	53.79	5.88	592	
W206	4.20	11.82	19.29	57.78	30.66	38.73	81.42	22.15	2.95	269	
W207	14.55	10.59	19.06	44.41	23.67	29.78	98.96	21.96		263	
W208	5.28	3.23	9.11	22.75	87.46	36.47	76.03	20.59	2.08	263	
Total	26.59	53.13	135.73	314.47	230.75	159.14	645.52	141.76	10.91	1718	
Chi-Square Analysis											
	Cnglom	VCrsSS	CrsSS	MedSS	FineSS	VFineSS	SiltSt	MudStone	ClayStone	Total	p-Value
W201		0.80	5.06	4.87	3.09	2.62	0.15	8.30		24.90	0.00036
W202			19.23	4.52	5.94	6.28	1.88	1.34		39.19	2.18E-07
W203		1.83	2.45	20.78	0.46	0.27	3.07	2.56		31.41	0.00002
W204		0.62	0.01	1.06	0.51	3.08	1.64	1.06		7.98	0.23973
W205	0 08	17.05	7.47	0.66	2.48	0.33	22.40	14.79	0.13	65.39	4.05E-11
W206	1.15	0.28	1.15	0.25	4.44	12.19	0.00	45.77	5.57	70.81	3.39E-12
W207	0.17	0.55	3.31	10.49	4.51	8.36	19.53	16.51		63.42	3.13E-11
W208	0 02	0.02	0.49	8.92	19.65	0.34	0.65	24.40	57.48	111.96	1.51E-20

2.3 Multiple Regressions

A series of step-wise multiple regressions was carried out using a data-mining application, SAS™. The results are summarized in Table 10. This table contains the results for the six multiple regressions with the highest R-square value for different numbers of independent variables.

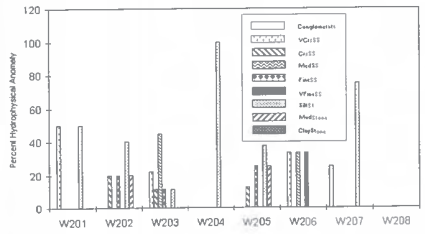

Figure 4. Percent of hydrophysical anomalies by lithology for individual wells. The height of the bars represents the percent of the logged interval of the well comprised by each lithology. Missing bars indicate the absence of a particular lithology in a well.

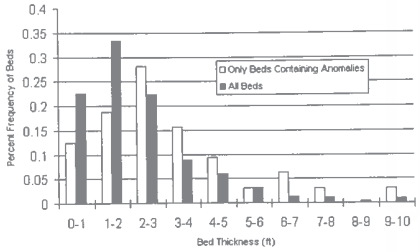

Figure 5. Bed thickness histograms. Open bars represent the histogram of bed thickness for all beds encountered by the wells. Black bars represent the histogram of bed thickness for only those beds containing hydrophysical anomalies. The vertical axis represents the percent of the beds belonging to a particular bed thickness class.

Improvement in R-square decreased significantly after seven variables. Those variables that produced the best R-square values for a given number of parameters are shown in the table and marked by an "X." The table demonstrates that certain variables explain much of the variance in anomaly strength. These variables include the distance to the nearest fractures (D1, D2, D3), the aperture, or width of the fractures (W3), the absolute lithologic contrast (ATC), the dip of the unit below the anomaly (CONDIPB), and the contrast with the unit above (ALCA).

Thus, the multiple regression results suggest that the distances to the three nearest fractures are important, as well as the data on a strong lithology contrast and wider fracture apertures. These variables account for approximately 80% of the variability in anomaly strength.

2.4 Neural Net Analyses

All neural net analyses were carried out using NeuroShell II™ Version 3.0 [*Ward,* 1996]. A genetic adaptive GRNN architecture was used [*Specht,* 1991]. GRNNs are designed to predict a continuous variable. They are memory-based feed-forward networks based on the estimation of probability density functions. The classic GRNN contains only one adjustable parameter, termed the *smoothing factor.* The smoothing factor allows the GRNN to interpolate between patterns in the training data set. The genetic adaptive GRNN differs in that it has smoothing factors for each input parameter as well as a conventional overall smoothing factor. These smoothing factors are

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Table 8. Fractures > 0.03 in. are distributed uniformly with lithologic layer.

Well	Total Thickness (inches)	Total Fractures	Expected Fractures	Chi Square	p-value
W201	854.54	18	10.1	6.23	
W202	1948.43	24	23.0	0.05	
W203	1086.74	9	12.8	1.13	
W204	722.19	21	8.5	18.31	
W205	7131.56	59	84.1	7.48	
W206	4248.88	71	50.1	8.73	
W207	4821.84	70	56.8	3.04	
W208	5480.03	38	64.6	10.96	
Total	26294.21	310	310.0	55.93	9.75E-10

optimized by iterative changes in the factors based on cross-validation to minimize the mean squared error of the outputs over the entire test set. The genetic adaptive GRNN is much more robust against noisy data and redundant parameters than traditional GRNNs, and is particularly well suited when the input parameters are of different types, and some may have markedly more impact on predicting the output variable than others.

When an observation, which consists of parameter values for all input parameters under consideration, is presented to the GRNN, it is compared to all of the patterns in the training set to determine how closely this observation corresponds to those patterns. The GRNN essentially computes a weighting factor for each training data-set observation, and then computes an overall output value based upon these weights and the input training set parameter values.

Application of a neural net to the hydrophysical anomaly dataset would be improved if the data set were larger. This is because a small training set and a small test set increase the variability in the results. Also, with a very small training set, it is possible that the training data would not span the *n*-dimensional parameter space and would thereby have difficulty interpolating to new observations with characteristics outside of the data training subspaces. Likewise, it is important to have fewer degrees of freedom

Table 9. Evaluation of the degree to which fractures > 0.03 in. are distributed uniformly with lithologic layer in individual wells.

All Fractures >.0.03 in. by Lithology within Wells											
Expected Number of Fractures											
	Cnglom	VCrsSS	CrsSS	MedSS	FineSS	VFineSS	SiltSt	MudStone	ClayStone	Total	
W201		1.06	3.09	4.60	2.28	1.57	3.73	1.67		14.89	
W202			2.32	5.32	5.18	2.58	6.78	1.81		10.40	
W203		0.60	1.46	2.91	0.08	0.28	2.93	0.74		5.05	
W204		0.13	3.41	3.12	1.84	2.15	9.49	0.85		2.47	
W205	0.25	1.83	3.96	11.49	4.88	2.48	28.16	5.36	0.59	5.73	
W206	1.11	3.12	5.09	15.25	8.09	10.22	21.49	5.85	0.78	67.51	
W207	3.87	2.82	5.07	11.82	6.30	7.93	26.34	5.85		51.47	
W208	0.76	0.47	1.32	3.29	12.64	5.27	10.99	2.97	0.30	15.45	
Total	6.00	10.02	25.73	57.80	41.30	32.48	109.91	25.10	1.66	172.96	
Chi-Square Analysis											
	Cnglom	VCrsSS	CrsSS	MedSS	FineSS	VFineSS	SiltSt	MudStone	ClayStone	Total	p-Value
W201		0.84	0.39	0.08	0.03	1.57	0.80	11.19		14.89	0.02111
W202			1.21	1.35	3.38	2.58	1.53	0.37		10.40	6.47E-02
W203		0.60	1.46	1.50	0.08	0.28	0.39	0.74		5.05	0.53790
W204		0.13	0.10	1.13	0.01	0.01	0.23	0.85		2.47	0.87224
W205	0.25	0.75	0.23	0.54	0.26	0.88	0.05	2.47	0.29	5.73	6.78E-01
W206	1.11	0.00	0.86	1.18	1.18	5.10	0.10	44.62	13.35	67.51	1.54E-11
W207	0.00	0.01	0.73	5.66	1.16	4.43	14.20	25.28		51.47	7.42E-09
W208	0.76	0.61	1.32	2.24	2.51	0.57	0.36	5.45	1.63	15.45	5.10E-02

(i.e., input variables) in the network than training cases; otherwise, the net "memorizes" the training set without uncovering useful relations.

The performance of a neural net is determined by how well it predicts the strength of the anomaly of a test set as quantified by R and R-square statistics. These statistics vary from 0.0 to 1.0; a perfect prediction has an R and R-square statistic of 1.0. The importance of an input parameter is quantified by its smoothing factor, which can vary from 0.0 (no importance) to 3.0 (very important).

Because of the small (approximately 30) number of hydrophysical anomalies available for use as training and test patterns, the results are sensitive to the random subset selected as the training pattern. For this reason, several random subsets were selected and processed.

Correlation shows up in the smoothing factors as a substitution of one correlated variable in random samples. For example, in one run, the distance to the third nearest fracture might be important. In a subsequent run, this distance might have little importance but the distance to the second nearest fracture would now be important. Highly correlated variables can substitute for one another since virtually all of the information in all of the variables can be contained in any one of the variables.

Neural net regression was much more successful for the logarithm of the anomaly than for the anomaly itself. A series of preliminary neural nets was constructed to look at different components of the data—in particular, fracture-related parameters and lithological parameters. In the preliminary processing that focused on fractures, several parameters played an important role. These included depth of the fractures, width of the fractures, distance from the anomaly to the nearest fractures, and the lithology of the

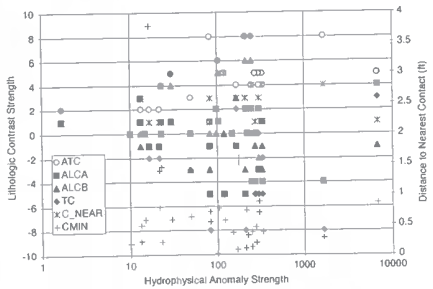

Figure 6. Anomaly strength vs. lithological contrast parameters. The vertical scale on the left-hand side of the graph pertains to the contrast parameters ATC, ALCA, ALCB, TC, and C_NEAR. The vertical scale on the right-hand side indicates the value of the distance parameter CMIN.

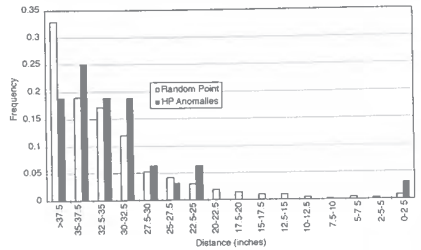

Figure 7. Percent frequency histogram of distance to nearest lithology change. Open bars represent distances between a location randomly assigned in the wells and the nearest contact. Black bars represent the distance from the locations of all hydrophysical anomalies to the nearest contact. The frequencies have been normalized to percentages in order to facilitate visual comparison.

nearest fractures. Depth was probably an artifact of the available dataset, however. Well W205, the deepest well, had the strongest anomalies. The other wells either were not drilled to the depth of W205, or else did not have all of the necessary parameters for the deeper portions of the borehole.

The lithologies above and below the hydrophysical unit did not appear to explain the hydrophysical anomaly. However, the lithologies of the four nearest fractures were quite informative. Although these lithologies correlated very strongly, surprisingly, at least three of them always seemed to have significant smoothing factors. This is reminiscent of the results from the step-wise regression, which showed that the distance to at least three of the four nearest fractures was important. If the information content in any one of these parameters were a good representation of the information content in any other, then it would be expected that only one of the lithology, depth, or aperture parameters would have a significant smoothing factor. The fact that more than one lithology parameter has a significant smoothing factor might be evidence that hydrophysical anomalies are in some way enhanced by the presence of multiple fractures near the anomaly, whether or not these fractures actually have an anomaly associated with them.

These preliminary runs guided the final runs in which redundant variables and depth measures had been eliminated. Tables 11 and 12 summarize those results.

Table 11 shows the mean of the smoothing factors for five randomly drawn training and test sets. The lithology of the fractures (L1 and L2), fracture width (W1 and W2), and proximity (D1 and D2) to fractures to the anomaly are

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Table 10. Results of step-wise regression.

No. of Variables	R-square	ALCA	ATC	CDA	CONDIP A	CON DIPB	D1	D2	D3	D4	LCA	LITH	Log(W1)	Log(W2)	Log(W3)	W1	W2	W3
2	0.477	X												X				
2	0.438		X											X				
2	0.419	X															X	
2	0.402							X						X				
2	0.387							X									X	
2	0.383		X														X	
3	0.527	X						X						X			X	
3	0.513		X			X		X										
3	0.511	X											X		X			
3	0.508	X								X				X				
3	0.507		X					X						X				
3	0.506	X				X								X				
4	0.622						X	X	X					X	X			X
4	0.596		X					X	X									
4	0.591						X	X	X						X			
4	0.581	X						X	X					X	X			
4	0.580		X			X	X	X										
4	0.571	X				X							X	X				
5	0.717		X				X	X	X						X			
5	0.711	X					X	X	X					X				X
5	0.687						X	X	X							X		X
5	0.684						X	X	X					X				X
5	0.679	X				X	X	X	X									X
5	0.677		X			X	X	X	X									X
6	0.802		X			X	X	X	X									X
6	0.783		X			X	X	X	X						X			
6	0.765		X				X	X	X					X				X
6	0.753	X					X	X	X						X			X
6	0.751		X				X	X	X					X				X
6	0.750		X				X	X	X						X			
7	0.828		X	X		X	X	X	X							X		
7	0.823		X			X	X	X	X						X			X
7	0.820		X			X	X	X	X					X				X
7	0.817		X		X	X	X	X	X									X
7	0.816		X			X	X	X	X		X							X
7	0.815		X			X	X	X	X			X						X

always important. In particular, the distance to the second closest fracture is much more important than the distance to the closest fracture. Two other parameters, used only in the neural net analysis, also were important—UNCONF and ABS(UNCF). These variables were introduced to assess structural or stratigraphic disruption, an area also important in the neural net analyses. Absolute lithology contrast (ATC), lithology of the anomaly (LITH), and distance to the nearest contact (CMIN), have a moderate impact. Bed thickness (BED_TH) and the contrast between the anomaly unit and the nearest adjacent unit (C_NEAR) play very minor roles.

Table 12 shows the R-square and r-square statistics for both the training and test sets. R-square is the coefficient of multiple determination, whereas r-square is the more familiar coefficient of determination [*Ward*, 1996], which is the square of the correlation coefficient. The R-square value for the training sets averages nearly 92%, with a variation of 81% to 100%. The R-square value for the test sets averages nearly 77%, with a variation of 50% to 97%. Note that the lowest R-square for the test set comes from realization 2, which conversely has the highest value (1.0) for the training sets. The smoothing factors for this realization are also somewhat anomalous. The R-square values for both the training and test sets are higher than for the multivariate regression. This suggests that some of the input parameters have a nonlinear relation with anomaly strength. In general, the GRNN achieves about a 20% improvement over the multivariate regression in terms of R-square values.

Table 13 shows the predictions made by the neural net method for the ten test sets of observations. In general, the predictions are reasonably accurate, the average error being −0.0250 and the standardized mean squared error 0.34.

Thus, the neural net analysis confirms the results of the simpler statistical techniques and suggests that a GRNN offers greater accuracy than multivariate regression.

Table 11. Average smoothing factors for neural net analyses.

Average of 5 Realizations	Smoothing Factor [0 to 3.0]
Lithology to 1st Nearest Fracture	2.37
Distance to 2nd Nearest Fracture	2.24
Lithology to 2nd Nearest Fracture	2.09
Aperture of 1st Nearest Fracture	1.97
Absolute Value of Angular Difference between Upper and Lower Contacts	1.86
Difference between Upper and lower Contacts	1.59
Distance to Nearest Contact	1.28
Aperture of 2nd Nearest Fracture	1.21
Absolute Grain Size Contrast	1.15
Grain Size of Unit Containing Anomaly	1.12
Distance to 1st Nearest Fracture	1.08
Minimum Apparent Distance to Nearest Contact	0.76
Bedding Thickness	0.60
Dip of Contact with Unit Above	0.47
Grain Size Contrast with Nearest Unit	0.29

3. CONCLUSIONS

The statistical results for the Wake Co. site support the following conclusions:

1. There are statistically significant correlations between the geologic variables directly measured or derived from core data or borehole imagery and the strength of hydrophysical anomalies.
2. Hydrophysical anomalies do not appear to be located preferentially in particular lithologies for all eight wells. The frequency histograms and associated statistical test results show that hydrophysical anomalies are located in randomly selected subsets of all of the lithologic units.
3. Hydrophysical anomalies are not preferentially located near to boundaries between contrasting lithologic units. Frequency histograms of the proximity of anomalies to the nearest lithologic boundary are statistically indistinguishable from the distance from a random point located in every unit to its nearest boundary.
4. There is a weak trend between the magnitude of a hydrophysical anomaly and the strength of the contrast between the lithologic unit containing the anomaly and the units above and below it.
5. The trend noted in the conclusion above is independent of whether the anomaly occurs in a fine-grained unit surrounded by coarse-grained units or a coarse-grained unit surrounded by fine-grained units.
6. There is no correlation between the strength of the hydrophysical anomaly and the strength of the contrast with the lithologic unit above or below.
7. There is no correlation between the strength of the hydrophysical anomaly and the distance to either the upper or lower contact with the adjacent lithologic units.
8. The strongest hydrophysical anomalies occur in the fine-grained lithologies in Well W205, which intersected the fault and was drilled and logged deeper than most of the other wells. The anomalies in well W205 have three unique characteristics: they occur preferentially in siltstone or mudstone lithologies,

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Table 12. Statistics for GRNN prediction of hydrophysical anomaly strength.

Training Set	#1	#2	#3	#4	#5	Average
R squared	0.91	1.00	0.99	0.81	0.88	0.92
r squared	0.94	1.00	0.99	0.90	0.88	0.94
Mean squared error	0.05	0.00	0.01	0.12	0.06	0.05
Mean absolute error	0.15	0.00	0.06	0.24	0.07	0.10
Min. Absolute error	0.00	0.00	0.00	0.00	0.00	0.00
Max. Absolute error	0.80	0.00	0.25	1.04	1.35	0.69
Correlation coefficient r	0.97	1.00	0.99	0.95	0.94	0.97
Percent within 5%	45.46%	100.00%	77.27%	27.27%	87.50%	67.50%
Percent within 5% to 10%	36.36%	0.00%	13.64%	22.73%	3.13%	15.17%
Percent within 10% to 20%	13.64%	0.00%	9.09%	31.82%	6.25%	12.16%
Percent within 20% to 30%	0.00%	0.00%	0.00%	9.09%	0.00%	1.82%
Percent over 30%	4.55%	0.00%	0.00%	9.09%	3.13%	3.35%
Test Set	**#1**	**#2**	**#3**	**#4**	**#5**	**Average**
R squared	0.86	0.50	0.97	0.85	0.67	0.77
r squared	0.96	0.53	0.98	0.87	0.73	0.81
Mean squared error	0.04	0.34	0.01	0.02	0.19	0.12
Mean absolute error	0.15	0.29	0.08	0.11	0.20	0.17
Min. Absolute error	0.00	0.00	0.00	0.03	0.00	0.01
Max. Absolute error	0.37	1.70	0.14	0.36	1.35	0.78
Correlation coefficient r	0.98	0.73	0.99	0.93	0.85	0.90
Percent within 5%	50.00%	60.00%	50.00%	80.00%	60.00%	60.00%
Percent within 5% to 10%	10.00%	0.00%	40.00%	0.00%	10.00%	12.00%
Percent within 10% to 20%	10.00%	30.00%	10.00%	10.00%	20.00%	16.00%
Percent within 20% to 30%	20.00%	0.00%	0.00%	0.00%	0.00%	4.00%
Percent over 30%	10.00%	10.00%	0.00%	10.00%	10.00%	8.00%

which is not true for anomalies in other wells; they occur at a greater depth than in the other wells; and the fractures nearest the anomalies have greater apertures than the fractures near anomalies in other wells. The depth correlation is probably an artifact.

9. Away from faults, hydrophysical anomalies are smaller on average and not as strongly associated with siltstone and mudstone. Near faults in the hanging wall, the strength of the anomalies is greater and they are correlated with fractures with larger aperture.
10. The results of our analyses confirm that a fault-related deformation produces new fractures or enhances the aperture of existing fractures in lithological units with lower resistance to shear—mudstones and siltstones—and thereby increases the strength of hydrophysical anomalies.

4. RECOMMENDATIONS

This section offers recommendations for using the results of this study to construct site-scale DFN and SC flow models. The results confirm that it is not correct to assign permeability values to grid cells or flow properties to fractures based on lithologic type alone. The boundaries between contrasting lithologic types do not focus strain. If they did, then the DFN model could have reproduced this effect by having large, bedding-parallel fractures at these interfaces with enhanced transmissivity values. SC models could have approximated this effect by having bedding-parallel layers of grid cells with enhanced subhorizontal permeability. While there is some correlation between lithological contrasts, the correlation is second order and should probably be ignored in preliminary flow models.

Table 13. Comparison of measured hydrophysical anomaly strength with strength predicted by GRNN for ten randomly selected anomalies not used in the GRNN calibration.[a]

#1		#2		#3		#4		#5	
Actual	GRNN	Actual	GRNN	Actual	GRNN	Actual	GRNN	Actual	GRNN
2.52	2.52	3.22	2.62	2.44	2.46	2.52	2.48	3.82	2.48
2.48	2.45	2.52	2.52	2.34	2.29	2.48	2.54	2.52	2.52
2.48	2.39	2.52	2.44	2.32	2.41	2.40	2.35	2.48	2.44
2.22	2.19	2.22	1.92	2.18	2.17	2.35	2.10	2.45	2.39
2.09	2.28	2.09	2.09	1.92	2.03	2.34	2.27	2.40	2.22
2.02	1.99	1.48	1.46	1.48	1.60	2.32	2.43	2.09	2.35
1.99	2.23	1.37	1.37	1.37	1.28	2.18	2.21	1.48	1.47
1.48	1.78	1.34	1.34	1.37	1.32	2.02	1.99	1.37	1.37
1.12	1.37	1.18	1.34	1.12	1.26	1.92	1.83	1.34	1.34
1.00	1.37	0.22	1.92	1.12	1.21	1.12	1.49	1.18	1.34

[a]The ten rows, corresponding to the randomly selected anomalies for each of the five test sets, were sorted by anomaly, from largest anomaly to smallest, to illustrate that the GRNN tends to overpredict the strength of small anomalies (calculations were carried out for five runs).

Fault proximity is a first-order control in and of itself, and lithology plays a significant role near faults. Deformation is greatest in the hanging-wall siltstones and mudstones within the deformation zone that extends from the fault eastward to the fold hinge that intersects the bottom of W204. This implies that fractures in these lithologies and structural positions should have larger aperatures, resulting in higher transmissivity. Alternatively, the grid cells within this region of a SC model would have higher layer-parallel permeability. Based on the data obtained, the footwall appears to be similar to the rock outside of the hanging-wall deformation zone.

The fact that anomalies do exist outside of the hanging-wall zone, but are smaller and not as strongly correlated with lithology, suggests simple "background" fracture and permeability models for the remainder of the rock mass. At least for the preliminary model, the background fracturing would be homogeneous throughout the model. This means that the discrete fractures in the DFN model would be distributed with the same size and orientation distributions, the same transmissivity and transport properties, and the same average intensity independent of depth, lithology, or location. In the SC model, the permeability, porosity, and transport parameter values would be assigned as random (Monte Carlo) draws from a single parent distribution for each parameter. Only in the vicinity of the hanging-wall deformation zone would properties be changed as previously described.

The next stage in refining these DFN or SC models would be to simulate field flow or transport experiments in order to assess whether the models are reproducing the first-order effects, and if so, whether certain second-order effects should be included to improve the modeling forecasts. There is considerable freedom in assigning transmissivity and transport properties either to the fractures themselves in the DFN formulation or as effective properties to the stochastic continuum models. Iterative refinement of these properties to match the field-flow or transport results is usually an important step in the evolution of models that will be used subsequently for forecast or design.

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REFERENCES

Cacas, M. C., E. Ledoux, G. De Marsily, B. Tillie, A. Barbreau, E. Durand, B. Feuaga, and P. Peaudecerf, Modeling fracture flow with a discrete fracture network: calibration and validation 1, the flow model, *Water Resour. Res.*, *26*(3), 479–489, 1990a.

Cacas, M. C., E. Ledoux, G. De Marsily, A. Barbreau, P. Calmesl, B. Gaillard, and R. Margritta, Modeling fracture flow with a discrete fracture network: calibration and validation 2, the transport model, *Water Resour. Res.*, *26*(3), 491–500, 1990b.

Dershowitz, W. S., *Rock Joint Systems*, Ph.D. thesis, Massachusetts Institute of Technology, Cambridge, Mass., 1984.

Dershowitz, W. S.N. Hurley, and K. Been, Stochastic discrete fracture modeling of heterogeneous and fractured reservoirs, in *Proceedings of the Third International Conference on the Mathematics of Oil Recovery,* Delft University Press, Delft, Holland, 1992.

Endo, H. K., J. C. S. Long, C. K. Wilson, and P. A. Witherspoon,

Electronic Filing: Received, Clerk's Office 06/20/2024

el for investigating mechanical transport in fractured *Water Resour. Res.*, *20*(10), 1390–1400, 1984.
. A., and P. R. La Pointe, Printed circuits for studying ass permeability, *Int. J. Rock Mechanics and Mining and Geomechanics Abstracts*, *17*, 297–301, 1980.
, P. R., P. C. Wallmann, and S. Follin, Continuum ig of rock masses: Is it useful?, *Proceedings of the Int. of Rock Mechanics Symposium on Prediction and iance in Rock Mechanics and Rock Engineering—TK '96*, pp. 343–350, Balkema, Rotterdam, 1996.
. S., J. S. Remer, C. R. Wilson and P. A. Witherspoon, media equivalents for networks of discontinuous s, *Water Resour. Res.*, *18*(3), 645–658, 1982.
Research Council, Committee on Fracture erization and Fluid Flow, *Rock Fractures and Fluid* Chap. 6, pp. 307–404, National Academy Press, gton, D.C., 1996.
P., *Connectivity, flow and transport in network models ured media*, Ph.D. thesis, Oxford University, UK, 1984.
and F. W. Schwartz, An analysis of the influence of geometry on mass transport in fractured media, *Water Res.*, *20*(9), 1241–1252, 1984.
Specht, D. F., A generalized regression neural network, *IEEE Trans. on Neural Networks, 2*, 568–576, 1991.
Swaby, P. A., and K. D. Rawnsley, An interactive 3D fracture modelling environment, *Proceedings of the Petroleum Computer Conference, SPE 36004*, Society of Petroleum Engineers, Dallas, Tex., 1996.
Ward, Inc., *NeuroShell 2 User's Manual*, Ward Systems Group, Inc., Frederick, Md., 1996.
Zimmerman, D. A., G. De Marsily, C. A. Gotway, M. G. Marietta, C. L. Axness, R. L. Beauheim, R. Bras, J. Carrera, G. Dagan, P. B. Davies, D. P. Gallegos, A. Galli, J. Gómez-Hernández, S.M. Gorelick, P. Grindrod, A. L. Gutjahr, P. K. Kitanidis, A. M. Lavenue, D. McLaughlin, S. P. Neuman, B. S. Rama Rao, C. Ravenne, and Y. Rubin, A comparison of seven geostatistically-based inverse approaches to estimate transmissivities for modeling advective transport by groundwater flow, *Water Resour. Res.*, *34*(6), 1373–1413, 1998.

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Coals

Coals are classified as ***humic coals*** if they are *derived from humic substances via a peat stage* and as ***sapropelic coals*** if they are *formed from fairly fine-grained organic muds in quiet, oxygen-deficient shallow waters*. The humic coals are lustrous, dark-brown to black, exhibit stratification, and often contain the remains of woody tissue. The sapropelic coals are dull, unstratified, and contain allochthonous organic and mineral matter. The sapropelic coals are subdivided into cannel and boghead coals. The conversion of organic matter to coal involves two stages: biochemical and geochemical. The biochemical phase involves biological processes; the geochemical stage involves physicochemical processes due to increasing pressure and temperature. These processes lead to a release of volatiles, primarily methane, water, and carbon dioxide; the elimination of oxygen-containing functional groups; and an increase in the percent of aromatic units. These changes are illustrated in Figure 5–27, which shows the relative increase in carbon with increasing degree of coalification.

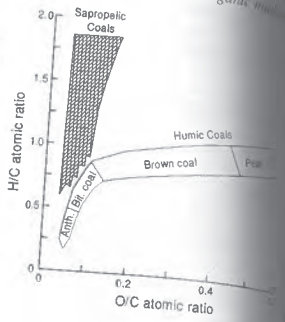

Figure 5–27
van Krevelen (1963) diagram indicating the changes in hydrogen, oxygen, and carbon content during the coalification process. After Killops and Killops (1993).

Of major environmental interest is the metal, sulfur, and fly ash content of coals. Metals that were incorporated in the original organic material tend to remain during the coalification process. Thus, coal is often high in a number of trace elements of environmental concern. Lyons et al. (1989) determined the concentrations of trace elements in a variety of coals, ranging from high-volatile bituminous coals to meta-anthracites. Concentration ranges determined for elements of environmental interest are given in Table 5–6.

Lyons et al. (1989) also investigated the distribution of these trace elements between organic and inorganic (i.e., mineral) components of the coal. For the elements listed in Table 5–6, they concluded that As, Co, Cu, Ni, Sc, and Th generally showed an inorganic association, whereas Cr, Sb, U, V, W, and Zn generally showed an organic association. Se and Pb did not correlate with either association. Metals associated with inorganic components would presumably remain with the fly ash and could be successfully removed from the effluent stream by electrostatic precipitation of the fly ash. Metals associated with

Table 5–6 Concentration Ranges in Coal for Some Elements of Environmental Interest*

Element	Concentration range (ppm)	Element	Concentration range (ppm)
Sc	0.6–10.3	As	0.7–31
V	6–109	Se	0.4–3.3
Cr	2.6–25.4	Sb	0.1–7.3
Co	1.1–24.1	W	0.2–1.3
Ni	2–50	Pb	3–20
Cu	6–54	Th	0.5–3.7
Zn	3–65	U	0.2–3.8

*From Lyons et al. (1989).

CASE STUDY 5–4
Distribution of Metals and Other Elements in Coals

A number of studies have been carried out on the distribution of metals and other elements in coal. Several of these are cited in this case study to indicate the variability of these elemental associations in coal. Christanis et al. (1998) found that in the Philippi peat of eastern Macedonia, Greece, Ge, Mo, Pb, Se, Ta, Tl, U, and W were correlated with organic content and the other trace elements were correlated with mineral phases. For lignites from central Anatolia, Turkey, Querol et al. (1997) found that Mn, B, Be, Ge, Y, Zr, Nb, Hf, W, and U showed positive correlation with organic matter and Mn, U, Th, Sc, Ge, and HREE showed positive correlation with phosphate, suggesting that apatite or another phosphate mineral is the major host. Co, Mo, Ta, Pb, and IREE showed positive correlation with both Fe and S, indicating that Fe-sulfide minerals are the hosts for these elements. As and V had mixed affinities. For United Kingdom coal fields, Spears and Zheng (1999) found that Rb, Cr, Th, Ce, Zr, Y, Ga, La, Ta, Nb, and V were associated with the clay minerals; As, Mo, Sb, Tl, Se, Bi, and Pb with pyrite; Sr and Ba with phosphate minerals. Germanium was the only element that had a major organic association. For medium- to high-volatile bituminous coals from Nova Scotia, Canada, Mukhopadhyay et al. (1998) found that most lithophile elements, including B, Cr, U, V, and the REE, were associated with the clay minerals; Cu, Pb, and Zn with the sulfide minerals; and Cl, Ca, As, and Mn with organic matter. Of note is the marked variability of the element associations. Major factors affecting trace element concentrations are the abundance and sources of detrital minerals, the presence of volcanic material, and seawater or brine incursions into the basins of deposition.

organic components would be released to the effluent stream during combustion and dispersed into the atmosphere. These associations would be expected to vary on a coal-by-coal basis, so it is necessary to determine the distribution of elements in a particular coal in order to determine the potential trace metal contribution of this coal to the atmosphere during combustion (see Case Study 5–4).

Sulfur occurs in coal either combined with organic molecules or as physically separate sulfide minerals (of which pyrite is the most common). Sulfur occurs in reduced form (S^-, S^{2-}) because the organic-rich depositional environment is reducing (see Chapter 4). If Fe^{2+} (or other metal ions) is present, it will combine with the reduced sulfur to produce minerals such as marcasite (FeS) and pyrite (FeS_2). If there is a low abundance of metal ions, free hydrogen sulfide (H_2S) and polysulfides (HS_4^-, HS_5^-, S_4^{2-}, S_5^{2-}) are formed. These species can combine with various organic molecules to form a variety of sulfur-containing compounds. In terms of "cleaning up" coal, the way in which sulfur occurs in the coal is of key importance. If the sulfur occurs in separate sulfide minerals, then in principle it can be physically separated by flotation techniques. If the sulfur is bound to organic molecules, there is no effective way to remove the sulfur before burning the coal.

Petroleum

Petroleum *is any hydrocarbon-rich fluid (liquid or gas) derived from kerogen by increases in pressure and temperature.* ***Kerogen*** *is a polymeric organic material that occurs in sedimentary rocks in the form of finely disseminated organic macerals (the preserved remains of plant material).* Four types of kerogen (I, II, III, and IV) have been distinguished on the basis of H/C and O/C atomic ratios, types of organic molecules (aliphatics versus aromatics), functional groups, and other criteria. Type II kerogen is the most common precursor for petroleum. Type I has the highest petroleum-forming potential but is present in low abundance. Type IV kerogen is not a petroleum precursor. Kerogen is converted to petroleum through a series of reactions starting in the ***diagenetic environment*** *(the environment in which processes occur at pressures and temperatures greater than those of the weathering environment but below those required to produce metamorphism)* and ending at temperatures of about 225°C. These reactions result in the expulsion of CO_2 and CH_4 and a reduction in the size of the hydrocarbon molecules. The hydrocarbon formation process for a typical source rock is schematically illustrated in Figure 5–28 (p. 148). Note that natural gas is generated throughout the P–T range, but the formation of oil is confined to a narrow P–T range. Thus, the thermal history of a basin is an important factor in terms of its oil-producing capability. Also note the reduction in the size of the mean hydrocarbon molecule with increasing temperature.

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Graphical Representations of Water Chemistry Two types of diagrams are commonly used to portray water chemistry, Stiff and Piper. Stiff diagrams show the concentrations (in milliequivalents) of the major ions (both cations and anions) as a shape that gives both the relative abundance of the various species and the total abundance. Piper diagrams are trilinear representations of cation, anion, and combined cation and anion proportions. Piper diagrams are often used to classify water types. The following two examples illustrate the plotting of Stiff and Piper diagrams.

EXAMPLE 9–1 In this example we will plot the chemical data for the Columbia and Rio Grande rivers and the Pennsylvania groundwater (Table 9–7) on a Stiff diagram. The following table illustrates the calculation for the Columbia River water. We start by determining the concentration of each ion in millimoles per liter and then calculate the concentration of each ion in milliequivalents. The concentrations in milliequivalents are plotted on the Stiff diagram, as shown in Figure 9–5, and the various points are connected by straight lines. Note that the concentrations of the Na^+ and K^+ ions have been combined.

	Columbia River						
	Ca^{2+}	Mg^{2+}	Na^+	K^+	Cl^-	SO_4^{2-}	HCO_3^-
mg L^{-1}	19	5.1	6.2	1.6	3.5	17.1	76
mmol L^{-1}	0.47	0.21	0.27	0.04	0.1	0.18	1.25
meq L^{-1}	0.95	0.42	0.27	0.04	0.1	0.36	1.25

The shape of the field is a representation of the relative proportions of the various ions, and the size of the field represents the total ionic concentration. The Rio Grande river and Central Pennsylvania ground waters are also plotted in Figure 9–5. From the shape of the Stiff diagrams we can easily infer that the Rio Grande has a much greater concentration of all ionic species than the Columbia River and that the bicarbonate ion, relative to the sulfate ion, is much less important in the Rio Grande than it is in the Columbia River. Inspection of the Central Pennsylvania groundwater diagram reveals that the dominant cation is Ca^{2+} and the dominant anion is HCO_3^-, so this is a Ca-carbonate water. Stiff diagrams are particularly useful when plotted on a map because they give a graphical representation of regional variations in water chemistry.

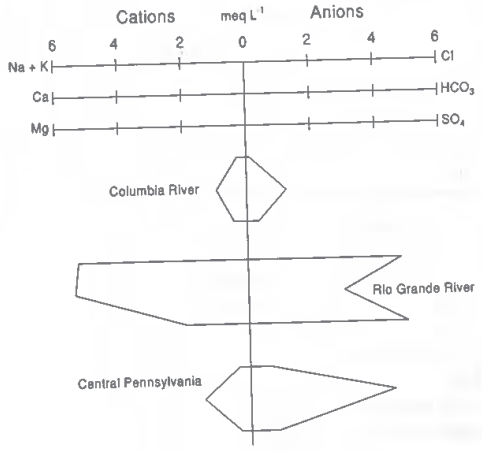

Figure 9–5
Stiff diagram for Columbia and Rio Grande river waters and Central Pennsylvania groundwater. See text for discussion. ■

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EXAMPLE 9–2 In this example we plot the Columbia River data from Example 9–1 on a Piper diagram. As in Example 9–1, we start by calculating the concentration of each ion in milliequivalents. We now normalize the cations and the anions to 100% (as shown in the following table) so that we can plot them on the Piper diagram.

	Cation concentrations			Anion concentrations	
	meq L^{-1}	Normalized		meq L^{-1}	Normalized
Ca^{2+}	0.95	56.5	Cl^-	0.10	5.8
Mg^{2+}	0.42	25.0	SO_4^{2-}	0.36	21.1
$Na^+ + K^+$	0.31	18.5	HCO_3^-	1.25	73.1
Total	1.68	100.0		1.71	100.0

The normalized cation and anion concentrations are plotted in their appropriate triangle (Figure 9–6). The data plotted on each triangle are then projected into the quadrilateral by drawing a line from the point on the cation triangle parallel to the Mg axis into the quadrilateral and by drawing a line from the point in the anion triangle parallel to the SO_4 axis into the quadrilateral. The intersection of these two lines marks the location of the point to be plotted on the quadrilateral (Figure 9–6). Symbols of different size are sometimes used to indicate differences in total dissolved species. This convention is used in the example. The data for the Rio Grande river and the Central Pennsylvania ground waters are also plotted in Figure 9–6. ■

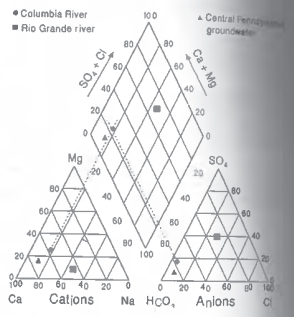

Figure 9–6
Piper diagram for Columbia and Rio Grande river waters and Central Pennsylvania groundwater. See text for discussion.

Piper diagrams have two main uses. The first is the graphical representation of water chemistry for the purpose of water classification (see the next section). The second is to determine if a series of water compositions represent the mixing of two end members. If the samples are the result of two-end-member mixing, they will plot along straight lines in each of the fields of the diagram. If they do not plot along straight lines, then their compositions are not controlled by simple two-end-member mixing (Case Study 9–2).

Hydrofacies Back (1966) divided the ion triangles of the Piper diagram into various fields that correspond to water type or *chemical facies* (Figure 9–7). This is a convenient way to classify water types on the basis of their major ion chemistry. Examples of chemical facies names are calcium bicarbonate and sodium chloride. If the water plots in the center of an ion triangle, it is referred to as *mixed-cation* or *mixed-anion facies*. With reference to the waters plotted in Figure 9–6, the Columbia River water belongs to the calcium-bicarbonate facies, the Rio Grande river water to the mixed-cation–mixed-anion facies, and the Central Pennsylvania groundwater to the calcium-bicarbonate facies. The hydrochemical facies in which the water sample plots potentially reveals information about the factors controlling the water chemistry. For example, the observation that the Columbia River water plots in the calcium-bicarbonate facies suggests that rock weathering is the major factor controlling water chemistry (see next section). The observation that the Central Pennsylvania groundwater plots in the calcium-bicarbonate facies suggests that dissolution of limestone, which would provide the Ca and bicarbonate ions, is important

CASE STUDY 9–2
Mixing of Acid Mine Drainage and Lake Water

In Case Study 2–1, Foos (1997) investigated the mixing of acid mine drainage from an abandoned coal mine with water discharged from a lake. The chemical compositions of the acid mine drainage, lake water, and the stream water downstream from the point of mixing were plotted on a Piper diagram (Figure 9–C2–1). This plot indicated that simple mixing would explain the concentrations of the major ions in the stream (mixed water). Further testing of the mixing model revealed that Ca^{2+}, Mg^{2+}, Na^+, K^+, and Cl^- concentrations could be explained by simple mixing, but not HCO_3^- and SO_4^{2-} concentrations. For HCO_3^- and SO_4^{2-}, the deviation from simple mixing was about 14%, so as a first approximation simple mixing is a reasonable assumption. The deviations from simple mixing for Fe^{2+} (1800%) and Mn^{2+} (39%) were significant. The reasons for the nonconservative behavior of these two species was discussed in Case Study 2–1. In this study, the Piper diagram was used to make an initial evaluation of the conservative versus nonconservative behavior of various species in solution.

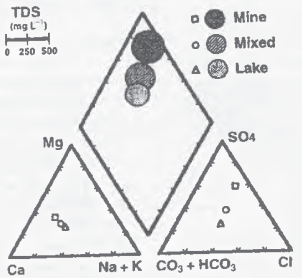

Figure 9–C2–1
Piper diagram showing the compositions of the mine and lake discharges and the mixed stream water. From Foos (1997).

Source: Foos (1997).

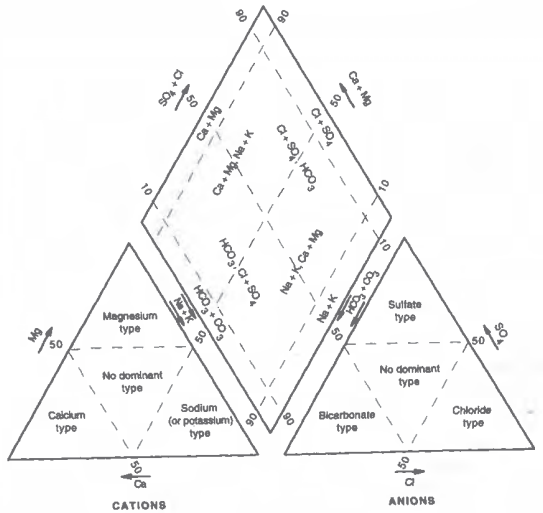

Figure 9–7
Hydrochemical facies. After Back (1966).

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CASE STUDY 9–7
Sulfide Mine Tailings at Two Sites in New Mexico, U.S.A.

Boulet and Larocque (1998) investigated the characteristics of two sulfide mine tailings sites. For both deposits the common ore minerals were chalcopyrite, sphalerite, and galena. At one site (CPA) the tailings were deposited in a polyethylene-lined bermed impoundment. Mining at this site ended in 1995. At the other site (CM) the tailings were deposited in a valley at the headwaters of an ephemeral stream. Mining ceased at this site in 1950.

At the CPA site the dominant tailings minerals are calcite, quartz, and pyrite. A lime slurry was added to the tailings before they were discharged to the tailings pond. The tailings pond water is alkaline (pH = 7 to 8.3) and mineralogical investigation showed no evidence of dissolution of the primary calcite, indicating that the added lime slurry is still providing sufficient buffering capacity. Under the present conditions, the metals in the CPA tailings are immobile and acid drainage is not a problem at this site.

At the CMT site significant weathering and oxidation has occurred. Besides the sulfide minerals, the other primary minerals in this tailing pile were quartz, calcite, and several other silicate minerals. Because of weathering and oxidation, the current assemblage of primary minerals are quartz and the sulfide minerals pyrite, sphalerite, and chalcopyrite. Essentially all the primary calcite has been consumed in buffering reactions. Water draining from the site is strongly acidic (pH = 2.3) and has high metal concentrations. There has been a significant redistribution of metals within the tailings pile. Abundant secondary minerals (the result of the weathering of the primary minerals) have formed throughout the tailings pile. These secondary minerals consist of various iron oxides, hydroxides, and sulfates plus gypsum. In places, these secondary minerals have cemented the tailings to form *hardpans*. The hardpan represents a local zone of neutralization and precipitation, and the highest metal concentrations are found in the hardpan. Elements such as Ag, Au, Pb, and Sb were found at highest concentrations in the layer above the hardpan. These elements form highly insoluble complexes with sulfate, and the slight increase in pH as the waters percolated down through the tailings pile was sufficient to lead to the precipitation of the metal sulfates. The trapping of metals (Ag, Au, As, Pb, and Sb) in the hardpan layers was an important process that inhibited movement of these metals into the local environment. Metals (Cd, Cu, Fe, and Zn) not trapped in the hardpan layers were readily transported by the acid waters draining the site.

Source: Boulet and Larocque (1998).

vironments, such as deltas. Subsequent exposure of this material to subaerial weathering leads to acid drainage and the release of metals. This exposure can be due to either uplift or artificial drainage for land recovery (Case Study 9–8).

Heavy Metals

As defined earlier, heavy metals are those metals of atomic number 20 and greater. Of the heavy metals, the transition elements, As and Se (strictly speaking, metalloids), Cd, Hg, and Pb have attracted the greatest environmental interest. Other metals specifically involved in issues of nuclear waste disposal and radioactive fallout will be considered in the next section.

In a strongly reducing environment, and in the presence of sulfur, all these elements form insoluble sulfides. This, of course, is the reason why coals, which form in strongly reducing environments, contain significant amounts of heavy metals. As long as the environment remains reducing, the elements are immobile and are retained in the sediment. Changes in oxidation–reduction conditions can lead to a release of these elements. For less strongly reducing conditions, or environments that lack sulfur, the heavy metals can become variably mobile. The factors that control element mobility are pH, Eh, and the presence of organic compounds. The most important factors differ depending on the element. Thus, it is convenient to form three metal groups: (1) transition metals, Zn, Cd, and Pb; (2) As and Se; and (3) Hg.

Transition Metals, Zn, Cd, and Pb Under most oxidation–reduction conditions, these elements occur in solution as divalent or trivalent cationic species. Brookins (1988), a very useful reference, gives a number of calculated Eh–pH diagrams for virtually all systems of geochemical interest, and the student should consult this source for Eh–pH diagrams for specific metals. At high pH, many of these elements form insoluble oxyhydroxides or, in the presence of carbonate, insoluble carbonates. As we know from

CASE STUDY 9–8
The Effect of Acid Soil Leaching on Metal Concentrations in Streams

Sulfide-bearing marine and lacustrine sediments are common in the coastal regions of Finland. Artificial drainage of these areas during the past few decades has exposed these sediments to atmospheric O_2 and a high oxidation rate. The result has been the development of acid soils (pH = 2.5 to 5.0). Water-chemistry measurements were made for a stream draining this region under various flow conditions (Åström, 2001). The headwaters originate in an unpopulated area underlain by glacial till, peat, and glaciofluvial deposits. Water-chemistry measurements made at this point constitute the metal baseline concentrations. The concentrations of the metals in the outlet waters (after the stream had traversed the sulfide-bearing sediments) were compared to the baseline values. The outlet-to-baseline ratios varied from 0.3 to 55 as a function of the metal, the magnitude of the stream flow, and the season. The metals that showed downstream depletion were As, Pb, Sb, Ti, and V. The limited leaching of these metals from the acid sulfate soils was believed to be due to low absolute abundances, low concentrations in easily weathered minerals, or low mobility in the soils due to complexation with oxyhydroxides and humic substances. For the elements that showed downstream enrichment, the order, from most enriched to least enriched, was Ni > Co ≈ Cd ≈ Zn > U ≈ Al ≈ Cu ≈ Mn. Åström noted that the downstream variations for all the elements were closely similar to that for SO_4^{2-}, suggesting that the metal and sulfate had a similar hydrogeochemical behavior.

Figure 9–C8–1 shows a typical pH–depth profile for acid sulfate soils and the various redox environments. Seasonal changes in this profile can be directly related to variations in metal release to the stream. Åström proposed the following model to explain the seasonal variations in metal and sulfate concentrations in the stream:

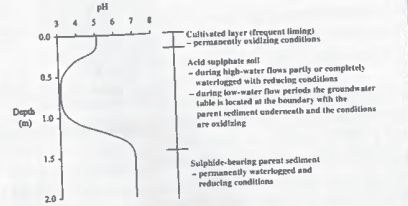

Figure 9–C8–1
pH, redox, and hydrological characteristics of a typical acid sulfate soil. After Åström (2001).

1. During the summer, higher temperatures and a lowered groundwater table favor aerobic bacterial oxidation of sulfide minerals and the release of metals and sulfate to the soils. Substantial alteration of soil minerals also occurs.
2. During periods of heavy rainfall in the autumn, the soluble weathering products are washed from the soils, and sulfate, metal ions, and hydrogen ions are discharged to the stream. As winter approaches, temperatures fall and the water table rises, leading to a cessation in the formation of soluble weathering products.
3. Metal and sulfate inputs to the stream during the early summer are small because most of the soluble weathering products were removed during the fall rains and there has been little formation of new material.
4. Under low flow conditions (summer and early autumn), the contribution from the acid soils is negligible compared to that of the areas covered with the other sediments.

Source: Åström (2001).

earlier discussions, adsorption is an important process. Thus, another important factor is the presence of suitable sorbates, among which are Mn and Fe oxyhydroxides. At low pH, sorbtion is negligible for these metals, but with increasing pH, adsorption becomes an important process (Figure 9–16), effectively removing the metals from solution by adsorption to particles and ultimately to the sediments. These elements also form complexes with dissolved organic matter (humic acids). Tipping and Hurley (1992) determined the following binding order for various metals and humic substances: $Mn^{2+} < Cd^{2+} < Co^{2+} < Ni^{2+} \sim Zn^{2+} < Pb^{2+} < Cu^{2+} < VO^{2+}$.

One notable exception to the behavior just described is vanadium. Under reducing conditions, V occurs as the relatively immobile V^{3+}. In oxic environments, the solubility of V increases dramatically because of conversion to higher oxidation states, V^{4+} and V^{5+}, and the formation of vanadyl cations, $VO_2(OH)_3^{2-}$, H_2VO^{4-}, and HVO_4^{2-}.

Selective Extraction In any given environment, the actual distribution of a metal among various phases may differ substantially from that predicted from first principles. One way to address this question is by a technique known as *selective extraction*, in which various leaching experiments are done to remove the metals from specific phases. The leaching agents are selected so that they remove metals that occur in different ways, i.e., as exchangeable cations, bound to carbonates, bound to amorphous Fe and Mn hydroxides,

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bound to organic matter and sulfides, and as essential components of soil minerals. The experiment is done in a stepwise fashion, starting with a leaching agent that removes only the least tightly held cations. The last step is often a strong acid leach that breaks down the soil minerals. From these types of experiments, estimates can be made of the mobility of various metals in the specific environment. Case Study 9–9 describes a typical selective extraction experiment.

Arsenic and Selenium Arsenic and selenium differ from the transition metals in that they occur in solution as neutral and negatively charged species. Under oxidizing conditions, arsenic is in the +5 state. Given the range of pH values found for the natural environment, As^{5+} exists in solution as $H_2AsO_4^-$ and $HAsO_4^{2-}$. Under reducing conditions, arsenic is in the +3 state and exists in solution as $H_3AsO_{3\,(aq)}$ and $H_2AsO_3^-$. Selenium also shows multiple oxidation states. Under strongly oxidizing conditions, it is in the +6 state (SeO_4^{2-}), under intermediate oxidizing conditions in the +4 state ($HSeO_3^-$ and SeO_3^{2-}), and under reducing conditions, it occurs in its elemental form or in the −2 state (HSe^-). Under reducing conditions, if sulfur is present, both As and Se are incorporated in sulfide minerals. Because As and Se exist in solution as negatively charged species, adsorption increases with declining pH (the surface becomes less negatively charged or positively charged). The arsenate (+5) species form inner-sphere complexes at the iron oxyhydroxide surface and are strongly adsorbed near neutral pH (note from Table 9–11 that for the oxyhydroxides $pH_{pznpc} = 7.8–8.5$), whereas the arsenite (+3) species are only weakly adsorbed at all pH values. For selenium, the situation is reversed and the selenite (+4) species are strongly adsorbed whereas the selenate (+6) species are weakly adsorbed.

The difference in adsorption behavior for the various species of arsenic and selenium is important in terms of their transport in the surface environment. In the case of arsenic, a strongly oxidizing environment that favors the formation of arsenate species will lead to adsorption by oxyhydroxides and removal from the aqueous environment. If conditions become reducing, the bound arsenate will be converted to arsenite and can be liberated from the particles to the solution. The reverse behavior would be noted for the various selenium species; i.e., selenium tends to remain in solution under oxidizing conditions but is removed under reducing conditions. The important point is that changes in the redox conditions of the environment can lead to either removal or liberation of arsenic and selenium. The other important point is that the kinetics of the redox reactions is slow, so

CASE STUDY 9–9
Geochemical Behavior and Mobility of Metals in a Sediment Retention Pond

Lee et al. (1997) studied the mobility of metals in a sediment retention pond located along a motorway in France. The purpose of these retention ponds is to accumulate particulates contaminated by heavy metals, thus preventing their discharge to surrounding streams. Eight sediment cores were driven to depths of 16 to 20 cm. The interstitial fluids were extracted and analyzed for their metal content. The metals associated with the solid phases were then analyzed using sequential chemical extraction. The authors used a five-step process, as follows:

1. Fraction I: *Exchangeable*, 1 M $MgCl_2$ at pH 7
2. Fraction II: *Bound to carbonate*, 1 M sodium acetate adjusted to pH 5.0 with acetic acid for 5 h
3. Fraction III: *Bound to amorphous Fe and Mn hydroxides*, 0.04 M hydroxylamine hydrochloric acid in 25% (v/v) acetic acid at 96°C for 6 h
4. Fraction IV: *Bound to organic matter and sulfides*, 30% H_2O_2 and 0.02 M nitric acid at 85°C for 5 h
5. Fraction V: *Residual*, concentrated HNO_3 and $HClO_4$

For the four metals of interest, Pb was concentrated in Fraction V (35–60%) and Fraction III (20–44%), Zn in Fraction V (30–65%) and Fraction III (13–47%), and Cd in Fraction II (25–68%). Mn showed a more complex behavior, with the bulk of the Mn in the surface layers in the exchangeable fractions (I, II, and III) and a notable increase with depth of Mn in the nonexchangeable Fraction V. The authors ascribed this increase in the nonexchangeable fraction to either the precipitation of Mn^{4+} oxides or the incorporation of Mn in Fe oxyhydroxides. Metals concentrated in Fraction V would be essentially immobile in the surface environment.

Source: Lee et al. (1997).

disequilibrium is common. Thus, predicting the mobility of arsenic and selenium under a particular set of environmental conditions is difficult.

Both elements are of environmental interest. Arsenic in very high concentrations (not those encountered in surface and ground waters, but perhaps due to human intervention) is a poison. Low-level, long-term exposure to arsenic may lead to an increased risk of cancer (National Academy of Sciences, 1999). For this reason, the USEPA (U.S. Environmental Protection Agency) has recommended lowering the allowable amount of arsenic in drinking water. The major anthropogenic source of arsenic is pesticides applied to orchards and other crop lands. Selenium is an essential metal for human health, but at slightly higher levels it becomes a toxic element. Certain plants can accumulate selenium, causing toxicity problems for ruminants that graze on the plants. The major anthropogenic source for selenium is deposition of atmospheric aerosols derived from the burning of coal.

Mercury Under a wide range of Eh–pH conditions mercury exists as mercury metal (remember that at room temperature mercury metal is a liquid). Liquid mercury is essentially insoluble in water, but mercury is transferred to the atmosphere by volatilization. Under strongly oxidizing conditions mercury exists either as the Hg^{2+} ion or its hydrolysis product $Hg(OH)_{2\,(aq)}$. In a reducing environment, if sulfur is present, mercury can form the insoluble sulfide HgS (cinnabar).

The global cycle of mercury is dominated by the vapor phase transport of Hg^0 (Figure 9–21). The residence time of mercury in the atmosphere is 1 year. However, because of the equilibrium between the atmosphere and the surface ocean, the rate constant for mercury removal from the atmosphere is 0.29 y^{-1}. Because of the low removal rate of mercury by the surface ocean, the bulk of the mercury is deposited on land, where it is sequestered in the soils.

In its metallic form mercury is essentially inert. While this means it does not represent an immediate environmental hazard, it also means that mercury can persist for an extended period of time in the natural environment. Certain microorganisms, such as anaerobic bacteria, can mediate the methylation of mercury (Figure 9–21) to monomethyl mercury (CH_3Hg) or dimethyl mercury [$(CH_3)_2Hg$], which are highly soluble species that are readily taken up by aquatic organisms, particularly fish and shellfish. The mercury is concentrated up the food chain and can reach concentrations of several thousand ppm in organisms residing at the highest trophic levels. At these concentration levels, mercury is

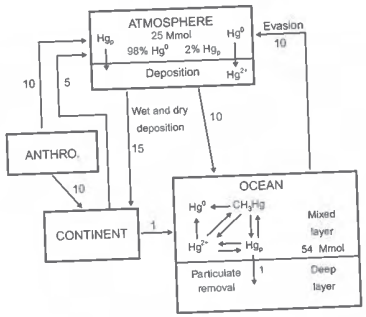

Figure 9–21
Present-day mercury cycle. The fluxes are given in Mmol L^{-1}. Hg_p represents mercury adsorbed to particles. Anthropogenic inputs are approximately 20 Mmol y^{-1}; half is returned to the surface close to the source and the other half is transferred to the atmosphere as volatile mercury. Adapted from Mason et al. (1994).

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hazardous to human health. Because methylation of mercury is mediated by anaerc bacteria, some of the mercury deposited in sediments in a reducing environment, eve sulfur is present, may be converted to soluble methyl species rather than insoluble merc sulfide.

Metal Variations in Space and Time A variety of approaches are used to determ both natural and anthropogenic distributions of metals in the surface environment. (such approach is a regional geochemical survey in which the metal content of s streams, and groundwater is determined (Reimann et al., 2001; Sewell, 1999). The purp of such studies is to gather information on both the background concentrations of the r als and areas of abnormally high metal concentrations. The bulk of these techniques v developed in the 1950s and 1960s, when they were used in geochemical exploration grams for base metal ore deposits. The sampling of different types of material can be u to infer the source of the metals. For example, Reimann et al. (2001) used four diffe sample materials: terrestrial moss, which predominantly reflects the atmospheric inpu metals; the O-soil horizon, which reflects the interplay among atmosphere, biosphere, lithosphere; the B-soil horizon, which reflects weathering processes; and the C-soil h zon, which represents the bedrock geochemistry.

The geochemical patterns can be compared to bedrock geology, surficial geol land use, etc. Such studies have been greatly facilitated by the advent of Geograph Information Systems (GIS), which enables a multidimensional correlation of various rameters. For example, in the case of high levels of arsenic in groundwater, which have both natural (bedrock) and anthropogenic sources (pesticides), a comparison bedrock geology, land use, and arsenic well water concentrations can be used to di guish between natural and anthropogenic sources of arsenic (Ayotte et al., 1999).

We are also interested in changes in metal concentrations with time. In Chapter 8 discussed how snow, ice, lake sediments, and biological indicators can be used to changes in atmospheric deposition of metals. In the case of the continental environm the most useful information is contained in lake sediments. In general, lake sediment the result of vertical sedimentation. As we have discussed in previous chapters, it is sible to determine the age of lake sediments as a function of depth. Chemical or iso analysis of the various layers can then be used to trace changes in anthropogenic input time.

Metal Contamination of Soils and Sediments A number of processes seque metals in sediments. One way to look at the anthropogenic enrichment of metals in ments is to compare the abundance of the metals to background (or reference) values. of the commonly used references is average shale. The calculation is analogous to tha enrichment factors (discussed in Chapter 8); i.e.,

$$\text{Enrichment factor} = \frac{\text{Concentration in sediment}}{\text{Concentration in reference material}} \quad (9$$

The geoaccumulation index (Müller, 1979) can be used to assess the degree of cont nation. The index is calculated as follows

$$I_{geo} = \log_2\left(\frac{C_n}{1.5B_n}\right) \quad (9$$

where I_{geo} is the geoaccumulation index, $\log_2$ is log base 2, C_n is the concentration i sediment, and B_n is the background or reference concentration. After the geoaccum tion index has been calculated, it can be used to classify the sediment in terms of qu (Table 9–14).

Radioactive Isotopes and Radioactive Waste Disposal

Radioactive isotopes in the environment come from both natural sources (K, Th, and rocks and minerals) and anthropogenic sources (bomb testing, nuclear medicine, nu accidents, and the nuclear fuel cycle). Radioactivity and radioactive decay were disc

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health hazard. At these higher concentrations fluoride can cause dental fluorosis (tooth mottling) and skeletal fluorosis (bone deformation and painful brittle joints). Natural sources of fluorine are volcanic emissions and the weathering of fluoride-containing minerals. Anthropogenic sources are mining and industrial emissions.

The concentration of fluoride in natural waters is largely controlled by dissociation reactions involving fluoride-containing minerals, of which the most important is fluorite. The dissociation reaction is

$$CaF_{2\ \text{fluorite}} \rightarrow Ca^{2+} + 2F^-$$

From the data in Appendix II, source 3, the equilibrium constant for this reaction, at 25°C, is

$$K_{\text{fluorite}} = [Ca^{2+}][F^-]^2 = 10^{-10.51}$$

Writing this equation in logarithmic form gives

$$\log K_{\text{fluorite}} = \log[Ca^{2+}] + 2[\log F^-] = -10.51$$

On a logarithmic plot, the relationship between the concentrations of the two ionic species in solution and fluorite solubility plots as a straight line (Figure 9–24). This is a very useful plot because it allows us to determine if a water is saturated with respect to fluorite, the major mineral controlling F^- concentrations. Consider a water sample of composition A. The water sample is undersaturated with respect to fluorite, and fluoride can be added to the water until it becomes saturated (A → B). At this point the concentration of fluoride will remain constant unless we reduce the Ca^{2+} concentration, in which case the F^- concentration can increase (B → C). If we increase the Ca^{2+} concentration (A → D), the solution will eventually become saturated in fluorite. Continued addition of Ca^{2+} will lead to a decrease in the F^- concentration in solution (D → E). It has been suggested that Ca^{2+} could be added (in the form of gypsum) to high F^- waters, leading to the precipitation of fluorite and a reduction in the F^- concentration. Most natural waters are undersaturated or just saturated with respect to fluorite, suggesting that fluorite solubility controls the F^- concentration of natural waters (Case Study 9–10).

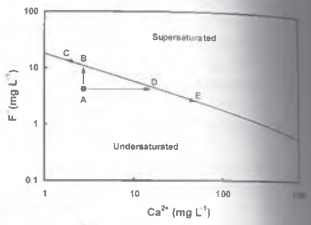

Figure 9–24
Solubility of fluorite at 25°C as a function of F^- and Ca^{2+} concentrations. See text for discussion.

Cl^- and Br^- Chlorine and bromine have both natural and anthropogenic sources. Natural sources include seawater, subsurface brines, and evaporite deposits. Anthropogenic sources for bromine include pesticides, medicines, industrial solvents, gasoline additives, and water purification. For chlorine, the list is even more extensive because it is one of the most widely used elements in modern industrial chemistry. Degradation of these anthropogenic compounds releases Cl^- and Br^- to solution, apparently largely in the form of simple ions. Hydrochemical characteristics of both compounds are (1) low concentration in most rock-forming minerals, (2) high solubility of most nonsilicate compounds, (3) virtually no adsorption by particles, (4) lack of volatile compounds, and (5) generally low bioconcentrations in aqueous systems. Because of these characteristics, both elements behave as conservative species and they have been widely used as tracers in hydrological systems. Bromine and chlorine, however, do differ in several important ways: (1) Bromide compounds are even more soluble than chloride compounds. During the formation of evaporite deposits Br is concentrated with respect to Cl in the late-stage brines, leading to a decrease in the Cl/Br ratio. (2) Br does show some adsorption characteristics, particularly at low pH, on kaolinite and iron oxide surfaces.

CASE STUDY 9–10
F^- Concentrations in Streams and Groundwaters from Nalgonda District, India

Ground and surface waters in the Nalgonda District of India contain elevated levels (0.4 to 20 mg L^{-1} for groundwater and 0.4 to 6.6 mg L^{-1} for surface waters) of fluoride, which has led to endemic fluorosis (Ramamohana Rao et al., 1993). There are no fluorine-based industries in the area (nor volcanoes), so the fluorine must originate from the minerals in the rocks and soils. The area is underlain by several varieties of granites that contain the fluorine-bearing minerals fluorite (0 to 3.3%), biotite (0.1 to 1.7%), and hornblende (0.1 to 1.1%). Whole-rock F content ranges from 325 ppm to 3200 ppm, with a mean of 1440 ppm. Acid-soluble fluoride content (fluoride contained in fluorite and fluoroapatite, which can be removed by acid leaching) ranges from 40 to 1150 ppm, with a mean of 410 ppm. The overlying soils are also relatively high in fluoride, have relatively low Ca and Mg concentrations and high Na concentrations. There is an inverse relationship between hardness (Ca + Mg) and fluoride concentration and a direct relationship between alkalinity (due to the presence of Na in the soils) and fluoride concentration. All the soils have basic pH values. In a series of experiments the authors found that the solubility of fluorite was significantly increased in the presence of sodium carbonate and sodium bicarbonate, due to the following reactions:

$$CaF_{2\ \text{fluorite}} + 2Na^+ + CO_3^{2-} \rightarrow CaCO_{3\ \text{calcite}} + 2Na^+ + 2F^-$$

and

$$CaF_{2\ \text{fluorite}} + 2Na^+ + 2HCO_3^- \rightarrow CaCO_{3\ \text{calcite}} + 2Na^+ + 2F^- + H_2O + CO_2$$

The authors concluded that these reactions led to the precipitation of calcite and a reduction in the amount of Ca^{2+} available for fluorite precipitation, thus increasing the amount of F^- in solution.

Source: Ramamohana Rao et al. (1993).

(3) There is some evidence that marine plants and surface plants do concentrate Br (Davis et al., 1998).

Because there are natural processes that will change the Cl/Br ratio, plus anthropogenic inputs that may lead to relative increases in Br or Cl concentrations and changes in the Cl/Br ratio, Davis et al. (1998) suggested that Cl/Br ratios could be used to fingerprint the sources of various waters in an aquifer. Once Cl and Br have entered a groundwater system, they tend to behave conservatively. Thus, variations in the Br/Cl ratio reflect variable degrees of end-member mixing. In Chapter 6 we developed mixing equations for isotopic systems. Analogous mixing equations can be written for conservative species. For a simple binary mixture involving two end members, the mathematics are straightforward if we use the abundances of the conservative species rather than ratios. For a mixture involving one conservative species and two end members, we can write

$$X_M = X_A f_A + X_B(1 - f_A) \tag{9–42}$$

where X_M is the concentration of species X in the mixture, X_A is the concentration of species X in end member A, X_B is the concentration of species X in end member B, and f_A (the mixing parameter) is the fraction of end member A. For a second conservative species in a mixture, we can write

$$Y_M = Y_A f_A + Y_B(1 - f_A) \tag{9–43}$$

where Y is the second conservative species. For a binary mixture involving conservative species, f_A must be the same for all species. We can solve equations 9–42 and 9–43 for f_A and equate the results:

$$f_A = \frac{X_M - X_B}{X_A - X_B} = \frac{Y_M - Y_B}{Y_A - Y_B} \tag{9–44}$$

Cross multiplying equation 9–44 and solving for Y_M gives

$$Y_M = X_M \frac{Y_A - Y_B}{X_A - X_B} + \frac{X_A Y_B - X_B Y_A}{X_A - X_B} \tag{9–45}$$

which is the equation for a straight line (Figure 9–25, p. 368). For any simple binary mixture of two conservative species, the data will fall on a straight line. The purpose of this

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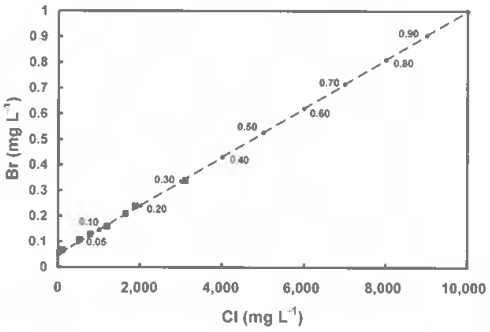

Figure 9–25
Binary mixture of groundwater (0.05 mg L^{-1} Br and 5 mg L^{-1} Cl) and brine (1 mg L^{-1} Br and 10,000 mg L^{-1} Cl). Labeled points are fraction of brine in the mixture. Groundwater samples from an aquifer (filled squares) fall along this line, suggesting they represent mixtures of uncontaminated groundwater and brine. The maximum amount of brine in the groundwater is approximately 31%.

exercise is to determine if a set of data obeys a simple binary mixing model. If the data do obey a simple binary mixing model, and if we know the composition of the end members, either equation 9–42 or 9–43 can be solved for the fraction of each end member in the individual samples. For example, groundwater samples were collected from a number of wells in an aquifer (filled squares in Figure 9–25). It is believed that subsurface brines are mixing with the groundwater. The well data plot on a straight line. The end-member compositions, based on measurements of groundwater entering the aquifer and the brine, are 0.05 mg L^{-1} of Br and 5 mg L^{-1} of Cl for the uncontaminated groundwater and 1 mg L^{-1} of Br and 10,000 mg L^{-1} of Cl for the brine. The labeled points on the diagram represent the fraction of brine. Inspection of Figure 9–25 reveals that the groundwater samples represent mixtures containing from 1% to about 31% brine.

Suppose our water samples consist of a mixture of three end members. As was discussed in Chapter 6, the data will fall within a triangular field. We can determine the fraction of the three end members in any particular sample using a graphical solution (Figure 6–14). If we know the end-member compositions, we can determine the fraction of each end member by solving a set of linear equations. For a three-end-member (A, B, and C) mixture, the concentration of X in the mixture is

$$X_M = X_A f_A + X_B f_B + X_C f_C \tag{9–46}$$

and the concentration of Y in the mixture is

$$Y_M = Y_A f_A + Y_B f_B + Y_C f_C \tag{9–47}$$

The symbols are as defined earlier. For our third equation,

$$f_A + f_B + f_C = 1 \tag{9–48}$$

because the total end-member fractions must add up to 1. Simultaneous solution of these three equations yields the end-member fractions.

Nitrogen

Nitrogen shows a complex and varied behavior in the natural environment (Figure 9–26). In Chapter 4 we constructed the Eh–pH diagram (Figure 4–9) for the various nitrogen species found in water. Depending on redox conditions, nitrogen can occur in natural wa-

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METHOD 1314[1]

LIQUID-SOLID PARTITIONING AS A FUNCTION OF LIQUID-SOLID RATIO FOR CONSTITUENTS IN SOLID MATERIALS USING AN UP-FLOW PERCOLATION COLUMN PROCEDURE

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required methods used for the analysis of method-defined parameters, are intended to be guidance methods that contain general information on how to perform an analytical procedure or technique, which a laboratory can use as a basic starting point for generating its own detailed standard operating procedure (SOP), either for its own general use or for a specific project application. Performance data included in this method are for guidance purposes only and must not be used as absolute quality control (QC) acceptance criteria for purposes of laboratory QC or accreditation.

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[1] This method has been derived from the CT001 procedure (Ref. 4) and is analogous to column percolation method CEN/TS 14405 (Ref. 5) developed for the Comité Européen de Normalisation (CEN).

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1.0 SCOPE AND APPLICATION

1.1 This method is designed to provide the liquid-solid partitioning (LSP) of inorganic constituents (e.g., metals, radionuclides) and non-volatile organic constituents (e.g., polycyclic aromatic hydrocarbons (PAHs), dissolved organic carbon, etc.) in a granular solid material as a function of liquid-to-solid ratio (L/S) under percolation conditions. The first eluates of the column test may provide insight into the composition of pore solution either in a granular bed (e.g., soil column) or in the pore space of low-permeability material (e.g., solidified monolithic or compacted granular fill). Analyses of eluates for dissolved organic carbon and of the solid phase for total organic carbon afford evaluation of the impact of organic carbon release and the influence of dissolved organic carbon on the LSP of inorganic constituents.

1.2 This method is intended to be used as part of an environmental leaching assessment for the evaluation of disposal, beneficial use, treatment effectiveness, and site remediation. The method is not required by federal regulations to determine whether waste passes or fails the toxicity characteristic as defined at 40 CFR 261.24.

1.3 This method is suitable to a wide range of granular solid materials. Example materials include industrial wastes, soils, sludges, combustion residues, sediments, construction materials, and mining wastes. This method is not suitable to monolithic materials (e.g., cement-based and stabilized materials) without particle size reduction prior to testing.

1.4 This test method is intended as a means for obtaining a series of extracts (i.e., the eluates) of a granular solid material that may be used to show eluate concentrations and/or cumulative release as a function of L/S, which can be related to a time scale when data on mean infiltration rate, density and height of application are available.

1.5 This method provides options for the preparation of analytical samples that provide flexibility based on the level of detail required. For example, when the purpose of characterization is for comparison to previous testing, compositing of eluates may be possible to create a reduced set of analytical samples. Table 1 outlines the eluate fractions and collection options, based on whether concentration or cumulative release is to be reported. The collection schemes are described below.

1.5.1 Complete characterization

For complete characterization of eluate concentration and cumulative release as a function of L/S, nine discrete eluate collections and analyses are required (see Table 1, Option A). No compositing of eluate fractions is performed for complete characterization, and all eluate fractions are analyzed.

Eluate concentrations from complete characterization may be used in conjunction with information regarding environmental management scenarios to estimate anticipated leaching concentrations, release rates, and extents of release for individual material constituents in the management scenarios evaluated. Eluate concentrations may also be used along with geochemical speciation modeling to infer the mineral phases that control the LSP in the pore structure of the solid material.

1.5.2 Limited analysis

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Under a limited analysis approach, nine eluate collections and analysis of six analytical samples are required. If evaluation is based on eluate concentrations, six discrete eluate fractions are chemically analyzed (see Table 1, Option B). If evaluation is based on cumulative release, some eluate fractions are composited by volume-weighted averaging to create a set of six analytical samples (see Table 1, Option C). The concentrations of composite analytical samples cannot be interpreted along with eluate fractions on the basis of concentration.

1.5.3 Index testing

For the determination of consistency between the subject material and previously characterized materials, nine eluate collections and analysis of three analytical samples are required. If consistency is to be determined by eluate concentrations, three discrete eluate fractions are chemically analyzed (see Table 1, Option D). If consistency is to be determined by cumulative release, some eluate fractions are composited by volume-weighted averaging to create a set of three analytical samples (see Table 1, Option E). The concentrations of composited analytical samples cannot be interpreted along with eluate fractions on the basis of concentration.

1.6 This method is not applicable to characterize the release of volatile organic analytes.

1.7 This method provides eluate solutions considered indicative of leachate under field conditions only where the field leaching pH is controlled by the alkalinity or acidity of the solid material and the field leachate is not subject to dilution or other attenuation mechanisms. The cumulative mass of constituent released over a L/S range may be considered an estimate of the maximum mass of that constituent to be leached under field leaching over intermediate timeframes (e.g., up to 100 years) and the domain of laboratory test pH.

1.8 Prior to employing this method, analysts are advised to take reasonable measures to ensure that the granular sample is homogenized to the most practical extent. Particle size reduction may provide additional assurance of sample homogenization.

1.9 In preparation of solid materials for use in this method, particle size reduction or exclusion of samples with large grain size is used to enhance the approach towards liquid-solid equilibrium over the residence time of eluent in the column.

1.10 The structure and use of this method is similar to that of NEN 7343 (see Ref. 3) and CEN/TS 14405 (see Ref. 5).

1.11 Prior to employing this method, analysts are advised to consult the base method for each type of procedure that may be employed in the overall analysis (e.g., Methods 9040, 9045 and 9050, and the determinative methods for the target analytes) for additional information on QC procedures, development of QC acceptance criteria, calculations, and general guidance. Analysts also should consult the disclaimer statement at the front of the manual and the information in Chapter Two for: 1) guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and 2) the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

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In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to federal testing requirements. The information contained in this method is provided by the Environmental Protection Agency (EPA or the Agency) as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives (DQOs) for the intended application. Guidance on defining DQOs can be obtained at http://www.epa.gov/QUALITY/qs-docs/g4-final.pdf.

1.12 This method is restricted to use by, or under supervision of, properly experienced and trained personnel. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

Eluent is introduced into a column of moderately packed granular material in an up-flow pumping mode, with eluate collection performed as a function of the cumulative L/S. Up-flow pumping is used to minimize air entrainment and flow channeling. The default eluent for most materials is reagent water. However, a solution of 1.0 mM calcium chloride in reagent water is used when testing materials with either a high clay content (i.e., to prevent deflocculation of clay layers) or high organic matter (i.e., to moderate mobilization of dissolved organic carbon). The flow rate is maintained between 0.5-1.0 L/S per day to increase the likelihood of local equilibrium between the solid and liquid phases, due to residence times longer than one day. Eluate volumes are chemically analyzed for a combination of inorganic and non-volatile organic analytes depending on the constituents of potential concern (COPC). For the purposes of chemical speciation modeling, the entire eluent volume up to 10 mL/g dry sample (g-dry) is collected in nine specific aliquots of varying volume. A limited subset of eluent volumes within the same L/S range may be collected and analyzed for regulatory and compliance purposes. A flowchart for performing this method is shown in Figure 1.

3.0 DEFINITIONS

3.1 Constituent of potential concern (COPC) – A chemical species of interest, which may or may not be regulated, but may be characteristic of release-controlling properties of the sample geochemistry.

3.2 Release – The dissolution or partitioning of a COPC from the solid phase to the aqueous phase during laboratory testing (or under field conditions). In this method, mass release is expressed in units of mg COPC/kg dry solid material.

3.3 Liquid-solid partitioning (LSP) – The distribution of COPCs between the solid and liquid phases at the conclusion of the extraction.

3.4 Liquid-to-solid ratio (L/S) – The fraction of the total liquid volume (including the moisture contained in the "as-used" solid sample) to the dry mass equivalent of the solid material. L/S is typically expressed in volume units of liquid per dry mass of solid material (mL/g-dry).

3.5 "As-tested" sample – The solid sample at the conditions (e.g., moisture content and particle size distribution) present at the time of the start of the test procedure. The "as-tested"

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conditions will differ from the "as-received" sample conditions if particle size reduction and drying were performed.

3.6 Dry-mass equivalent – The mass of an "as-tested" (i.e., "wet") sample that equates to the mass of dry solids plus associated moisture, based on the moisture content of the "as-tested" material. The dry-mass equivalent is typically expressed in mass units of the "as-tested" sample (g).

3.7 Eluent – The solution used to contact the solid material in a leaching test. The eluent is usually free of COPCs but may contain other species used to control the test conditions of the extraction.

3.8 Eluate – The solution collected as an extract from a leaching test that contains the eluent plus constituents leached from the solid phase.

3.9 Refer to Chapter One, Chapter Three, and the manufacturer's instructions for definitions that may be relevant to this procedure.

4.0 INTERFERENCES

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences during sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method to be used for specific guidance on QC procedures and to Chapters Three and Four for general guidance on glassware cleaning. Also refer to Methods 9040, 9045 and 9050 and the determinative methods to be used for information regarding potential interferences.

4.2 When the test method is applied to solid materials with a clay content greater than 10% or an organic matter content greater than 1%, a solution of 1.0 mM calcium chloride in reagent water is recommended to minimize deflocculation of clay minerals. However, the use of calcium chloride solution will interfere with the determination of actual calcium and chloride release.

4.3 When this method is applied to fine-grained granular materials, tamping during column preparation may result in flow problems due to a low-permeability sample bed. This problem can be resolved by incorporating 20 - 50% inert material (e.g., 20-30-mesh normal sand or 2-mm borosilicate glass beads) into the solid sample. Alternatively, mass release from low-permeability materials may be measured using Method 1315.

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The laboratory is responsible for maintaining a safe work environment and a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals specified in this method. A reference file of safety data sheets (SDSs) should be available to all personnel involved in these analyses.

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5.2 During preparation and processing of extracts and/or eluents/eluates, some waste materials may generate heat or evolve potentially harmful gases when contacted with acids and bases. Adequate prior knowledge of the material being tested should be used to establish appropriate personal protection and workspace ventilation.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for use. The products and instrument settings cited in SW-846 methods represent those products and settings used during the method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

This section does not list common laboratory glassware (e.g., beakers and flasks) that might be used.

6.1 Column apparatus

This method recommends the use of a specific column apparatus (see Figure 2). Equipment with equivalent specifications may be substituted. The apparatus should have valves and quick connectors (e.g., Luer lock fittings) such that the column with end caps can be removed for packing with test material and mass measurements.

6.1.1 A 30-cm, straight cylindrical column with an inner diameter (ID) of 5 cm and constructed of inert material, resistant to high and low pH conditions and interaction with constituents of interest.

6.1.1.1 For the evaluation of inorganic COPC mobility, equipment composed of borosilicate glass (e.g., Kimble-Kontes CHROMAFLEX #420830-3020 or equivalent), polytetra-fluoroethylene (PTFE), high density polyethylene (HDPE), polypropylene (PP), or polyvinyl chloride (PVC) is recommended.

6.1.1.2 For the evaluation of non-volatile organic and mixed organic/inorganic COPCs, equipment composed of glass or Type 316 stainless steel is recommended. PTFE is not recommended for non-volatile organics, due to sorption of species with high hydrophobicity (e.g., PAHs). Borosilicate glass is recommended over other types of glass, especially when inorganic analytes are of concern.

6.1.2 The column must be of sufficient volume to accommodate a minimum of 300 g dry material plus a 1-cm layer of silica sand (20-30 mesh) used at the bottom of the column to distribute eluent flow and at the top of the column to form a coarse filter for eluate particulates.

6.1.3 The column must have end cap materials that form a leak-proof seal and that can withstand pressures, such as encountered when pumping eluent through the column.

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6.2 Eluent feed stock container – Resealable bottle or other container, constructed of inert material, capable of withstanding extreme pH conditions and interaction with any constituents of interest (see guidance in Sec. 6.1.2)

6.3 Eluent feed tubing – 2-mm or similarly small ID tubing composed of chemically inert material such as PVC or equivalent

NOTE: Larger ID tubing may be required as a feed to the pump and manifold if a single eluent stock container is used to feed multiple column set-ups.

6.4 Eluate collection bottles – Capable of assembly with column apparatus using simple water locks in order to prevent the intrusion of air (see Figure 2)

6.5 20-30 mesh normal washed quartz sand

6.6 Balance – Capable of 0.01 g resolution for masses less than 500 g

6.7 Filtration apparatus – Pressure or vacuum filtration apparatus composed of appropriate materials so as to maximize the collection of extracts and minimize loss of the COPCs (e.g., Nalgene #300-4000 or equivalent) (see Sec. 6.1)

6.8 Filtration membranes – Composed of hydrophilic polypropylene or equivalent material with an effective pore size of 0.45 µm (e.g., Gelman Sciences GH Polypro #66548 from Fisher Scientific or equivalent)

6.9 pH meter – Laboratory model with the capability for temperature compensation (e.g., Accumet 20, Fisher Scientific or equivalent) and a minimum resolution of 0.1 pH units

6.10 pH combination electrode – Composed of chemically resistant materials

6.11 Conductivity meter – Laboratory model (e.g., Accumet 20, Fisher Scientific or equivalent), with a minimum resolution of 5% of the measured value

6.12 Conductivity electrodes – Composed of chemically resistant materials

7.0 REAGENTS AND STANDARDS

7.1 Reagent-grade chemicals, at a minimum, should be used in all tests. Unless otherwise indicated, all reagents should conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS), where such specifications are available. Other grades may be used, provided the reagent is of sufficiently high purity to permit use without lessening the accuracy of the determination. Inorganic reagents and extracts should be stored in plastic to prevent interaction of constituents from glass containers.

7.2 Reagent water – Reagent water must be interference free. All references to water in this method refer to reagent water unless otherwise specified.

7.3 Calcium chloride (1.0 mM), $CaCl_2$ – Prepared by dissolving 0.11 g of ACS grade (or better) solid calcium chloride in 1 L of reagent water

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8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1 See Chapter Three, "Inorganic Analytes," and Chapter Four, "Organic Analytes," for sample collection and preservation instructions.

8.2 All samples should be collected using an appropriate sampling plan.

8.3 All containers should be composed of materials that minimize interaction with solution COPCs. For further information, see Chapters Three and Four.

8.4 Preservatives should not be added to samples before extraction.

8.5 Samples can be refrigerated, unless refrigeration results in an irreversible physical change to the sample.

8.6 Analytical extracts should be preserved according to the guidance given in the individual determinative methods for the COPCs.

8.7 Extract holding times should be consistent with the aqueous sample holding times specified in the determinative methods for the COPCs.

9.0 QUALITY CONTROL

9.1 Refer to Chapter One for guidance on quality assurance (QA) and quality control (QC) protocols. When inconsistencies exist between QC guidelines, method-specific QC criteria take precedence over both technique-specific criteria and Chapter One criteria, and technique-specific QC criteria take precedence over Chapter One criteria. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a quality assurance project plan (QAPP) or a sampling and analysis plan (SAP), which translates project objectives and specifications into directions for those who will implement the project and assess the results.

Each laboratory should maintain a formal QA program. The laboratory should also maintain records to document the quality of the data generated. Development of in-house QC limits for each method is encouraged. Use of instrument-specific QC limits is encouraged, provided such limits will generate data appropriate for use in the intended application. All data sheets and QC data should be maintained for reference or inspection.

9.2 In order to demonstrate the purity of reagents, at least one eluent blank should be tested. If multiple batches of eluent are employed, one eluent blank from each batch should be analyzed.

9.3 The analysis of extracts should follow appropriate QC procedures, as specified in the determinative methods for the COPCs. Refer to Chapter One for specific QC procedures.

9.4 Unless the "as-received" samples are part of a time-dependent (e.g., aging) study, solid materials should be processed and tested within one month of their receipt.

9.5 Initial demonstration of proficiency (IDP)

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Leachate methods are not amenable to typical IDPs when reference materials with known values are not available. However, prior to using this method an analyst should have documented proficiency in the skills required for successful implementation of the method. For example, skill should be demonstrated in the use of an analytical balance, the determination of pH using Methods 9040 and 9045, and the determination of conductance using Method 9050.

10.0 CALIBRATION AND STANDARDIZATION

10.1 The balance should be calibrated and certified, at a minimum, annually or in accordance with laboratory policy.

10.2 Prior to measurement of eluate pH, the pH meter should be calibrated using a minimum of two standards that bracket the range of pH measurements. Refer to Methods 9040 and 9045 for additional guidance.

10.3 Prior to measurement of eluate conductivity, the meter should be calibrated using at least one standard at a value greater than the range of conductivity measurements. Refer to Method 9050 for additional guidance.

11.0 PROCEDURE

A flowchart for the method procedure is presented in Figure 1. Microsoft Excel® data templates are available to aid in collecting and archiving of laboratory and analytical data.[2]

11.1 Preparatory procedures – Particle size reduction (if required)

11.1.1 In this method, particle size reduction is used to prepare large-grained samples for the column test so that the approach toward liquid-solid equilibrium is enhanced and fluid channeling along column walls is minimized. The maximum particle size of the solid should ≤ 1/20 of the column diameter. For the column recommended in this method, a maximum particle size of 2.5 mm is acceptable. Therefore, 85% of the test material should pass through a 2.38-mm (U.S. No. 8) sieve. If less than 15% of the solid material is larger than the maximum acceptable particle size, this fraction of the solid may be excluded from the material tested, rather than particle size-reduced. The mass and nature of the discarded fraction should be documented.

11.1.2 Particle size reduction of an "as received" sample may be achieved through crushing, milling, or grinding with equipment made from chemically inert materials. During the reduction process, care should be taken to minimize the loss of sample and potentially volatile constituents in the sample.

11.1.3 If the moisture content of the "as received" material is greater than 15% (wet basis), air drying or desiccation may be necessary. Oven drying is not recommended for the

[2] These Excel® templates form the basis for uploading method data into the data management program, LeachXS Lite™. Both the data templates and LeachXS Lite™ are available at http://vanderbilt.edu/leaching.

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preparation of test samples due to the potential for mineral alteration and volatility loss. In all cases, the moisture content of the "as received" material should be recorded.

NOTE: If the solid material is susceptible to interaction with the atmosphere (e.g., carbonation, oxidation), drying should be conducted in an inert environment.

11.1.4 When the material seems to be of a relatively uniform particle size, calculate the percentage less than the sieve size as follows:

$$\%\ \text{Passing} = \frac{M_{\text{sieved}}}{M_{\text{total}}} \times 100\%$$

Where: M_{sieved} = mass of sample passing the sieve (g)
M_{total} = mass of total sample (g) (e.g., M_{sieved} + mass not passing sieve)

11.1.5 The fraction retained by the sieve should be recycled for further particle size reduction until at least 85% of the initial mass has been reduced below the designated maximum particle size. Calculate and record the final percentage passing the sieve and the designated maximum particle size. For the uncrushable fraction of the "as-received" material, record the fraction mass and nature (e.g., rock, metal or glass shards, etc).

11.1.6 Store the size-reduced material in an airtight container in order to prevent contamination via gas exchange with the atmosphere. Store the container in a cool, dark, and dry place prior to use.

11.2 Determination of solids and moisture content

11.2.1 In order to provide the dry mass equivalent of the "as-tested" material, the solids content of the subject material should be determined. Often, the moisture content of the solid sample is recorded. In this method, the moisture content is determined and recorded on the basis of the "wet" or "as-tested" sample.

WARNING: The drying oven should be contained in a hood or otherwise properly ventilated. Significant laboratory contamination or inhalation hazards may result when drying heavily contaminated samples. Consult the laboratory safety officer for proper handling procedures prior to drying samples that may contain volatile, hazardous, flammable, or explosive materials.

11.2.2 Place a 5 to10-g sample of solid material into a tared dish or crucible. Dry the sample to a constant mass at 105 ± 2 °C. Check for constant mass by returning the dish to the drying oven for 24 hours, cooling to room temperature in a desiccator and re-weighing. The two mass readings should agree within the larger of 0.2% or 0.02 gram.

NOTE: The oven-dried sample is not used for the extraction and should be properly disposed once the dry mass is determined.

11.2.3 Calculate and report the solids content as follows:

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$$SC = \frac{M_{dry}}{M_{test}}$$

Where: SC = solids content of "as-tested" material (g-dry/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.2.4 Calculate and report the moisture content (wet basis) as follows:

$$MC_{wet} = \frac{M_{test} - M_{dry}}{M_{test}}$$

Where: MC_{wet} = moisture content on a wet basis (g_{H_2O}/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.3 Apparatus preparation

11.3.1 Prepare the column test apparatus as depicted in Figure 2. Eluent feed should be directed through the lower end cap and upwards into the column to minimize air retention in the packed bed and fluid channeling along the column walls.

NOTE: When solid samples may be affected by dissolved oxygen in the feed stock, an inert gas (e.g., nitrogen or argon) may be bubbled through the feed solution to displace oxygen or used to purge the headspace above the feed solution.

NOTE: When alkaline or other air-sensitive eluates are expected, the vapor space of empty collection bottles may be purged with an inert gas (e.g., nitrogen or argon) prior to eluate collection.

11.4 Column packing

11.4.1 The column is packed with test material surrounded by layers of quartz sand at the top and bottom of the column to provide flow pattern regulation and coarse filtration.

NOTE: The following procedure describes the packing of the column from starting at the outflow (top) of the column and ending with the inflow (bottom) of the column. This is done to allow for a wider layer of quartz sand on the inflow side in cases where less than a full column of test material is available. The column is inverted prior to assembly into the leaching apparatus and initial wetting.

11.4.2 Record the mass of the empty column with end caps and any tubing leads or valves that would be needed to completely separate the column, which may include both solid material and water, from the entire apparatus.

11.4.3 Secure one end cap to the outflow side of the column and invert the column and end cap so that the outflow side of the column is facing downward.

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11.4.4 Place an approximately 1-cm thick layer of quartz sand (Sec. 6.5) on the outflow side of the column using a small scoop or spoon. Record the mass of the column and sand layer. Level the sand layer by tapping the sides of the column.

11.4.5 Pack the main body of the column with a minimum 300-g dry-mass equivalent of "as-tested" sample in approximately five layers with light tamping with a glass or plastic rod to level the material between layers. When enough test material is available to produce a full column, the top of the packed sample should be approximately 1 cm from the level of the column interface with the inflow end cap (the end facing upwards). Record the mass of the column, lower sand layer, and "as-tested" sample.

11.4.6 Place a layer of sand to fill the remaining gap between the sample packing and the interface between the column and inflow end cap. When enough test material is available to pack a full column, the sand layer at the inflow end of the column should be approximately 1 cm. This gap may be larger if less test material is used. Record the total mass of the completely packed column.

11.4.7 Secure the inflow end cap. Invert the column so that the inflow end of the column is downward prior to inserting the column into the leaching apparatus.

11.4.8 Calculate the "as-tested" mass of the sample packing by subtracting the mass of the column and lower sand layer (Sec. 11.4.4) from the mass of the column, sand layer and packing (Sec. 11.4.5).

11.4.9 Calculate the dry mass equivalent packed of "as-tested" sample into the column using the solids content as follows:

$$M_{dry} = SC \cdot M_{test}$$

Where: M_{dry} = dry-mass equivalent of sample in column (g-dry)
SC = solids content (g-dry/g)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.5 Pump setup

11.5.1 Prior to the start of the test, set the flow rate of the pump to a value that will provide an eluate production rate of 0.75 ± 0.25 L/S per day. For example, given a dry-mass equivalent of 300 g-dry, an L/S of 0.75 mL/g-dry would translate to a volume of 225 mL/g-dry, in which case the pump should be set to a flow rate of 225 mL (0.75 L/S) per day.

11.5.2 Prime the tubing with eluent

11.5.2.1 Detach the inlet tubing from the bottom of the column and place the open end into a waste container.

11.5.2.2 Turn on the pump and allow the inlet tubing to fill with eluent. Remove any air bubbles trapped in the inlet tubing.

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11.5.2.3 When the inlet tubing is full with eluent, stop the pump and reconnect the tubing to the bottom of the column.

11.6 Eluent collection schedule

11.6.1 Table 2 provides a schedule of fraction end-point L/S, interval L/S, and eluate fraction volumes for collection, assuming a dry-mass equivalent of 300 g-dry. The minimum volume of each collection bottle should be scaled so as to capture the entire eluate fraction.

11.6.2 Using the assumed pump rate and the dry mass equivalent of the sample, estimate the durations of column testing required to reach the target eluate collection L/S shown in Table 2 as follows:

$$T_i = \frac{M_{dry} - \sum L/S_i}{R_i}$$

Where: T_i = target time from start for collection of eluent fraction, i (day)
M_{dry} = dry-mass equivalent of sample in column (g-dry)
$\sum L/S$ = target cumulative L/S for interval i from Table 1 (mL/g-dry)
R_i = pump rate assumed for interval, i (mL/day)

Alternatively, use the Microsoft Excel® spreadsheet template available at http://www.vanderbilt.edu/leaching/downloads/test-methods/ to develop the schedule of target collection times.

NOTE: The schedule of predicted collection times is for reference purposes only. Typically, the eluate collection rate is slower that predicted initially, due in part to pump inefficiency, back pressure, and dead-volume lag times. The decision to switch collection bottles should be made based on the volume of eluate collected with time. The schedule may be revised with each eluate fraction collected, so that the prediction of future collections may be more accurate. Pump flow rate adjustment may be necessary.

11.6.3 After each eluate collection, calculate the time required to reach the next collection time using the equation in 11.6.2 and the pump rate calculated from the previous collection interval.

NOTE: If eluate volumes other than those calculated for the fraction volume (i.e., T01, T02, etc.) are collected (e.g., manual collection will have inherent errors in the collection volumes), the cumulative L/S may quickly become out of alignment with the tolerances shown in Table 2. If this happens or appears to be likely, adjustments to the collection volumes for the two large collection fractions (i.e., T06 and T08) can be made in order to bring the cumulative L/S for subsequent collection intervals back in line with tolerances. The objective is to maintain the cumulative L/S target values for fractions T07 and T09. The Excel® data template available with LeachXS Lite™ can be helpful in maintaining target L/S ratios if updated after each collection interval. However, throughout the test, the user should ensure that the minimum eluate volume required for the chosen chemical analyses is collected.

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11.7 Column test procedure – Column/eluent equilibration

11.7.1 Turn on the pump and allow the column to fill with eluent, thus wetting the column packing.

11.7.2 When the column packing is completely wetted and the eluent level is even with the top of the column (or just beginning to be seen through the effluent tubing at the top of the column apparatus), stop the pump and allow the column to equilibrate for 21 ± 3 hours.

11.8 Column test

11.8.1 Following equilibration, begin the column test by starting the pump and recording the date and time.

NOTE: The eluate production rate should be monitored frequently during the column test and the pump rate adjusted, such that the eluate production rate is maintained at approximately 0.75 ± 0.25 L/S per day.

11.8.2 When the eluate fraction has reached the target volume according to the predicted collection schedule, release the Luer lock connecting the active collection bottle and attach the eluent tubing to a new collection bottle.

NOTE: Alkaline eluate solutions may be susceptible to neutralization due to carbon dioxide uptake. When materials with alkaline pH are tested, precautions (e.g., purging collection bottles with inert gas) should be taken to prevent contact of the eluate with air.

11.9 Eluate processing

11.9.1 Decant a minimum volume (approximately 5 mL) of the eluate fraction from the collection vessel in order to measure the solution characteristics.

11.9.2 Measure and record the pH, specific conductivity, and oxidation-reduction potential (ORP) of the eluate (see Methods 9040, 9045 and 9050).

NOTE: Measurement of pH, conductivity, and ORP should be taken within 15 minutes of eluate processing (Sec. 11.9.1) to avoid neutralization of the solution due to exposure to carbon dioxide, especially when alkaline materials are tested.

NOTE: The measurement of ORP is optional, but strongly recommended, especially when testing materials where oxidation is likely to change the LSP of COPCs.

11.9.3 Separate any suspended particulates from the remaining liquid in the collection bottle by pressure or vacuum filtration through a 0.45-µm filtration membrane (Sec. 6.8).

NOTE: If either low volatility organic species or mercury is a COPC, pressure filtration is recommended over vacuum filtration in order to minimize volatility losses.

11.9.4 Immediately preserve and store the volume(s) of eluate required for chemical analysis. Preserve all analytical samples in a manner that is consistent with the determinative chemical analyses to be performed.

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11.10 Reiterate Secs. 11.8.2 - 11.9.4 until nine eluate fractions are collected up to an L/S of 10 ± 0.2 mL/g-dry.

NOTE: The complete method requires that all nine eluate fractions be collected from the column. However, for purposes of limiting chemical analysis or index testing where interpretation may be based on cumulative release from the column, eluate fractions may be composited by volume-weighted averaging to create a single analytical sample from multiple eluate fractions (see Sec 11.11).

11.11 Analytical sample preparation options

This method allows for options in the preparation of analytical samples based on the detail of characterization required (e.g., complete, limited or index) and the basis for data reporting (e.g., concentration or cumulative release). However, the complete set of nine eluate fractions must be collected in all cases.

11.11.1 Table 1 shows the analytical preparation scheme for Options A-E described in the following sections. Each composite sample may be created either by combining the total eluate volumes and preserving the total sample for analysis; or combining aliquots of two eluate fractions using volume-weighted averages. However, it is recommended that composite analytical samples be prepared using aliquots of eluate fractions whenever possible, rather than whole eluate fractions. This approach allows for potential analysis of discrete eluate fractions, if desired, at a later date.

11.11.1.1 Option A – This sample preparation option is used for complete characterization and includes analysis of all eluate fractions. Since the entire cumulative release curve is captured in nine discrete fractions, reported data may be based on either eluate concentrations or cumulative release.

11.11.1.2 Option B – This sample preparation option is used only for limited analyses based on eluate concentration. Six discrete eluate fractions are analyzed. Data obtained using this option cannot be used for cumulative release since there are sections of the cumulative release curve not analyzed.

11.11.1.3 Option C – This sample preparation option is used only for limited analysis based on cumulative release. Six analytical samples are created from three discrete eluate fractions and three composite samples. In the scheme shown in Table 1, the following fractions are composited:

- T04 and T05
- T06 and T07
- T08 and T09

11.11.1.4 Option D – This sample preparation option is used only for index testing based on eluate concentration. Three discrete eluate fractions are analyzed. Data obtained using this option cannot be used for cumulative release since there are sections of the cumulative release curve not analyzed.

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11.11.1.5 Option E – This sample preparation option is used only for index testing based on cumulative release. Three analytical samples are created from one discrete eluate fraction and two composite samples. In the scheme shown in Table 1, the following fractions are composited:

- T02, T03, T04, and T05
- T06, T07, T08, and T09

11.11.2 Volume-weighted composites

11.11.2.1 The volume of aliquots of eluate fractions for composite analytical samples may be calculated using the Excel template provided or the following formula:

$$V_i = \frac{F_i}{\sum_i^n F_i} \times V_{sample}$$

Where: V_i = the volume of an aliquot from eluate fraction, i (mL)
F_i = the collected volume of eluate fraction, i (mL)
V_{sample} = the total volume of the analytical sample (mL)
n = total number of eluate fractions to be composited

As an illustration of volume-weighted averaging, eluate fraction aliquots are calculated as required to create an analytical sample by compositing eluate fractions T06 through T09 for index testing based on cumulative release. The calculation follows the example volumes shown in Table 2 and assumes that an analytical sample volume of 100 mL is required.

$$\sum_i^n F_i = F_{T06} + F_{T07} + F_{T08} + F_{T09} = 450\ mL + 150\ mL + 1350\ mL + 150\ mL = 2100\ mL$$

$$V_{T06} = \frac{F_{T06}}{\sum_i^n F_i} \times V_{sample} = \frac{450\ mL}{2100\ mL} \times 100\ mL = 21.5\ mL$$

$$V_{T07} = \frac{F_{T07}}{\sum_i^n F_i} \times V_{sample} = \frac{150\ mL}{2100\ mL} \times 100\ mL = 7.1\ mL$$

$$V_{T08} = \frac{F_{T08}}{\sum_i^n F_i} \times V_{sample} = \frac{1350\ mL}{2100\ mL} \times 100\ mL = 64.3\ mL$$

$$V_{T09} = \frac{F_{T09}}{\sum_i^n F_i} \times V_{sample} = \frac{150\ mL}{2100\ mL} \times 100\ mL = 7.1\ mL$$

$$V_{sample} = V_{T06} + V_{T07} + V_{T08} + V_{T09} = 21.5\ mL + 7.1\ mL + 64.3\ mL + 7.1\ mL = 100.0\ mL$$

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NOTE: The above illustration uses example eluate fraction volumes based on interval L/S ratios and an assumed test material mass. When calculating the aliquots of collected eluate fractions for composite samples, the actual collected fraction volumes should be used.

12.0 DATA ANALYSIS AND CALCULATIONS (Excel® template[3])

12.1 Data reporting

12.1.1 Figure 3 shows an example of a data sheet that may be used to report the concentration results of this method. At a minimum, the basic test report should include the following:

a) Name of the laboratory
b) Laboratory technical contact information
c) Date and time at the start of the test
d) Name or code of the solid material
e) Particle size (85 wt% less than designated particle size)
f) Packed bed dimensions (column ID and bed depth (cm))
g) Mass of solid material in column packing
h) Moisture content of solid material packed in column (g_{H_2O}/g)
i) Eluate specific information (see Sec. 12.1.2 below)

12.1.2 The minimum set of data that should be reported for each eluate includes:

a) Eluate sample ID
b) Eluate collection date and time
c) Amount of eluate collected (mass or volume)
d) Measured eluate pH
e) Measured eluate conductivity (mS/cm)
f) Measured ORP (mV) (optional)
g) Concentration of all COPCs
h) Analytical QC qualifiers as appropriate

12.2 Data Interpretation (optional)

12.2.1 Concentration as a function of L/S

[3] Excel® data templates are provided to aid in collection and archiving of laboratory and analytical data. These templates form the basis for uploading method data into the data management program, LeachXS Lite™. Both the data templates and LeachXS Lite™ are available at http://vanderbilt.edu/leaching.

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12.2.1.1 A curve of the eluate concentration as a function of L/S can be generated for each COPC after chemical analysis of all extracts by plotting the constituent concentration in the liquid phase as a function of the cumulative collected L/S ratio. The curve indicates the nominal equilibrium concentration of the constituent of interest as a function of L/S from 0 to 10 mL/g-dry at natural pH. An example curve is provided in Figure 4.

12.2.1.2 The lower limit of quantitation (LLOQ) of the determinative method for each COPC may be shown as a horizontal line. COPC concentrations below this line indicate negligible or non-quantitative concentrations.

NOTE: The LLOQ is highly matrix dependent and should be determined as part of a QA/QC plan.

12.3 Cumulative release as a function of L/S

12.3.1 The cumulative mass release of a COPC per unit solid material may be calculated as follows:

$$\Sigma M_i = \sum_{i=1}^{9} \left[C_i \times \left(\Sigma L/S_i - \Sigma L/S_{i-1} \right) \right]$$

Where: ΣM_i = the cumulative mass release through interval i (mg/kg-dry)

C_i = the concentration of the COPC in the eluent collected during interval i (mg/L)

$\Sigma L/S_i$ = the cumulative L/S of eluate collected through interval i (L/kg-dry)

$\Sigma L/S_{i-1}$ = the cumulative L/S of eluate collected through interval i-1 (L/kg-dry)

12.3.2 Prepare a curve of the cumulative mass release generated for each COPC by plotting the cumulative mass release calculated in Sec. 12.3.1 as a function of the cumulative collected L/S. This curve provides an interpretation of the cumulative mass expected to be leached from a column of material as a function of L/S percolating through the column.

12.3.3 A comparison of the slope of the mass release curve to a unity slope, which is indicative of solubility-controlled release, may be made by plotting the cumulative mass release calculated in Sec. 12.3.1 versus the logarithm of the cumulative collected L/S. An example is provided in Figure 5.

12.4 Interpolation/extrapolation to target L/S values

The collected L/S dependence data may be interpolated or extrapolated to the nearest target L/S value for purposes of comparing different data sets (e.g., test replicates of the same or different materials). The most transparent and straightforward method is linear interpolation/extrapolation of data after $\log_{10}$ transformation.

12.4.1 Log_{10} transformation

Collected concentration values are transformed by taking the $\log_{10}$ of the measured concentration at each test position, i:

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$$C_i = \log_{10}(c_i)$$

Where: C_i = $\log_{10}$-transformed concentration at test position i ($\log_{10}$[mL/g-dry])
c_i = the concentration measured at test position i (mg/L)

12.4.2 Linear interpolation/extrapolation

Given a set of coordinate data { ($\Sigma L/S_i$,C_i) : i = 1,...n } sorted by increasing order according to $\Sigma L/S$ value (e.g., $\Sigma L/S_1 < \Sigma L/S_2 < \cdots < \Sigma L/S_n$), an interpolated/extrapolated $\log_{10}$-transformed concentration at a known L/S target is calculated as:

$$C_T = a_T + b_T \cdot \sum L/S_T$$

Where: C_T = the concentration at target $\Sigma L/S$ value, $\Sigma L/S_T$ ($\log_{10}$[mg/L])
a_T and b_T are coefficients of the linear interpolation/extrapolation equation
$\Sigma L/S_T$ = a target pH value

Depending on the values of observed L/S values relative to target L/S values, the calculations of the coefficients a_T and b_T in the equation may differ according to the following algorithm:

If $\Sigma L/S_T < \Sigma L/S_1$, then $b_T = (C_2 - C_1) / (\Sigma L/S_2 - \Sigma L/S_1)$ and $a_T = C_2 - b_T \cdot \Sigma L/S_2$ (extrapolation from the two points with closest L/S values);

If $\Sigma L/S_T \geq \Sigma L/S_n$, then $b_T = (C_n - C_{n-1}) / (\Sigma L/S_n - \Sigma L/S_{n-1})$ and $a_T = C_n - b_T \cdot \Sigma L/S_n$ (extrapolation from the two points with closest L/S values);

If $\Sigma L/S_{j-1} \leq \Sigma L/S_T < \Sigma L/S_j$, then $b_T = (C_j - C_{j-1}) / (\Sigma L/S_j - \Sigma L/S_{j-1})$and $a_T = y_j - b_T \cdot \Sigma L/S_j$ (interpolation from the two closest points surrounding $\Sigma L/S_T$).

NOTE: Interpolation or extrapolation of data should only be conducted within a distance of ±20% of the target L/S value. Since the allowable L/S tolerance about a target L/S value is variable (see Table 2), interpolation/extrapolation should not create data at a target L/S value where collected data is missing.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. Performance data must not be used as absolute QC acceptance criteria for purposes of laboratory QC or accreditation.

13.2 Interlaboratory validation of this method was conducted using a contaminated smelter site soil (material code CFS) and a brass foundry sand (material code JaFS). Repeatability and reproducibility were determined at an L/S of 10 mL/g-dry for eluate concentration (see Table 3) and for cumulative mass released (see Table 4). More details on the interlaboratory validation may be found in Ref. 1.

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13.3 Ref. 2 and Ref. 4 may provide additional guidance and insight on the use, performance, and application of this method.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operations. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction*, a free publication available from the ACS, Committee on Chemical Safety, https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/less-is-better.pdf.

15.0 WASTE MANAGEMENT

The EPA requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Laboratories are urged to protect air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available at: http://www.labsafetyinstitute.org/FreeDocs/WasteMgmt.pdf.

16.0 REFERENCES

1. A.C. Garrabrants, D.S. Kosson, R. DeLapp, P. Kariher, P.F.A.B. Seignette, H.A. van der Sloot, L. Stefanski, and M. Baldwin, "Interlaboratory Validation of the Leaching Environmental Assessment (LEAF) Method 1314 and Method 1315," EPA 600/R-12/624, *U.S. Environmental Protection Agency*, Washington, DC, 2012.

2. A.C. Garrabrants, D.S. Kosson, H.A. van der Sloot, F. Sanchez, and O. Hjelmar, "Background Information for the Leaching Environmental Assessment Framework (LEAF) Test Methods," EPA/600/R-10-170, *U.S. Environmental Protection Agency*, Washington, DC, 2010.

3. NEN 7343, "Leaching Characteristics of Solid Earth and Stony Materials - Leaching Tests - Determination of the leaching of Inorganic Constituents from Powdery and Granular Materials with the Percolation Test," *Dutch Standardization Institute*, Delft, The Netherlands, 1995.

4. D.S. Kosson, H.A. van der Sloot, F. Sanchez, and A.C. Garrabrants, "An Integrated Framework for Evaluating Leaching in Waste Management and Utilization of Secondary Materials," *Environmental Engineering Science,*, 19(3) 159-204, 2002.

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5. CEN/TS 14405, "Characterization of Waste - Leaching Behaviour Tests - Up-flow Percolation Test (Under Specified Conditions)," *Comité Européen de Normalisation*, Brussels, Belgium, 2004, 2004.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables and figures referenced by this method.

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TABLE 1

SCHEDULE OF FRACTION COLLECTIONS AND ANALYTICAL SAMPLES

Fraction Label	ΣLS (mL/g-dry)	Option A: Characterization – Conc.	Option A: Characterization – ΣRel	Option B: Limited Analysis – Conc.	Option C: Limited Analysis – ΣRel	Option D: Index Testing – Conc.	Option E: Index Testing – ΣRel
T01	0.2 ± 0.1	✓	✓	✓	✓	✓	✓
T02	0.5 ± 0.1	✓	✓	✓	✓	X	↓
T03	1.0 ± 0.1	✓	✓	✓	✓	X	↓
T04	1.5 ± 0.2	✓	✓	X	↓	X	↓
T05	2.0 ± 0.2	✓	✓	✓	T05c	✓	✓T05c
T06	4.5 ± 0.2	✓	✓	X	↓	X	↓
T07	5.0 ± 0.2	✓	✓	✓	✓T07c	X	↓
T08	9.5 ± 0.2	✓	✓	X	↓	X	↓
T09	10.0 ± 0.2	✓	✓	✓	✓T09c	✓	✓T09c

NOTE: ΣRel = Cumulative release

✓ = Collect eluate fraction (or pool of fractions) as analytical sample

↓ = Composite eluate fraction with next fraction to create analytical sample

X = No fraction to collect

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TABLE 2

SCHEDULE OF ELUATE FRACTIONS FOR COLLECTION WITH EXAMPLE VOLUMES

Interval Label	End Point ΣL/S (mL/g-dry)	Fraction L/S (mL/g-dry)	Example Fraction Volume (mL)
T01	0.2 ± 0.1	0.2	60
T02	0.5 ± 0.1	0.3	90
T03	1.0 ± 0.1	0.5	150
T04	1.5 ± 0.2	0.5	150
T05	2.0 ± 0.2	0.5	150
T06	4.5 ± 0.3	2.5	750
T07	5.0 ± 0.2	0.5	150
T08	9.5 ± 0.3	4.5	1350
T09	10.0 ± 0.2	0.5	150
B01	Eluent	N/A	100

NOTE: Example fraction volumes based on assumed packing mass of 300 g-dry

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TABLE 3

METHOD PRECISION FOR ELUATE CONCENTRATION AT L/S=10 mL/g-dry

Analyte	Symbol	Repeatability – CFS %RSD_r	Repeatability – JaFS %RSD_r	Reproducibility – CFS %RSD_R	Reproducibility – JaFS %RSD_R
Aluminum	Al	8.6	12.7	16.6	28.2
Barium	Ba	6.9	13.9	23.0	24.2
Boron	B	11.9	14.4	14.3	23.9
Cadmium	Cd	9.2	-	14.6	-
Calcium	Ca	6.9	5.6	12.7	52.5
Copper	Cu	8.1	13.3	15.2	31.8
Magnesium	Mg	-	7.7	-	53.3
Manganese	Mn	-	22.0	-	26.6
Molybdenum	Mo	25.2	27.5	28.4	54.4
Lead	Pb	7.3	12.4	14.8	23.5
Thallium	Tl	9.6	-	19.2	-
Zinc	Zn	8.6	23.0	16.0	58.5

Material	Repeatability – CFS %RSD_r	Repeatability – JaFS %RSD_r	Repeatability – Overall	Reproducibility – CFS %RSD_R	Reproducibility – JaFS %RSD_R	Reproducibility – Overall
Mean	10%	15%	13%	18%	38%	28%

Data taken from Ref. 1.

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TABLE 4

METHOD PRECISION FOR CUMULATIVE RELEASE AT L/S=10 mL/g-dry

Analyte	Symbol	Repeatability – CFS %RSD_r	Repeatability – JaFS %RSD_r	Reproducibility – CFS %RSD_R	Reproducibility – JaFS %RSD_R
Aluminum	Al	4.6	7.2	14.3	13.1
Barium	Ba	3.4	6.2	23.0	10.9
Boron	B	2.9	4.4	11.1	6.3
Cadmium	Cd	2.2	-	8.5	-
Calcium	Ca	2.1	3.6	8.2	19.9
Copper	Cu	3.9	4.6	15.3	21.4
Magnesium	Mg	-	4.2	-	17.2
Manganese	Mn	-	7.0	-	14.9
Molybdenum	Mo	4.4	4.5	12.3	11.1
Lead	Pb	1.8	9.5	10.8	15.1
Thallium	Tl	2.9	-	10.2	-
Zinc	Zn	4.0	7.3	11.3	18.6

Material	Repeatability – CFS %RSD_r	Repeatability – JaFS %RSD_r	Repeatability – Overall	Reproducibility – CFS %RSD_R	Reproducibility – JaFS %RSD_R	Reproducibility – Overall
Mean	3%	6%	5%	13%	15%	14%

Data taken from Ref. 1.

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FIGURE 1

METHOD FLOWCHART

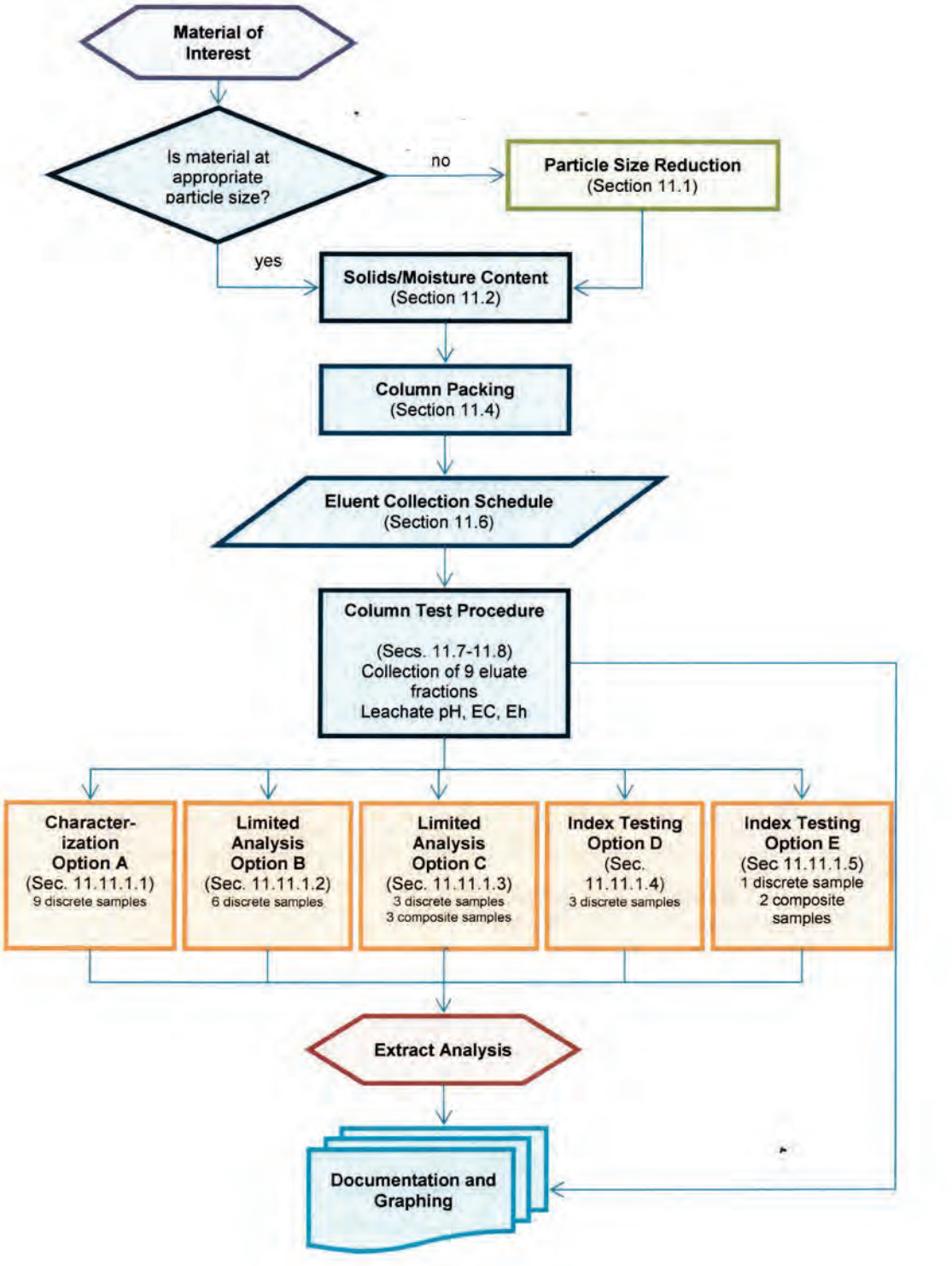

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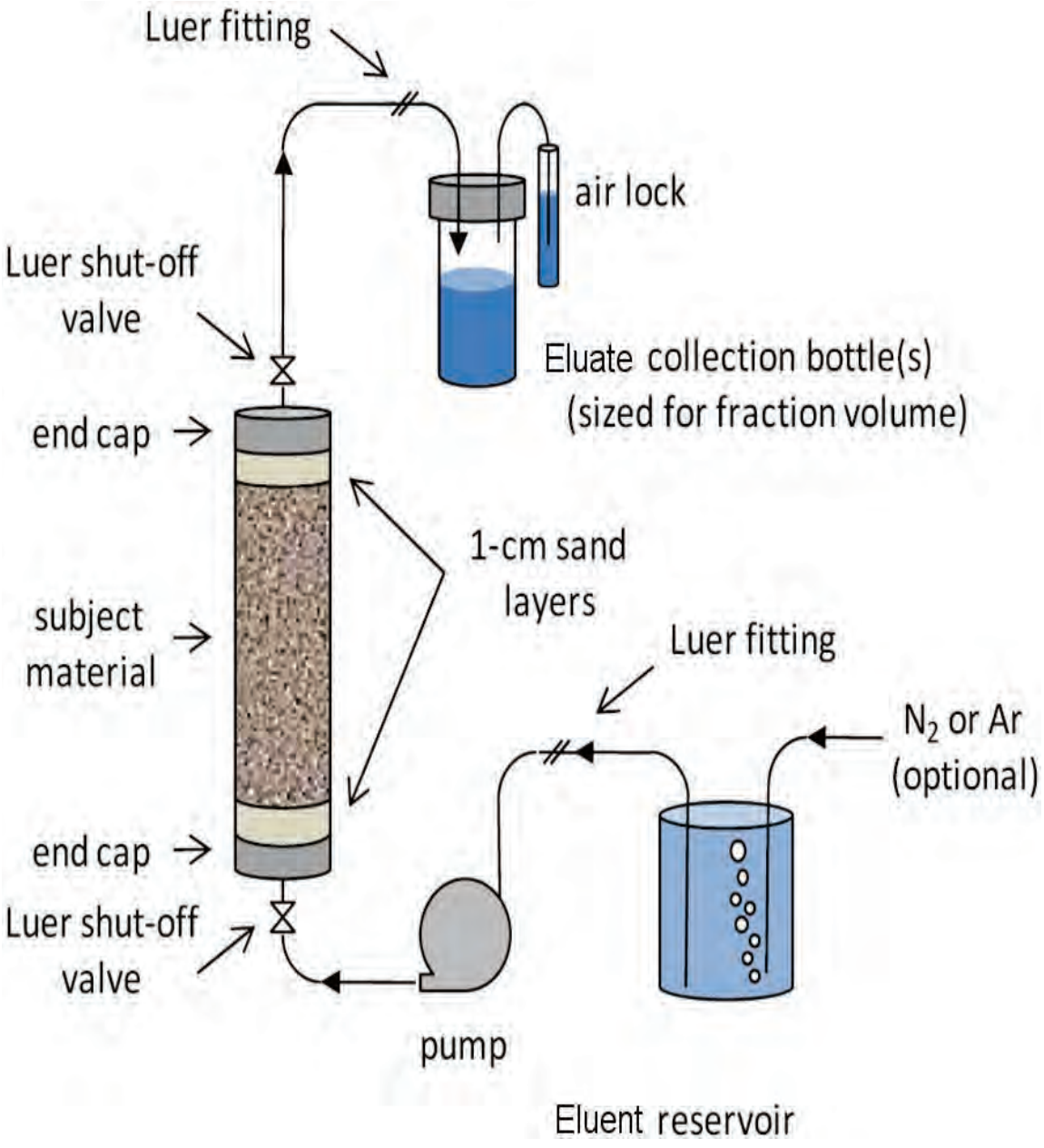
FIGURE 2

SCHEMATIC OF COLUMN TEST APPARATUS



NOTE: Figure not drawn to scale

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FIGURE 3

EXAMPLE DATA REPORT FORMAT

EPA METHOD 1314
Report of Analysis

ABC Laboratories
123 Main Street
Anytown, USA
Contact: John Smith
(555) 111-1111

Client Contact: Susan Jones
(555) 222-2222

Material Code:	XYZ	Particle Size:	88% passing 2-mm sieve
Material Type:	Coal Combustion Fly Ash	Mass used in Column:	360 g
Date Received:	10/1/20xx	Moisture Content:	0.002 g_{H_2O}/g
Test Date:	11/1/20xx	Column ID:	4.8 cm
Report Date:	12/1/20xx	Packing Bed Depth:	28 cm
		Eluent:	ASTM Type II Water
		Lab Temperature:	21 ± 2 °C

Test Position	Replicate	Value	Units	Method	Note
T01	A				
	Eluate Sample ID	**XYZ-1314-T01-A**			
	Collection Date	11/1/20xx			
	Collection Time	12:35	PM		
	Eluate Mass	70.4	g		
	Eluate pH	8.82	-	EPA 9040	
	Eluate Conductivity	5.4	mS/c	EPA 9050	
	Eluate ORP	NA	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	4.72	mg/L		EPA 6020	11/7/20xx	1000
As	0.12	mg/L		EPA 6020	11/7/20xx	10
Cl	5.42	mg/L		EPA 9056	11/9/20xx	1

Test Position	Replicate	Value	Units	Method	Note
T02	A				
	Eluate Sample ID	**XYZ-1314-T02-A**			
	Collection Date	11/1/20xx			
	Collection Time	9:15	AM		
	Eluate Mass	105.1	g		
	Eluate pH	9.15	-		
	Eluate Conductivity	2.3	mS/c		
	Eluate ORP	NA	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	2.99	mg/L		EPA 6020	11/7/20xx	1000
As	0.21	mg/L		EPA 6020	11/7/20xx	10
Cl	4.20	mg/L	U	EPA 9056	11/7/20xx	1

QC Flag Key: U Value below lower limit of quantitation as reported (< "LLOQ")

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FIGURE 4

EXAMPLE ELUATE CONCENTRATION CURVES FOR COMPLETE CHARACTERIZATION OF A COAL COMBUSTION FLY ASH

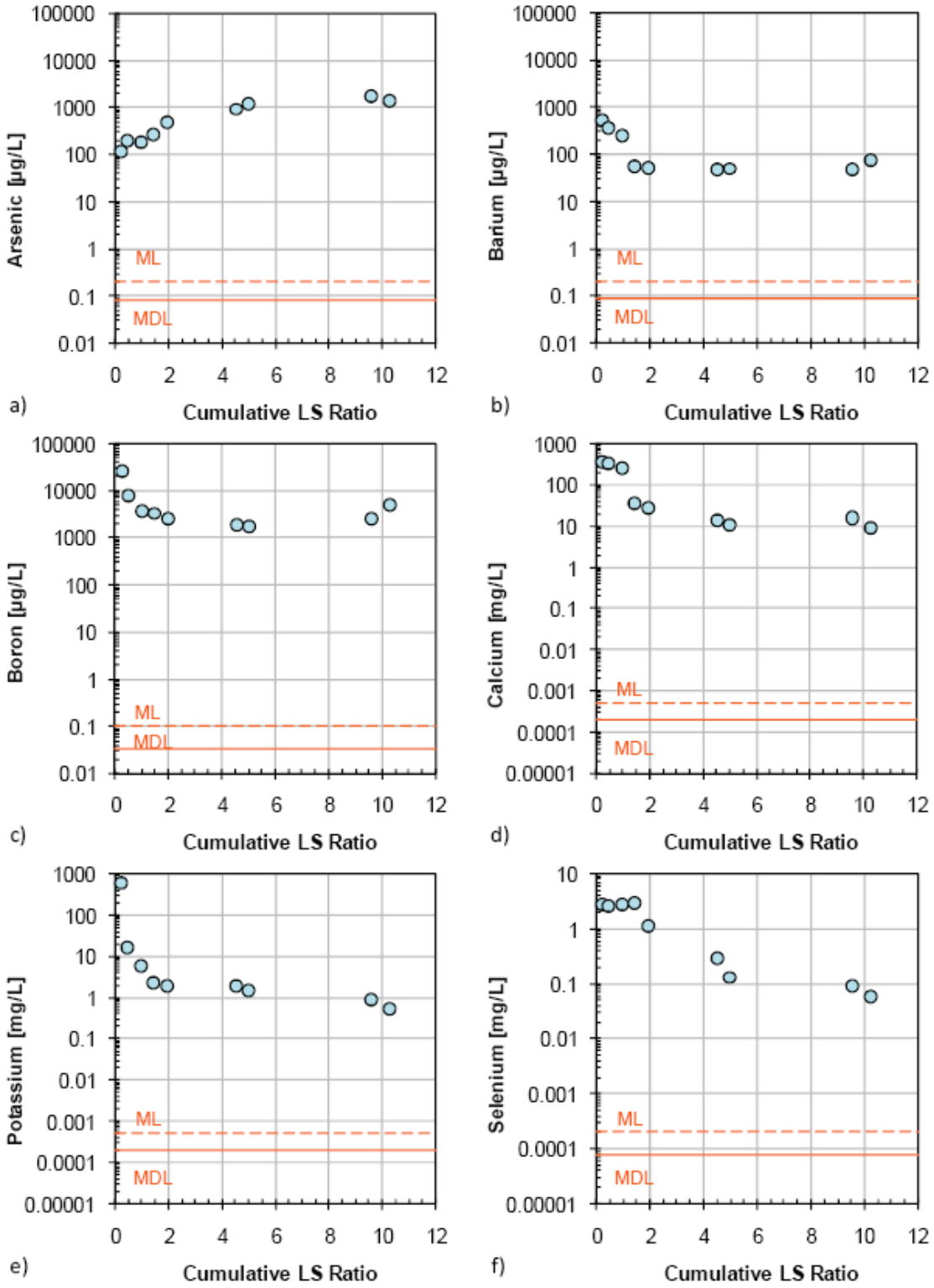

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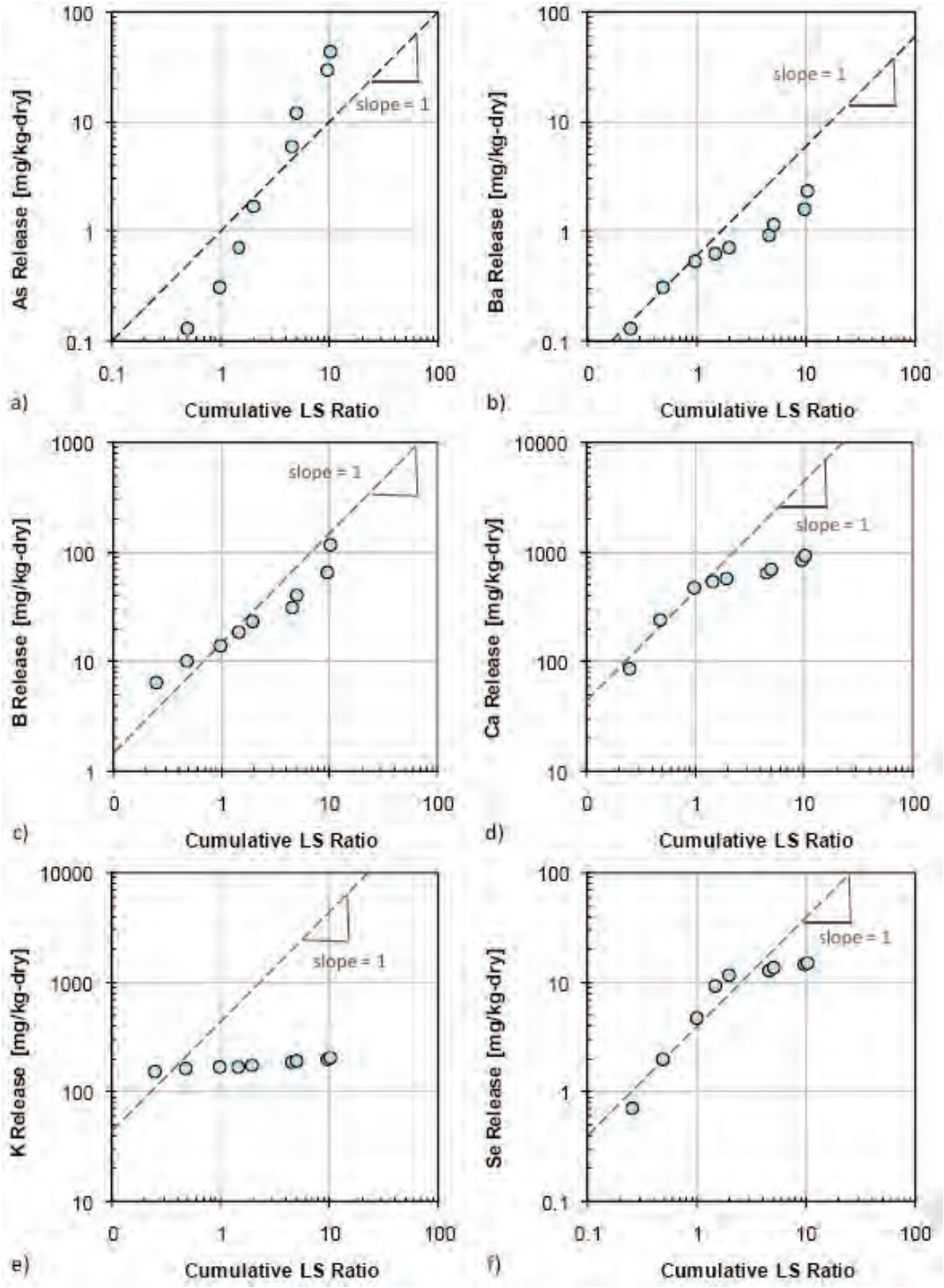
FIGURE 5

EXAMPLE CUMULATIVE RELEASE CURVES FOR COMPLETE CHARACTERIZATION OF A COAL COMBUSTION FLY ASH



NOTE: Dashed line represents solubility control (slope = 1).

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METHOD 1315[1]

MASS TRANSFER RATES OF CONSTITUENTS IN MONOLITHIC OR COMPACTED GRANULAR MATERIALS USING A SEMI-DYNAMIC TANK LEACHING PROCEDURE

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required methods used for the analysis of method-defined parameters, are intended to be guidance methods that contain general information on how to perform an analytical procedure or technique, which a laboratory can use as a basic starting point for generating its own detailed standard operating procedure (SOP), either for its own general use or for a specific project application. Performance data included in this method are for guidance purposes only and must not be used as absolute quality control (QC) acceptance criteria for purposes of laboratory QC or accreditation.

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[1] This method has been derived from the MT001 and MT002 procedures (Ref. 12). The method is analogous to the monolithic mass transfer methods NEN 7345 (Ref. 9) developed under Dutch regulation and CEN/TS 15863 (Ref. 13) developed for the Comité Européen de Normalisation (CEN).

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1.0 SCOPE AND APPLICATION

1.1 This method is designed to provide the mass transfer rates (release rates) of inorganic analytes contained in a monolithic or compacted granular material, under diffusion-controlled release conditions, as a function of leaching time. Observed diffusivity and tortuosity may be estimated through analysis of the resulting leaching test data.

1.2 This method is suitable to a wide range of solid materials which may be in monolithic form (e.g., cements, solidified wastes) or may be compacted granular materials (e.g., soils, sediments and stacked granular wastes) which behave as a monolith, in that the predominant water flow is around the material and release is controlled by diffusion to the boundary. The method is not required by federal regulations to determine whether waste passes or fails the toxicity characteristic as defined at 40 CFR 261.24.

1.3 This leaching characterization method provides intrinsic material parameters for release of inorganic species under mass transfer controlled leaching conditions. This test method is intended as a means for obtaining a series of eluents which may be used to estimate the diffusivity of constituents and physical retention parameters of the solid material under specified laboratory conditions.

1.4 This method is not applicable to characterize the release of organic analytes with the exception of general dissolved organic carbon.

1.5 This method is a characterization method and does not provide a solution considered to be representative of eluate under field conditions. This method is similar in structure and use to predecessor methods such as MT001.1 (see Ref. 12), NEN 7345 (see Ref. 9), ANSI/ANS 16.1 (see Ref. 15), and ASTM C1308 (see Ref. 11). However, this method differs from previous methods in that: 1) leaching intervals are modified to improve QC; 2) sample preparation accounts for mass transfer from compacted granular samples; and, 3) mass transfer may be interpreted by more complex release models that account for physical retention of the porous medium and chemical retention at the pore wall through geochemical speciation modeling.

1.6 The geometry of monolithic samples may be rectangular (e.g., bricks or tiles), cubes, wafers or cylinders. Samples may also have a variety of faces exposed to eluent, forming anything from 1-dimensional (1-D) through 3-dimensional (3-D) mass transfer cases. In all cases, a minimum sample size of 5 cm in the direction of mass transfer must be employed and the liquid-surface-area ratio (L/A) must be maintained at 9 ± 1 mL/cm^2.

Monolithic samples should be suspended or held in the leaching fluid such that at least 98% of the entire sample surface area is exposed to eluent and the bulk of the eluent (e.g., a minimum of 2 cm between any exposed surface and the vessel wall) is in contact with the exposed sample surface. Figure 1 provides examples of appropriate sample holders and leaching configurations for 3-D and 1-D cases.

1.7 Compacted granular materials are granular solids, screened to pass through a 2-mm sieve, compacted following a modified Proctor compaction effort (see Ref. 10). The sample geometry

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must be open-faced cylinders due to limitations of mechanical packing. However, the diameter and height of the sample holder may be altered to correspond appropriately with the diameter and volume of the leaching vessel. In all cases, the sample size of at least 5 cm in the direction of mass transfer must be employed and the L/A must be maintained at 9 ± 1 mL/cm^2.

The sample should be positioned at the bottom of the leaching vessel with a minimum of 5 cm of distance between the solid-liquid interface and the top of the vessel. The distance between the non-leaching faces (i.e., outside of the mold surfaces) and the leaching vessel wall should be minimized to < 0.5 cm, such that the majority of the eluent volume is on top of the sample. Figure 2 shows an example of a holder and leaching configuration for a compacted granular sample.

1.8 The solvent system used in this characterization method is reagent water. Other systems (e.g., groundwater, seawater, and simulated liquids) may be used to infer material performance under specific environmental conditions. However, interaction between the eluent and the solid matrix may result in precipitation and pore blocking, which may interfere with characterization or complicate data interpretation.

1.9 Prior to employing this method, analysts are advised to consult the base method for each type of procedure that may be employed in the overall analysis (e.g., Methods 9040, 9045 and 9050, and the determinative methods for the target analytes) for additional information on QC procedures, development of QC acceptance criteria, calculations, and general guidance. Analysts also should consult the disclaimer statement at the front of the manual and the information in Chapter Two for: 1) guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies; and, 2) the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to federal testing requirements. The information contained in this method is provided by the Environmental Protection Agency (EPA or the Agency) as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.10 This method is restricted to use by, or under supervision of, properly experienced and trained personnel. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

This method comprises leaching of continuously water-saturated monolithic or compacted granular material in an eluent-filled tank with periodic renewal of the leaching solution. The vessel and sample dimensions are chosen such that the sample is fully immersed in the leaching solution. Monolithic samples may be cylinders or parallelepipeds, while granular materials are compacted into cylindrical molds at optimum moisture content using modified Proctor compaction methods (see Ref. 10). In either case, the exposure of a regular geometric area to the eluent is recommended. Samples are contacted with reagent water at a specified L/A. The leaching solution is exchanged with fresh reagent water at nine pre-determined intervals (see NOTE below). The sample is freely drained and the mass is recorded to monitor the amount of eluent absorbed into the solid matrix at the end of each leaching interval. The eluate pH and specific conductance is measured for each time interval and

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analytical samples are collected and preserved accordingly based on the determinative methods to be performed. Eluate concentrations are plotted as a function of time, as a mean interval flux, and as a cumulative release as a function of time. These data are used to estimate mass transfer parameters (i.e., observed diffusivity) for each constituent of potential concern (COPC). A flowchart for performing this method is shown in Figure 3.

NOTE: The leaching schedule may be extended for additional exchanges with individual intervals of 14 days to provide more information about longer-term release.

3.0 DEFINITIONS

3.1 Constituent of potential concern (COPC) – A chemical species of interest, which may or may not be regulated, but may be characteristic of release-controlling properties of the sample geochemistry.

3.2 Release – The dissolution or partitioning of a COPC from the solid phase to the aqueous phase during laboratory testing (or under field conditions). In this method, mass release is expressed in units of mg COPC/kg dry solid material.

3.3 Liquid-to-surface area ratio (L/A) – The ratio representing the total liquid volume used in the leaching interval to the external geometric surface area of the solid material. L/A is typically expressed in units of mL of eluent/cm^2 of exposed surface area.

3.4 Observed mass diffusivity – The apparent, macroscopic rate of release due to mass transfer from a solid into a liquid as measured using a leaching test under conditions where mass transfer controls release. The observed diffusivity accounts for all physical and chemical retention factors influencing mass transfer and is typically expressed in units of cm^2/s.

3.5 Effective mass diffusivity – The intrinsic rate of mass transfer in a porous medium accounting for physical retention. The effective mass diffusivity is typically expressed in units of cm^2/s.

3.6 Physical retention factor – A mass transfer rate term that describes the retardation of diffusion due to intrinsic physical properties of a porous medium (e.g., effective porosity, tortuosity).

3.7 Chemical retention factor – A mass transfer rate term that describes the chemical processes (e.g., dissolution/precipitation, adsorption/desorption, complexation) occurring at the pore water interface with the solid mineral phases within the porous structure of the solid material.

3.8 Eluent – The solution used to contact the solid material in a leaching test. The eluent is usually free of COPCs but may contain other species used to control the test conditions of the extraction.

3.9 Eluate – The solution collected as an extract from a leaching test that contains the eluent plus constituents leached from the solid phase.

3.10 Refer to Chapter One and Chapter Three, and the manufacturer's instructions for definitions that may be relevant to this procedure.

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4.0 INTERFERENCES

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method to be used for specific guidance on QC procedures and to Chapters Three and Four for general guidance on glassware cleaning. Also refer to Methods 9040, 9045, and 9050 and the determinative methods to be used for information regarding potential interferences.

4.2 The reaction of atmospheric gases can influence the measured concentrations of constituents in eluates. For example, reaction of carbon dioxide with eluents from highly alkaline or strongly reducing materials will result in neutralization of eluate pH and precipitation of carbonates. Leaching vessels, especially those used when testing highly alkaline materials, should be designed to be airtight in order to minimize the reaction of samples with atmospheric gases.

4.3 Use of certain solvent systems may lead to precipitation at the material surface boundary, which may reduce mass transport rates. For example, exposure of cement-based materials to seawater leads to sealing of the porous block (see Ref. 8).

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The laboratory is responsible for maintaining a safe work environment and a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals specified in this method. A reference file of safety data sheets (SDSs) should be available to all personnel involved in these analyses.

5.2 During preparation and processing of extracts and/or eluents/eluates, some waste materials may generate heat or evolve potentially harmful gases when contacted with acids and bases. Adequate prior knowledge of the material being tested should be used to establish appropriate personal protection and workspace ventilation.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for use. The products and instrument settings cited in SW-846 methods represent those products and settings used during the method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

This section does not list common laboratory glassware (e.g., beakers and flasks) that might be used.

6.1 Sample holder

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6.1.1 Monolithic samples

6.1.1.1 A mesh or structured holder constructed of an inert material such as high density polyethylene (HDPE) or other material resistant to high and low pH is recommended.

6.1.1.2 The holder should be designed such that at least 98% of the external surface area of the sample may be exposed to eluent.

6.1.1.3 The holder should be designed to match the geometry of the mass transfer such that the bulk of the eluent may be in contact with the sample and the exposed surfaces of the sample centered within the leaching fluid.

NOTE: In the case of 1-D mass transfer from the axial face of a cylindrical sample, the outer diameter (OD) of the holder should be matched as closely as possible to the inner diameter (ID) of the leaching vessel so that the majority of the eluent is above the sample (e.g., in contact with the exposed material surface), while allowing for easy placement and removal of the holder in the leaching vessel (see Figure 1).

6.1.2 Compacted granular samples

6.1.2.1 A cylindrical mold constructed of an inert material such as HDPE or other material resistant to high and low pH is recommended.

6.1.2.2 The holder should be capable of withstanding the compaction force required to prepare the sample (see Sec. 11.3) without breaking or distorting.

NOTE: The outer diameter of the holder for a compacted granular sample should be matched as closely as possible to the inner diameter of the leaching vessel so that the majority of the eluent is above the sample (e.g., in contact with the exposed material surface) while allowing for easy placement and removal of the holder in the leaching vessel.

6.2 Leaching vessel

6.2.1 A straight-sided container constructed of a material resistant to high and low pH is recommended. Jars or buckets composed of HDPE, polycarbonate (PC), polypropylene (PP), or polyvinyl chloride (PVC) are recommended when evaluating the mobility of inorganic species.

6.2.2 The leaching vessel should have an airtight seal that can sustain long periods of standing without gas exchange with the atmosphere.

6.2.3 The container must be of sufficient volume to accommodate both the solid sample and an eluent volume based on an L/A of 9 ± 1 mL /cm^2 sample surface area. Ideally, the vessel should be sized such that the headspace is minimized within the tolerance of the L/A.

6.3 Leaching setup

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Example photos of three possible leaching equipment arrangements for monolithic and compacted granular samples are shown in Figures 1 and 2, respectively. The equipment used in the each of these cases is described below.

6.3.1 Figure 1a shows a monolithic sample 3-D configuration with the following accessories:

- Sample holder – PP sink washers, 43-mm OD, 37-mm ID, 6-mm high, with four holes drilled at the quadrants to accept 2-mm OD nylon string knotted at the top
- Sample stand – PVC pipe, 47-mm OD, 51-mm high, cut to have four legs approximately 8-mm wide and 30-mm high
- Leaching Vessel – PP bucket, 140-mm ID at top, 120-mm ID at bottom, 200-mm high (Berry Plastics #T51386CP3, VWR Scientific, or equivalent)

6.3.2 Figure 1b shows a monolithic sample 1-D configuration with the following accessories:

- Sample holder – Polyethylene (PE) mold, 54-mm OD, 100-mm high (MA Industries, Peach Tree City, GA, or equivalent), with the test sample cured in mold and cut to 51-mm high
- Leaching vessel – 250-mL PC jar, 60-mm ID, 100-mm high (Nalgene #2116-0250, Fisher Scientific, or equivalent)

6.3.3 Figure 2 shows a compacted granular sample 1-D Configuration with the following accessories:

- Sample holder – PE mold, 100-mm OD, 200-mm high, (MA Industries, Peach Tree City, GA, or equivalent) cut to 63-mm high with three tabs drilled for 0.7-mm fishing line knotted at the top
- Leaching vessel – 1000-mL PC jar, 110-mm ID at top, 130-mm high (Nalgene #2116-1000, Fisher Scientific, or equivalent)
- Glass beads, borosilicate – 2-mm diameter

6.4 Filtration apparatus – Pressure or vacuum filtration apparatus composed of appropriate materials to maximize the collection of extracts and minimize the loss of COPCs (Nalgene #300-4000 or equivalent)

6.5 Filtration membranes – Composed of hydrophilic polypropylene or equivalent material with an effective pore size of 0.45 µm (e.g., Andwin Scientific GH Polypro 28143-288 or equivalent)

6.6 pH meter – Laboratory model with the capability for temperature compensation (e.g., Accumet 20, Fisher Scientific or equivalent) and a minimum resolution of 0.1 pH units

6.7 pH combination electrode – Composed of chemically resistant materials

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6.8 Conductivity meter – Laboratory model (e.g., Accumet 20, Fisher Scientific or equivalent), with a minimum resolution of 5% of the measured value

6.9 Conductivity electrodes – Composed of chemically resistant materials

6.10 Proctor compactor (for compacted granular samples only) – Equipped with a slide hammer capable of dropping a 4.5-kg weight over a 0.46-m interval (see Ref. 10 for further details)

7.0 REAGENTS AND STANDARDS

7.1 Reagent-grade chemicals, at a minimum, should be used in all tests. Unless otherwise indicated, all reagents should conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS), where such specifications are available. Other grades may be used, provided the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination. Inorganic reagents and extracts should be stored in plastic to prevent interaction of constituents from glass containers.

7.2 Reagent water – Reagent water must be interference-free. All references to water in this method refer to reagent water unless otherwise specified.

7.3 Other reagents may be used in place of reagent water on a case-specific basis.

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1 See Chapter Three, "Inorganic Analytes," and Chapter 4, "Organic Analytes," for sample collection and preservation instructions.

8.2 Both plastic and glass containers are suitable for the collection of samples. All sample containers must be prewashed with a metal-free detergent and triple-rinsed with nitric acid and reagent water, depending on the history of the container. For further information, see Chapter Three.

9.0 QUALITY CONTROL

9.1 Refer to Chapter One for guidance on quality assurance (QA) and quality control (QC) protocols. When inconsistencies exist between QC guidelines, method-specific QC criteria take precedence over both technique-specific criteria and Chapter One criteria, and technique-specific QC criteria take precedence over Chapter One criteria. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a quality assurance project plan (QAPP) or a sampling and analysis plan (SAP), which translates project objectives and specifications into directions for those who will implement the project and assess the results.

Each laboratory should maintain a formal QA program. The laboratory should also maintain records to document the quality of the data generated. Development of in-house QC limits for each method is encouraged. Use of instrument-specific QC limits is encouraged, provided such limits will generate data appropriate for use in the intended application. All data sheets and QC data should be maintained for reference or inspection.

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9.2 In order to demonstrate the purity of reagents and sample contact surfaces, method blanks should be tested for each leaching interval. Refer to Chapter One for specific QC procedures.

9.3 The analysis of extracts should follow appropriate QC procedures, as specified in the determinative methods for the COPCs. Refer to Chapter One for specific QC procedures.

9.4 Initial demonstration of proficiency (IDP)

Leachate methods are not amenable to typical IDPs when reference materials with known values are not available. However, prior to using this method an analyst should have documented proficiency in the skills required for successful implementation of the method. For example, skill should be demonstrated in the use of an analytical balance, the determination of pH using Methods 9040 and 9045 and the determination of conductance using Method 9050.

10.0 CALIBRATION AND STANDARDIZATION

10.1 The balance should be calibrated and certified, at a minimum, annually or in accordance with laboratory policy.

10.2 Prior to measurement of eluate pH, the pH meter should be calibrated using a minimum of two standards that bracket the range of pH measurements. Refer to Methods 9040 and 9045 for additional guidance.

10.3 Prior to measurement of eluate conductivity, the meter should be calibrated using at least one standard at a value greater than the range of conductivity measurements. Refer to Method 9050 for additional guidance.

11.0 PROCEDURE

A flowchart of this method is presented in Figure 3. Microsoft Excel® data templates are available to aid in collecting and archiving of laboratory and analytical data.[2]

11.1 Preparatory Procedures – Determination of solids and moisture content

The moisture and solids content of the sample material are used to relate leaching results to dry-material masses. When preparing compacted granular samples for testing, the moisture content or solid content is used to determine the optimum moisture content following the modified Proctor test. This method calculates moisture content on the basis of the "wet" or "as-tested" sample.

WARNING: The drying oven should be contained in a hood or otherwise properly ventilated. Significant laboratory contamination or inhalation hazards may result when drying heavily contaminated samples. Consult the laboratory safety officer for proper handling procedures prior to drying samples that may contain volatile, hazardous, flammable, or explosive materials.

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[2] These Excel® templates form the basis for uploading method data into the data management program, LeachXS Lite™. Both the data templates and LeachXS Lite™ are available at http://vanderbilt.edu/leaching.

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11.1.1 Place 5 - 10 g of solid sample material into a tared dish or crucible. Dry the sample to a constant mass at 105 ± 2 °C. Check for constant mass by returning the dish to the drying oven for 24 hours, cooling to room temperature in a desiccator and re-weighing. The two mass readings should agree within the larger of 0.2% or 0.02 g.

NOTE: The oven-dried sample is not used for the extraction and should be properly disposed of once the dry mass is determined.

11.1.2 Calculate and report the solids content as follows:

$$SC = \frac{M_{dry}}{M_{test}}$$

Where: SC = solids content of "as-tested" material (g-dry/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.1.3 Calculate and report the moisture content (wet basis) as follows:

$$MC_{wet} = \frac{M_{test} - M_{dry}}{M_{test}}$$

Where: MC_{wet} = moisture content on a wet basis (g_{H_2O}/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.2 Preparation of monolithic samples

11.2.1 If the material to be tested is granular, disregard this section and proceed to Sec. 11.3.

11.2.2 A representative sample of monolithic material should be obtained by molding material components in place (e.g., cementitious media) or by coring or cutting a sample from a larger existing specimen.

11.2.3 The geometry of monolithic samples may be rectangular (e.g., bricks or tiles), cubes, wafers, or cylinders. Samples may also have a variety of faces exposed to eluent forming 1-, 2-, or 3-D mass transfer cases. Examples of monolithic sample leaching setups are shown in Figure 1.

11.2.4 A minimum sample size of 5 cm in the direction of mass transfer must be employed and the L/A must be maintained at 9 ± 1 mL/cm^2.

NOTE: Since the sample holder and leaching vessel must correspond to the specifications in Sec. 6.1, it is often easier to modify the sample size and geometry rather than the holder and vessel dimensions.

11.2.5 Proceed to Sec. 11.4.

11.3 Preparation of compacted granular samples

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Compacted granular materials, in most cases, must be open-faced cylinders due to the limitations of mechanical packing. However, the diameter and height of the sample holder may be altered to work appropriately with the diameter and volume of the leaching vessel. In all cases, a minimum sample size of 5 cm in the direction of mass transfer must be employed and the L/A must be maintained at 9 ± 1 mL/cm^2.

Granular samples are compacted into the sample holder using a variation on the modified Proctor compaction (see Ref. 10) to include the use of 6-cm high-test molds. Shorter or taller molds (or packing depths) may be used as long as the compaction effort of 56,000 ft-lb$_f$/ft^3 is achievable. The number of packing layers should be maintained at the five layers specified in Ref. 10. However, the number of blows per layer in a 4-in diameter mold may be changed according to the follow formula:

$$\frac{56{,}000\,\text{ft - lb}_\text{f}}{\text{ft}^3}\left|\frac{\text{blow}}{1.5\,\text{ft}\times 10\,\text{lb}_\text{f}}\right|\frac{\pi\left(0.\overline{3}/2\ \text{ft}\right)^2\times h\,\text{ft}}{5\,\text{layer}}=\frac{65.2\times h\,\text{blow}}{\text{layer}}$$

Where: *h* is the measured height of the sample mold (ft).

Thus, for the mold height of 4.584 in (0.382 ft) specified in the ASTM procedure, 25 blows per each of 5 layers are required. When a 6-cm (0.196 ft) mold height is used (as suggested in this method), 13 blows per each of 5 layers are required to obtain the same compaction effort.

The granular sample should be compacted at a moisture content corresponding to 90% of the modified Proctor optimum packing density in order to provide a uniform approach to obtaining a sample density that approximates field conditions. Optimum moisture content refers to the amount of moisture or fractional mass of water (g$_{H_2O}$/g material) in the granular sample that is present at the optimum packing density (g-dry material/cm^3). Optimum packing density is defined in Ref. 10. The optimum moisture content of the test material is determined from a pre-test that measures the packing density of granular materials compacted at different levels of moisture content.

11.3.1 Pre-test to determine optimum moisture content

The pre-test is conducted as a series of five batch-wise packing trials with consecutive increases in moisture content until the maximum packing density has been surpassed. The optimum moisture content is determined as the maximum of a third-order polynomial fit through the graph of dry-packing density as a function of moisture content (wet basis).

11.3.1.1 Place 1500 g of "as received" material into a pail or bowl and mix well by hand to homogenize. As an alternative to hand mixing, a mechanical paddle mixer may be used.

NOTE: The pre-test may be conducted from a bulk supply of solid material (e.g., 10 kg total for five batches) as long as the starting mass for each trial is recorded and incremental water additions are used.

11.3.1.2 Mix a known amount of tap water with the bulk material in the pail or bowl until homogenized based on visual inspection. For the first point in the pre-test, no water needs to be added.

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NOTE: The amount of water added should be enough to increase the moisture content in approximately 3 - 5% increments. Smaller additions may be needed in order to provide finer resolution of the packing density as a function of the moisture content curve.

11.3.1.3 Calculate the new moisture content (wet basis) for the trial as follows:

$$MC^{i}_{(wet)} = \frac{M_{test} \times MC_{wet} + W_{added}}{M_{test} + W_{added}}$$

Where: $MC^{i}_{(wet)}$ = moisture content on a wet basis of the pre-test trial (g_{H_2O}/g)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)
$MC_{(wet)}$ = moisture content on a wet basis of the "as-tested" material (g_{H_2O}/g)
W_{added} = mass of water added to the "as-tested" material (g_{H_2O}/g)

11.3.1.4 Compact approximately 1000 g of material into a tared 10-cm diameter mold into three consecutive layers of material. The compacted mass should have a level, flat surface as a top face.

11.3.1.5 Measure and record the height, diameter, and mass of the resulting compacted material.

11.3.1.6 Calculate and record the packing density (dry basis) as follows:

$$\rho_{pack} = \frac{m \times SC}{\pi \times h}\left(\frac{2}{d}\right)^2$$

Where: ρ_{pack} = packing density (dry basis) ($g\text{-dry}/cm^3$)
m = mass of the compacted sample (g)
SC = solids content of "as-tested" granular material (g-dry/g)
d = measured diameter of the compacted sample (cm)
h = measured height of the compacted sample (cm)

11.3.1.7 Repeat Sec. 11.3.1.1 - 11.3.1.6 for four subsequent trials until the value of the calculated packing density decreases.

11.3.1.8 Plot the packing density as a function of moisture content. Figure 4 shows an example of a packing density curve.

11.3.1.9 Determine the optimum moisture content at the maximum of the packing density curve. This value may be read directly from the graph or determined by the maximum of a third-order polynomial fit through the five pre-test data points (see the Microsoft Excel® spreadsheet template available at http://www.vanderbilt.edu/leaching/downloads/test-methods/).

11.3.2 Compacted granular test sample preparation

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11.3.2.1 Using the optimum moisture content determined in Sec. 11.3.1.9, calculate the amount of "as-received" material that is required to pack the sample holder to within 3 mm of the rim of the holder.

$$M_{test} = \frac{\rho_{opt} \times \pi \times (h - 0.3)}{SC} \left(\frac{d}{2}\right)^2$$

Where: M_{test} = mass of "as tested" solid equivalent to the dry-material mass (g)
ρ_{opt} = optimal packing density (dry basis) (g-dry/cm^3) – determined in Sec. 11.3.1.9
h = measured height of the sample mold (cm)
SC = solids content of "as-tested" granular material (g-dry/g)
d = measured diameter of the sample mold (cm)

11.3.2.2 Adjust the moisture content of the "as-received" material to the optimum moisture content using reagent water and mix until homogenized.

11.3.2.3 Pack the sample material into the sample holder using the modified Proctor compaction as described in Ref. 10.

11.3.2.4 Place a monolayer of borosilicate glass beads (Sec. 6.3.3) on the exposed sample surface to minimize scouring and mass loss during testing.

11.3.2.5 Begin the leach test procedure promptly or cover the sample with plastic wrap to minimize moisture loss to the atmosphere.

11.4 Leaching procedure

This protocol is a semi-dynamic, tank-leaching procedure (see schematic in Figure 5) where the sample is exposed to eluate for a series of leaching intervals interspersed with eluent exchanges. The chemical composition of each eluate is determined and mass transfer from the bulk solid is determined as a function of cumulative leaching time. The schedule of leaching intervals for this method is shown in Table 1.

11.4.1 Pre-test measurements – For the surface area calculation, measure and record the dimensions of the test specimen. This should include the diameter and height for a cylinder; length, width, and depth for a parallelepiped; or diameter of exposed surface for a compacted granular sample.

11.4.2 Measure and record the mass of the specimen. This value should be monitored for each eluent exchange.

11.4.3 If a holder is used, place the specimen in the monolith holder.

11.4.4 Measure and record the mass of the specimen and holder, if applicable.

11.4.5 The recommended temperature for conducting this method is room temperature (20 ± 2 °C). When conducted at temperature readings or variations other than those recommended, record the ambient temperature at each eluent renewal.

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11.5 Eluent exchange

11.5.1 Fill a clean leaching vessel with the required volume of reagent water based on an L/A of 9 ± 1 mL/cm^2. Record the amount of eluent used.

11.5.2 Carefully place the specimen or the specimen and holder in the leaching vessel (Figure 6a) so that the sample is centered in the eluent (see Figure 6b). Submersion should be gentle enough so that the physical integrity of the monolith is maintained and scouring of the solid is minimized.

11.5.3 Cover the leaching vessel with the airtight lid and place in a safe location until the end of the leaching interval. Table 1 shows the schedule of leaching intervals and cumulative release times for this method.

NOTE: Eluates of alkaline materials may be susceptible to neutralization through reaction with carbon dioxide. Precautions (e.g., ensuring airtight vessels or purging headspace) should be taken to minimize the effect of carbonation on eluates that may sit stationary for more than one week.

11.5.4 Prior to the end of the leaching interval, repeat Sec. 11.5.1 in order to prepare a vessel for the next leaching interval.

11.5.5 At the end of the leaching interval (see Table 1), carefully remove the specimen or the specimen and holder from the vessel (Figure 6c). Drain the liquid from the surface of the specimen into the eluate for approximately 20 sec.

11.5.6 Measure and record the mass of the specimen or the mass of the specimen and holder (Figure 6d).

NOTE: The change in sample mass between intervals is an indication of the potential absorption of eluent by the matrix (mass gain) or erosion of the matrix (mass loss). In the case where a holder is used, moisture may condense on the holder during the leaching interval and sample absorption may not be evident.

NOTE: Mass gain may also be indicative of carbonate precipitation if the vessel is not tightly sealed and carbon dioxide is absorbed from the atmosphere.

11.5.7 Place the specimen or the specimen and holder into the clean leaching vessel filled with new eluent as prepared in Sec. 11.5.4.

11.5.8 Cover the new leaching vessel with the airtight lid and place in a safe location until the end of the leaching interval.

11.6 Eluate processing

11.6.1 Measure and record the pH, specific conductivity, and oxidation reduction potential (ORP) of the eluate of the decanted eluate from the previous leaching interval (see Methods 9040, 9045, and 9050).

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NOTE: Measurement of pH, conductivity, and ORP should be taken within 15 minutes of eluent exchange (Sec. 11.5) to avoid neutralization of the solution due to exposure to carbon dioxide, especially when alkaline materials are tested.

NOTE: The measurement of ORP is optional, but strongly recommended, especially when testing materials where oxidation is likely to change the chemistry of COPCs.

11.6.2 Filter the remaining eluate through a 0.45-µm membrane (Sec. 6.5).

11.6.3 Immediately preserve and store the volume(s) of eluate required for chemical analysis. Preserve all analytical samples in a manner that is consistent with the determinative chemical analyses to be performed.

11.6.4 Collect all subsequent eluate by repeating the eluent exchange and eluate processing procedures in Secs. 11.5 and 11.6.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Data reporting

12.1.1 Figure 7 shows an example of a data sheet which may be used to report the concentration results of this method. At a minimum, the basic test report should include the following:

a) Name of the laboratory
b) Laboratory technical contact information
c) Date and time at the start of the test
d) Name or code of the solid material
e) Material description (including monolithic or compacted granular)
f) Moisture content of material used (g_{H_2O}/g)
g) Dimensions (cm) and geometry of sample used
h) Mass of solid material used (g)
i) Mass of sample and holder at start of test (g)
j) Eluate type (e.g., reagent water)
k) Eluate-specific information (see Sec. 12.1.2 below)

12.1.2 The minimum set of data that should be reported for each eluate includes:

a) Eluate sample ID
b) Target eluent exchange date and time
c) Actual eluent exchange date and time
d) Volume of eluent used (mL)
e) Mass of sample and holder (g)
f) Measured eluate pH

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g) Measured eluate conductivity (mS/cm)

h) Measured ORP (mV) (optional)

i) Concentration of all COPCs

j) Analytical QC qualifiers as appropriate

12.2 Data presentation

12.2.1 Interval concentrations

12.2.1.1 At the conclusion of the schedule of leaching intervals (see Table 1), the concentration of COPCs in each eluate may be plotted as a function of cumulative leaching time. An example of this is shown in Figure 8 for mass transport from a monolithic field sample of fixated scrubber sludge and lime.

12.2.1.2 If data is available from Method 1313, interval concentrations and Method 1313 data may be plotted on the same graph as a function of eluate pH. This QC step is conducted in order to determine whether the concentration of COPCs approached equilibrium in any leaching interval (i.e., the driving force for mass transport from the matrix may not be constant, which is a common assumption of dynamic-tank leach testing). Figure 9 shows this type of graph for the release from a field sample of fixated scrubber sludge and lime.

12.2.2 Interval mass release

At the conclusion of the schedule of leaching intervals (see Table 1), the interval mass released can be calculated for each leaching interval as follows:

$$M_{t_i} = \frac{C_i \times V_i}{A}$$

Where: M_{t_i} = mass released during the current leaching interval, i (mg/m^2)

C_i = constituent concentration in the eluate for interval i (mg/L)

V_i = eluate volume in interval i (L)

A = specimen external geometric surface area exposed to the eluent (m^2)

12.2.3 Mean interval flux

The flux of a COPC in an interval may be plotted as a function of the generalized mean of the square root of cumulative leaching time ($\sqrt{t}$). An example of a flux graph is show in Figure 10 for the release from a field sample of fixated scrubber sludge with lime. This graph may be used to interpret the mechanism of release (see Ref. 5 for further details).

12.2.3.1 The flux across the exposed surface of the sample can be calculated by dividing the interval mass release by the interval duration as follows:

$$F_i = \frac{M_i}{t_i - t_{i-1}}$$

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Where: F_i = flux for interval, i ($mg/m^2 \cdot s$)
M_i = mass released during the current leaching interval, i (mg/m^2)
t_i = cumulative time at the end of the current leaching interval, i (s)
t_{i-1} = cumulative time at the end of the previous leaching interval, i-1 (s)

12.2.3.2 The time used to plot each interval mass is the generalized mean of the square root of the cumulative leaching time using the cumulative time at the end of the ith interval, t_i, and the cumulative time at the end of the previous interval, t_{i-1}.

$$\overline{t_i} = \left(\frac{\sqrt{t_i} + \sqrt{t_{i-1}}}{2} \right)^2$$

Where: $\overline{t_i}$ = generalized mean leaching time for the current interval, i (s)
t_i = cumulative time at the end of the current leaching interval, i (s)
t_{i-1} = cumulative time at the end of the previous leaching interval, i-1 (s)

NOTE: If the concentrations of a COPC in the eluates approach that shown in Method 1313 for liquid-solid equilibrium, the flux curve will show the pattern in Figure 10 with intervals of the same duration having the same flux value. When the eluate concentration approaches saturation, the driving force for mass transfer approaches zero, interval flux is limited, and intervals with like durations will display similar flux limitations.

12.2.4 Cumulative release

12.2.4.1 The interval release calculated in 12.2.2 can be summed to provide the cumulative mass release as a function of leaching time. Figure 11 shows the cumulative release curves for a field sample of fixated scrubber sludge with lime.

12.2.4.2 Interpretation of the cumulative release of constituents is illustrated using the analytical solution for simple radial diffusion from a cylinder into an infinite bath presented by Crank (see Ref. 8).

$$M_t = 2\rho C_o \left(\frac{D^{obs}\, t}{\pi} \right)^{1/2}$$

Where: M_t = cumulative mass released during leaching interval i (mg/m^2)
ρ = density of the "as-tested" sample (kg/m^3)
C_o = concentration of available COPC in the solid matrix (mg/kg)
D^{obs} = observed diffusivity (m^2/s)
t = leaching time (s)

When transformed to a log-log scale, the analytical solution presented by Crank becomes linear with the square root of time.

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$$\log\left[M_t\right] = \log\left[2\rho C_o\left(\frac{D^{obs}}{\pi}\right)^{1/2}\right] + \frac{1}{2}t$$

Thus, under the assumptions of the analytical solution presented by Crank, the mass release should be proportional to the square root of time. A line showing the square root of time is plotted in Figure 11 along with the data. Since flux is the derivative of release, a similar treatment of flux as a function of leaching time using the simple diffusion model would be proportional to the negative square root of time as shown in Figure 10.

Models other than the simple diffusion model presented by Crank may also be used to interpret mass release. For example, the Shrinking Unreacted Core Model (see Ref. 2) and the Coupled Dissolution-Diffusion Model (see Ref. 7) incorporate chemical release parameters (e.g., as derived from Method 1313 data) into the model to better estimate release mechanisms and predictions (see Ref. 5 for further details).

12.2.5 Observed diffusivity

An observed diffusivity for each COPC can be determined using the logarithm of the cumulative release plotted versus the logarithm of time. In the case of a diffusion-controlled mechanism, this plot is expected to be a straight line with a slope of 0.5. An observed diffusivity can then be determined for each leaching interval where the slope is 0.50 ± 0.15 (see Ref. 1 and Ref. 14) by the following:

$$D_i^{obs} = \pi\left[\frac{M_{t_i}}{2\rho C_o\left(\sqrt{t_i} - \sqrt{t_{i-1}}\right)}\right]^2$$

Where: D_i^{obs} = observed diffusivity of a COPC for leaching interval i (m^2/s)

M_{t_i} = mass released during leaching interval i (mg/m^2)

t_i = cumulative contact time at the end of the current leaching interval, i (s)

t_{i-1} = cumulative contact time at the end of the previous leaching interval, i−1 (s)

ρ = sample density (dry basis) (kg-dry/m^3)

C_0 = initial leachable content (i.e., available release potential) (mg/kg)

The mean observed diffusivity for each COPC is then determined by taking the average of the interval observed diffusivities. It should be reported with the computed uncertainty (i.e., standard deviation).

NOTE: Since the analysis presented above assumes a diffusion process, only those interval mass transfer coefficients corresponding to leaching intervals with slopes of 0.50 ± 0.15 are included in the overall average mass-transfer coefficient.

12.3 Data representation by constituent

A concise representation of all relevant data for a single constituent may be presented as shown in Figure 12 for arsenic from a field core of fixated scrubber sludge with lime (FSSL) material. The data shows eluate pH generation as a function of leaching time (Figure 12a), comparison between eluate

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concentrations and Method 1313 data as a function of eluate pH (Figure 12b), constituent flux as a function of generalized mean cumulative leaching time (Figure 12c), and constituent release as a function of cumulative leaching time (Figure 12d).

12.4 Interpolation/extrapolation to target time values

The collected time dependence data may be interpolated or extrapolated to the nearest target cumulative time (Σt) value for purposes of comparing different data sets (e.g., test replicates of the same or different materials). The most transparent and straightforward method is linear interpolation/extrapolation of data after $\log_{10}$ transformation.

12.4.1 $\log_{10}$ transformation

Collected concentration values are transformed by taking the $\log_{10}$ of the measured concentration at each test position, i:

$$C_i = \log_{10}(c_i)$$

Where: C_i = $\log_{10}$-transformed concentration at test position i ($\log_{10}$[mg/L])
c_i = the concentration measured at test position i (mg/L)

12.4.2 Linear interpolation/extrapolation

Given a set of coordinate data sorted by increasing order according to Σt value (e.g., $\Sigma t_1 < \Sigma t_2 < \cdots < \Sigma t_n$), an interpolated/extrapolated $\log_{10}$-transformed concentration at a known Σt target is calculated as:

$$C_T = a_T + b_T \sum t_T$$

Where: C_T = the concentration at target Σt value, Σt_T ($\log_{10}$[s])
a_T and b_T are coefficients of the linear interpolation/extrapolation equation
Σt_T = a target cumulative time value

Depending on the values of observed Σt values relative to target Σt values, the calculations of the coefficients a_T and b_T in the equation may differ according to the following algorithm:

- If $\Sigma t_T < \Sigma t_1$, then $b_T = (C_2 - C_1) / (\Sigma t_2 - \Sigma t_1)$ and $a_T = C_2 - b_T \cdot \Sigma t_2$ (extrapolation from the two points with closest Σt values)
- If $\Sigma t_T \geq \Sigma t_n$, then $b_T = (C_n - C_{n-1}) / (\Sigma t_n - \Sigma t_{n-1})$ and $a_T = C_n - b_T \cdot \Sigma t_n$ (extrapolation from the two points with closest Σt values)
- If $\Sigma t_{j-1} \leq \Sigma t_T < \Sigma t_j$, then $b_T = (C_j - C_{j-1}) / (\Sigma t_j - \Sigma t_{j-1})$ and $a_T = y_j - b_T \cdot \Sigma t_j$ (interpolation from the two closest points surrounding Σt_T)

NOTE: Interpolation or extrapolation of data should only be conducted within a distance of ±20% of the target Σt value. Since the allowable L/S tolerance about a target L/S value is variable (see Table 1), interpolation/extrapolation should not create data at a target Σt value where collected data is missing.

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13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. Performance data must not be used as absolute QC acceptance criteria for laboratory QC or accreditation.

13.2 Interlaboratory validation of this method was conducted using a solidified waste analog (material code SWA) and a contaminated smelter site soil (material code CFS). Repeatability and reproducibility was determined for mean interval flux excluding the first wash-off interval (see Table 2) and for cumulative mass released after 63 days of leaching (see Table 3). More details on the interlaboratory validation may be found in Ref. 4.

13.3 Ref. 5 and Ref. 12 may provide additional guidance and insight on the use, performance, and application of this method.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operations. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction*, a free publication available from the ACS, Committee on Chemical Safety, https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/less-is-better.pdf.

15.0 WASTE MANAGEMENT

The EPA requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Laboratories are urged to protect air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available at: http://www.labsafetyinstitute.org/FreeDocs/WasteMgmt.pdf.

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16.0 REFERENCES

1. International Ash Working Group (IAWG), *Municipal Solid Waste Incinerator Residues*, Amsterdam, the Netherlands, 1997.

2. Crank, *Mathematics of Diffusion*, Oxford University Press,, London, 1986.

3. A.C. Garrabrants, and D.S. Kosson, "Leaching Processes and Evaluation Tests for Inorganic Constituents Release from Cement-Based Matrices," in *Solidification/Stabilization of Hazardous, Radioactive and Mixed Wastes*, R. Spence, and C. Shi (eds), CRC Press, 2005.

4. A.C. Garrabrants, D.S. Kosson, R. DeLapp, P. Kariher, P.F.A.B. Seignette, H.A. van der Sloot, L. Stefanski, and M. Baldwin, "Interlaboratory Validation of the Leaching Environmental Assessment (LEAF) Method 1314 and Method 1315," EPA 600/R-12/624, *U.S. Environmental Protection Agency*, Washington, DC, 2012.

5. A.C. Garrabrants, D.S. Kosson, H.A. van der Sloot, F. Sanchez, and O. Hjelmar, "Background Information for the Leaching Environmental Assessment Framework (LEAF) Test Methods," EPA/600/R-10-170, *U.S. Environmental Protection Agency*, Washington, DC, 2010.

6. J. de Groot, and H. A. van der Sloot, "Determination of Leaching Characteristics of Waste Materials Leading to Environmental Product Certification," in *Solidification and Stabilization of Hazardous, Radioactive, and Mixed Wastes*, 2nd Volume, ASTM STP 1123, T. M. Gilliam, and C. C. Wiles (eds), American Society for Testing and Materials, Philadelphia, PA, 1992.

7. Hinsenveld, and P.L. Bishop, "Use of the shrinking core/exposure model to describe the leachability from cement stabilized wastes," in *Stabilization and Solidification of Hazardous, Radioactive, and Mixed Wastes,*, 3rd Volume, ASTM STP 1240, T. M. Gilliam, and C. C. Wiles (eds), American Society for Testing and Materials,, Philadelphia, PA, 1996.

8. D.E. Hockley, and H.A. van der Sloot, "Long-term Processes in a Stabilized Coal Waste Block Exposed to Seawater," *Environmental Science and Technology*, 25(8) 1408-1414, 1991.

9. NEN 7345, "Leaching Characteristics of Solid Earth and Stony Materials - Leaching Tests - Determination of the Leaching of Inorganic Constituents from Molded and Monolithic Materials with the Diffusion Test," *Dutch Standardization Institute*, Delft, The Netherlands, 1995.

10. ASTM D1557-07, "Standard Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))," *ASTM International*, West Conshohocken, PA,

11. ASTM D1308-95, "Standard Method for Accelerated Leach Test for Diffusive Releases from Solidified Waste and a Computer Program to Model Diffusive, Fractional Leaching from Cylindrical Waste Forms," *ASTM International*, West Conshohocken, PA, 2001.

12. D.S. Kosson, H.A. van der Sloot, F. Sanchez, and A.C. Garrabrants, "An Integrated Framework for Evaluating Leaching in Waste Management and Utilization of Secondary Materials," *Environmental Engineering Science*, 19(3) 159-204, 2002.

13. CEN/TS 15863, "Characterization of waste – Leaching Behaviour Tests – Dynamic Monolithic Leaching Test with Periodic Leachant Renewal," *Comité Européen de Normalisation*, Brussels, Belgium, 2009.

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14. Sanchez, "Étude de la lixiviation de milieux poreux contenant des espèces solubles: Application au cas des déchets solidifiés par liants hydrauliques," doctoral thesis, Institut National des Sciences Appliquées de Lyon, Lyon, France, 1996.

15. ANSI/ANS 16.1, "American National Standard Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-term Test Procedure," *American Nuclear Society*, La Grange Park, IL, 1986.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables and figures referenced by this method.

TABLE 1

SCHEDULE OF ELUATE RENEWALS

Interval Label	Interval Duration (h)	Interval Duration (d)	Cumulative Leaching Time (d)
T01	2.0 ± 0.25	–	0.08
T02	23.0 ± 0.5	–	1.0
T03	23.0 ± 0.5	–	2.0
T04	–	5.0 ± 0.1	7.0
T05	–	7.0 ± 0.1	14.0
T06	–	14.0 ± 0.1	28.0
T07	–	14.0 ± 0.1	42.0
T08	–	7.0 ± 0.1	49.0
T09	–	14.0 ± 0.1	63.0

NOTE: This schedule may be extended for additional 14-day contact intervals to provide more information regarding longer-term release.

TABLE 2

METHOD PRECISON FOR MEAN INTERVAL FLUX (2nd – 9th Intervals)

Analyte	Symbol	Reapeatability – SWA %RSD_r	Repeatability – CFS %RSD_r	Reproducibility – SWA %RSD_R	Reproducibility – CFS %RSD_R
Aluminum	Al	7.3	13.3	25.3	25.3
Antimony	Sb	9.2	14.8	21.8	23.8
Arsenic	As	19.9	-	31.1	-
Barium	Ba	13.2	7.5	44.8	18.3
Boron	B	10.8	7.2	27.3	27.1
Cadmium	Cd	-	7.6	-	23.2
Calcium	Ca	8.1	6.6	28.7	26.0
Chromium	Cr	10.2	-	23.8	-
Lead	Pb	-	4.3	-	19.8
Potassium	K	12.4	10.8	28.8	40.1
Selenium	Se	10.9	13.3	30.8	32.4
Vanadium	V	8.5	11.3	22.3	30.6

Material	Reapeatability – SWA %RSD_r	Repeatability – CFS %RSD_r	Repeatability – Overall	Reproducibility – SWA %RSD_R	Reproducibility – CFS %RSD_R	Reproducibility – Overall
Mean	11%	10%	11%	29%	27%	28%

NOTE: First interval is removed from mean interval flux because of variances associated with wash-off of surface contaminants that do not pertain to the method precision.

Data taken from Ref. 4.

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TABLE 3

METHOD PRECISON FOR CUMULATIVE RELEASE AFTER 63 DAYS

Analyte	Symbol	Repeatability – SWA %RSD_r	Repeatability – CFS %RSD_r	Reproducibility – SWA %RSD_R	Reproducibility – CFS %RSD_R
Aluminum	Al	5.4	5.3	23.6	22.9
Antimony	Sb	6.9	5.9	19.7	14.4
Arsenic	As	15.9	-	31.0	-
Barium	Ba	7.5	3.9	35.6	16.5
Boron	B	8.4	3.7	22.6	25.7
Cadmium	Cd	-	4.8	-	18.4
Calcium	Ca	4.6	3.2	23.9	24.6
Chromium	Cr	7.7	-	17.7	-
Lead	Pb	-	1.6	-	12.0
Potassium	K	10.8	6.3	24.8	44.4
Selenium	Se	8.7	3.6	26.7	20.5
Vanadium	V	5.7	4.2	21.1	22.8

Material	Repeatability – SWA %RSD_r	Repeatability – CFS %RSD_r	Repeatability – Overall	Reproducibility – SWA %RSD_R	Reproducibility – CFS %RSD_R	Reproducibility – Overall
Mean	8%	4%	6%	25%	22%	23%

Data taken from Ref. 4.

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FIGURE 1

EXAMPLES OF MONOLITHIC SAMPLE HOLDERS

3-D Configuration



Sample Holder



Sample, Holder and Stand



3-D Leaching Setup

1-D Configuration



Empty Sample Holder



Full Sample Holder



1-D Leaching Setup

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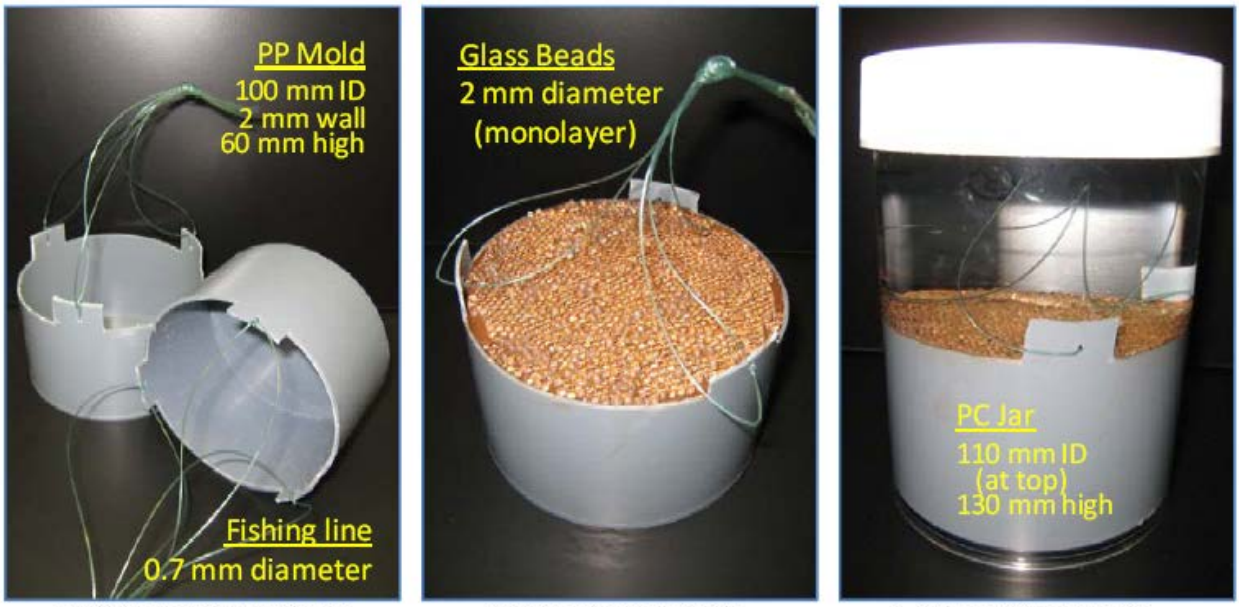
FIGURE 2

EXAMPLE COMPACTED GRANULAR SAMPLE HOLDER AND SETUP



Empty Sample Holder | Compacted Sample | 1-D Leaching Setup

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FIGURE 3

METHOD FLOWCHART

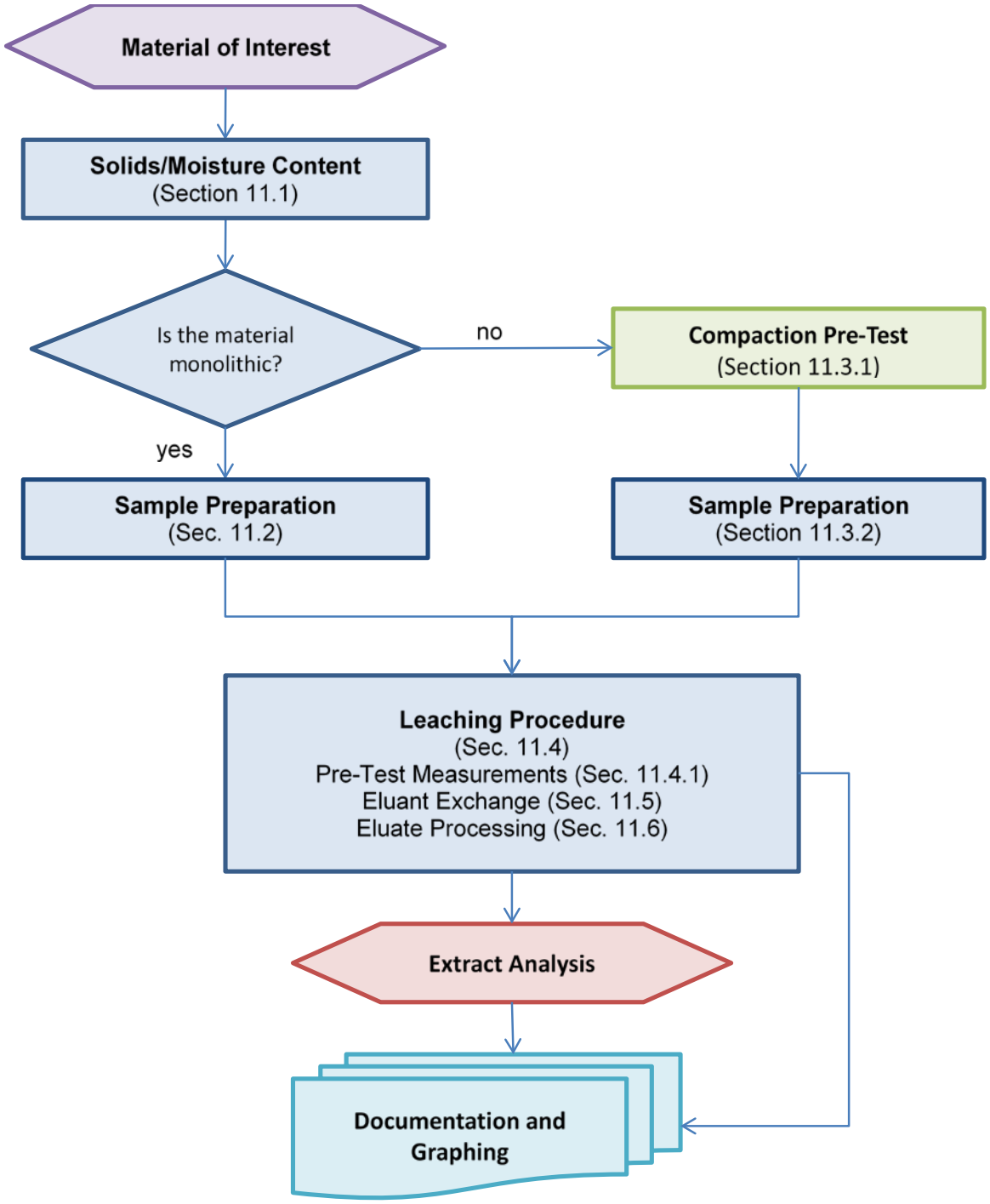

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FIGURE 4

EXAMPLE CURVE OF PACKING DENSITY AS A FUNCTION OF MOISTURE CONTENT

$y = 55.975x^3 – 65.036x^2 + 1.8352$

$r^2 = 0.983$

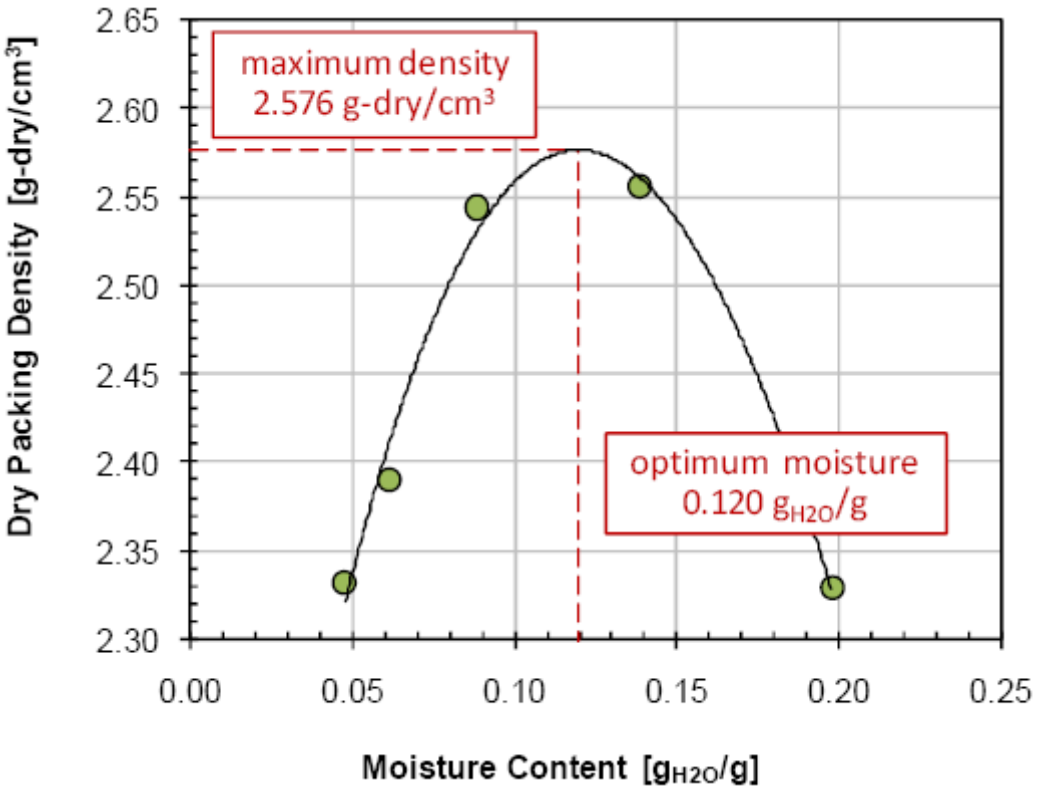

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FIGURE 5

SCHEMATIC OF SEMI-DYNAMIC MASS TRANSFER TEST PROCESS

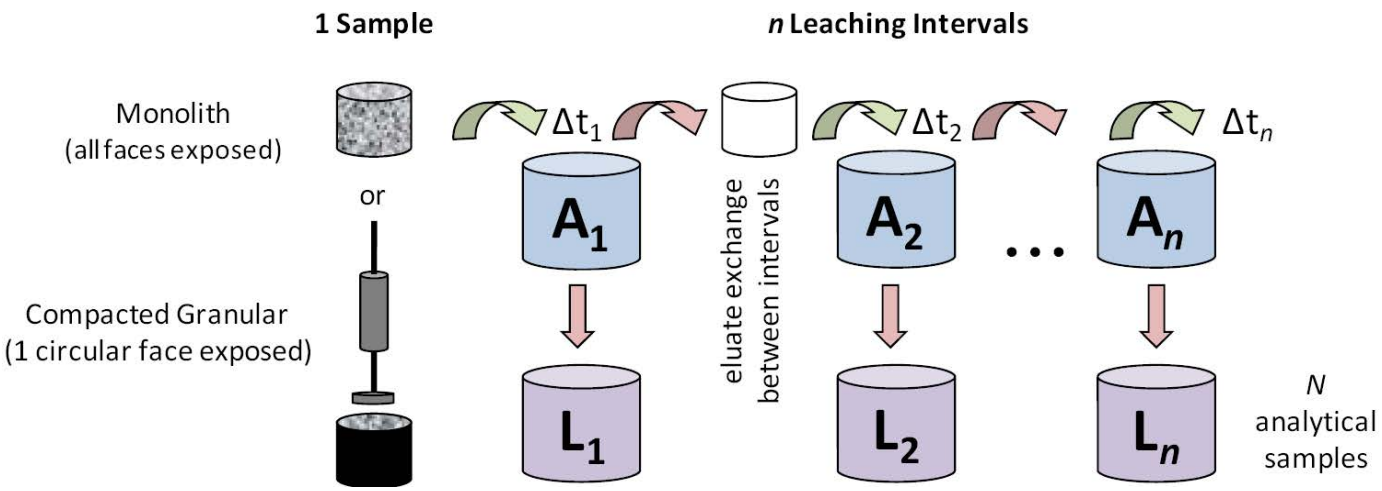

Figure obtained and modified from Ref. 1.

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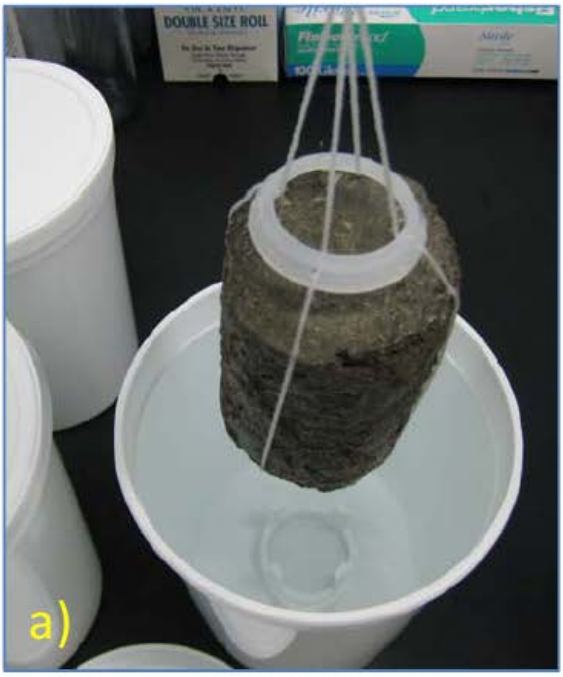
FIGURE 6

EXAMPLE LEACHING PROCEDURE STEPS



Start of Leaching Interval



Sample Centered in Eluant (top view)



Removing Sample for Exchange



Mass of Sample and Holder

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FIGURE 7

EXAMPLE DATA REPORTING FORMAT

EPA METHOD 1315
Report of Analysis

ABC Laboratories
123 Main Street
Anytown, USA
Contact: John Smith
(555) 111-1111

Client Contact: Susan Jones
(555) 222-2222

Material Code:	XYZ	Particle Size:	88% passing 2-mm sieve
Material Type:	Coal Combustion Fly Ash	Mass used in Column:	860 g
Date Received:	10/1/20xx	Moisture Content:	0.002 g_{H_2O}/g
Test Start Date:	11/1/20xx	Sample Geometry:	Cylinder
Report Date:	12/1/20xx	Sample Diameter	10.0 cm
		Sample Depth:	60.3 cm
Test Type:	Compacted Granular	Mass of Sample & Holder	1020 g
Eluent:	ASTM Type II Water	Lab Temperature:	21 ± 2 °C

Test Position	Replicate	Value	Units	Method	Note
T01	A				
	Eluate Sample ID	**XYZ-1315-T01-A**			
	Exchange Date	11/1/20xx			
	Target Exchange Time	12:00	PM		
	Actual Exchange Time	12:15	PM		
	Mass of Sample & Holder	1026	g		
	Eluate Mass	730.4	g		
	Eluate pH	8.82	-	EPA 9040	
	Eluate Conductivity	5.4	mS/c	EPA 9050	
	Eluate ORP	NA	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	4.72	mg/L		EPA 6020	11/7/20xx	1000
As	0.12	mg/L		EPA 6020	11/7/20xx	10
Cl	5.42	mg/L		EPA 9056	11/9/20xx	1

Test Position	Replicate	Value	Units	Method	Note
T02	A				
	Eluate Sample ID	**XYZ-1315-T02-A**			
	Exchange Date	11/1/20xx			
	Target Exchange Time	12:00	PM		
	Actual Exchange Time	12:18	PM		
	Mass of Sample & Holder	1027	g		
	Eluate Mass	725.0	g		
	Eluate pH	9.15	-	EPA 9040	
	Eluate Conductivity	2.8	mS/c	EPA 9050	
	Eluate ORP	NA	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	2.99	mg/L		EPA 6020	11/7/20xx	1000
As	0.21	mg/L		EPA 6020	11/7/20xx	10
Cl	4.20	mg/L	U	EPA 9056	11/7/20xx	1

QC Flag Key: U Value below lower limit of quantitation as reported (< "LLOQ")

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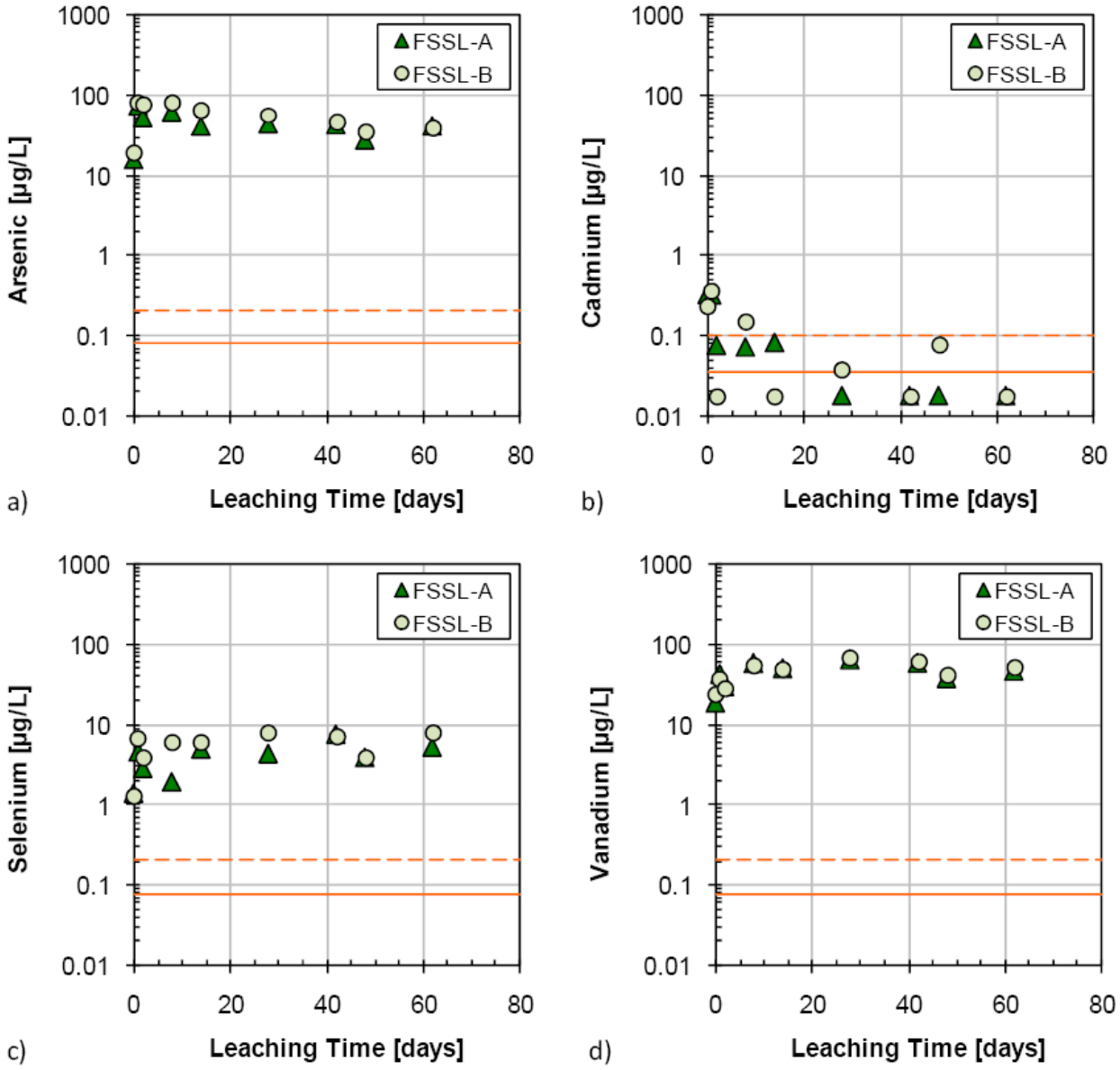
FIGURE 8

EXAMPLE INTERVAL CONCENTRATION GRAPHS



NOTE: Orange lines represent cumulative release if all eluate extracts were at the quantitation limit (dashed) and detection limit (solid). Chemical analyses below the detection limit are shown at ½ the detection limit value.

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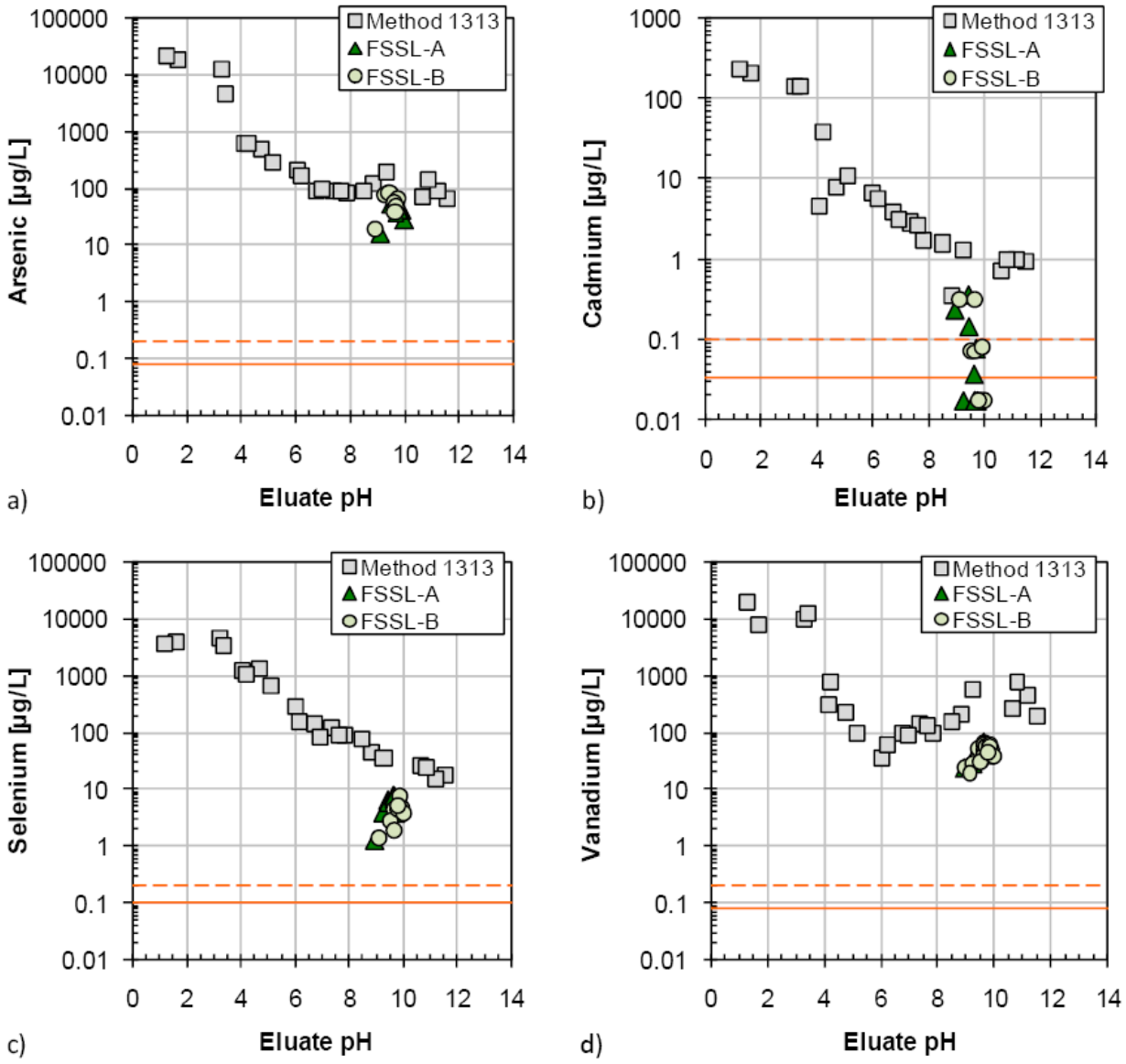
FIGURE 9

EXAMPLE OF SATURATION CHECK BETWEEN INTERVAL CONCENTRATIONS AND METHOD 1313 DATA



NOTE: Orange lines represent cumulative release if all eluate extracts were at the quantitation limit (dashed) and detection limit (solid). Chemical analyses below the detection limit are shown at ½ the detection limit value.

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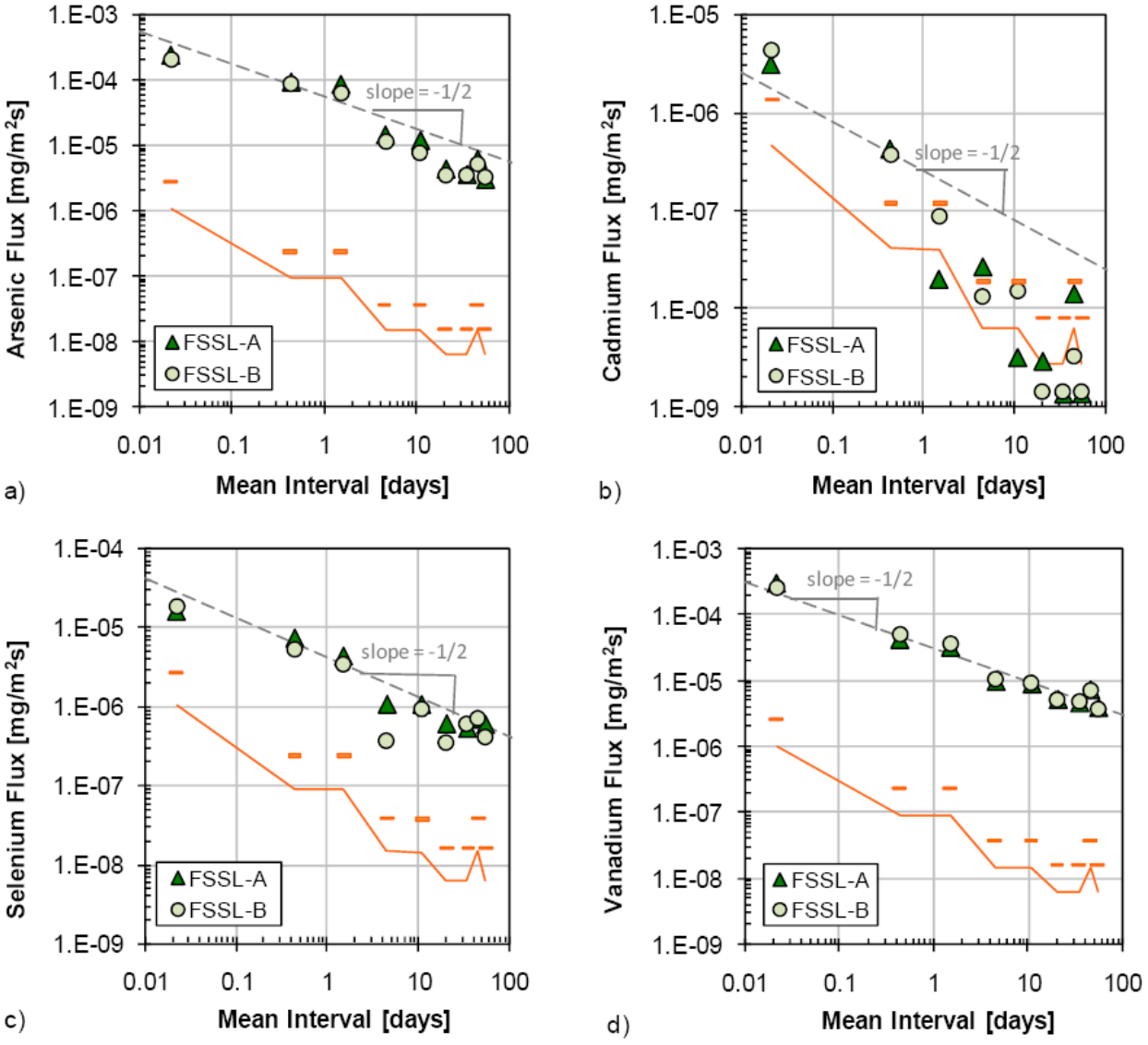
FIGURE 10

EXAMPLE INTERVAL FLUX GRAPHS



NOTE: Orange data represent cumulative release if all eluate extracts were at the quantitation limit (dashes) and detection limit (solid line).

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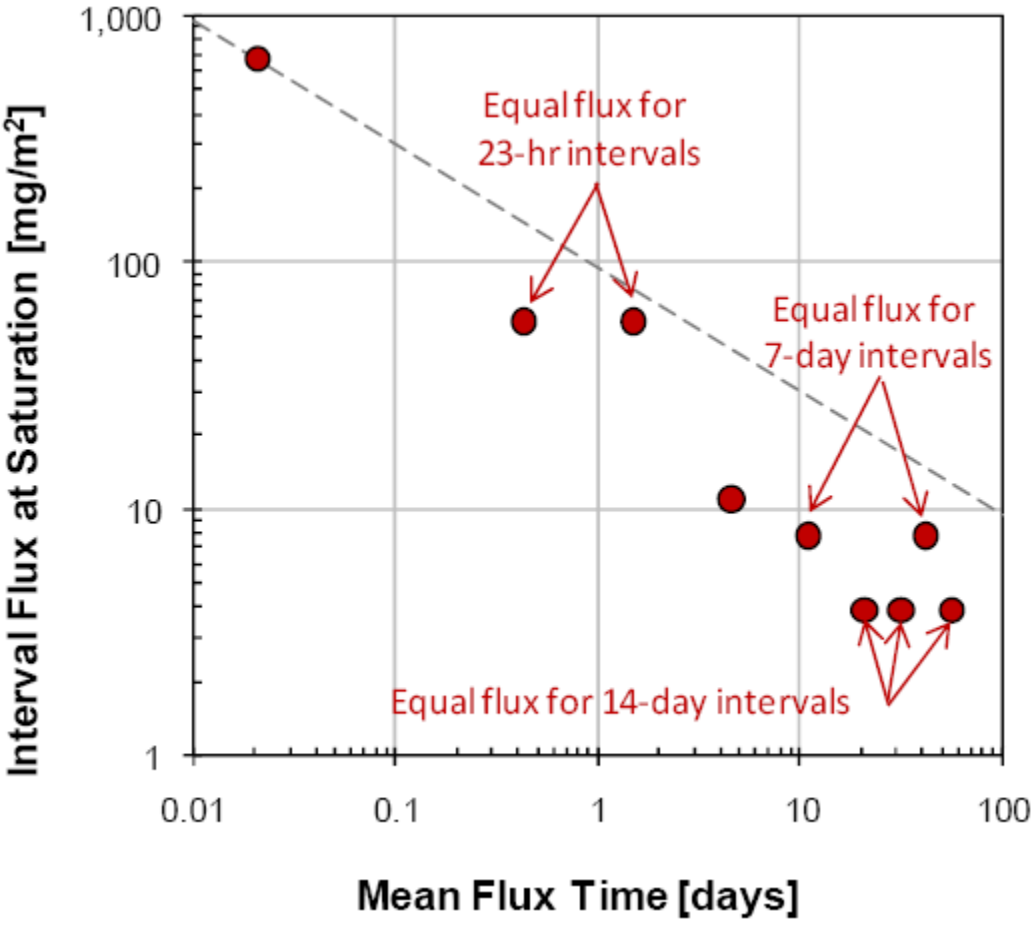
FIGURE 11

INTERVAL FLUX AT ELUATE SATURATION



NOTE: This figure assumes that the concentration in the eluate approaches saturation during the leaching interval (i.e., the driving force for diffusion approaches zero). When the leaching solution is saturated, the resulting mass release and interval flux is constant for intervals of the same duration.

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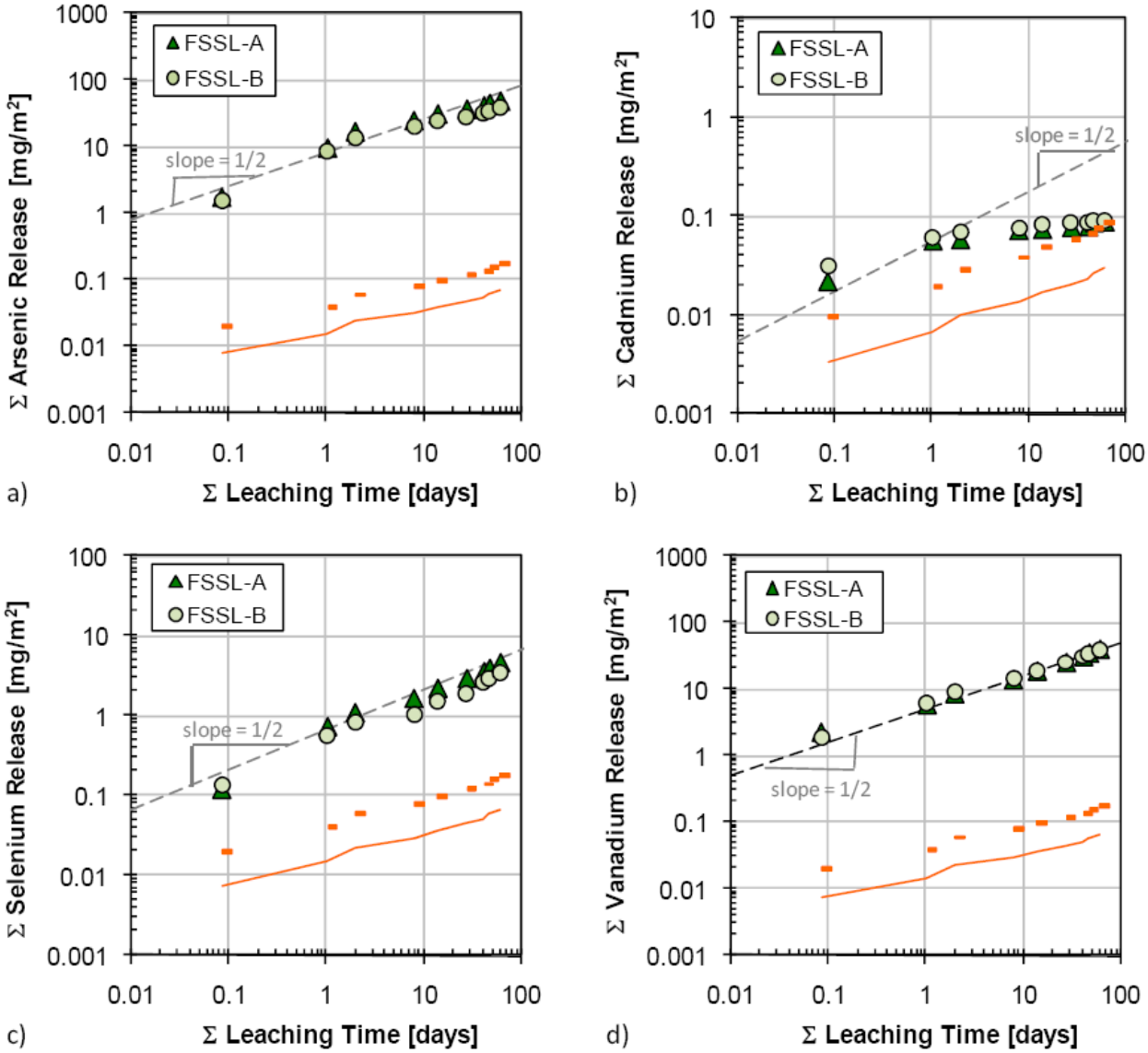
FIGURE 12

EXAMPLE CUMULATIVE RELEASE GRAPHS



NOTE: Orange data represent cumulative release if all eluate extracts were at the quantitation limit (dashes) and detection limit (solid line).

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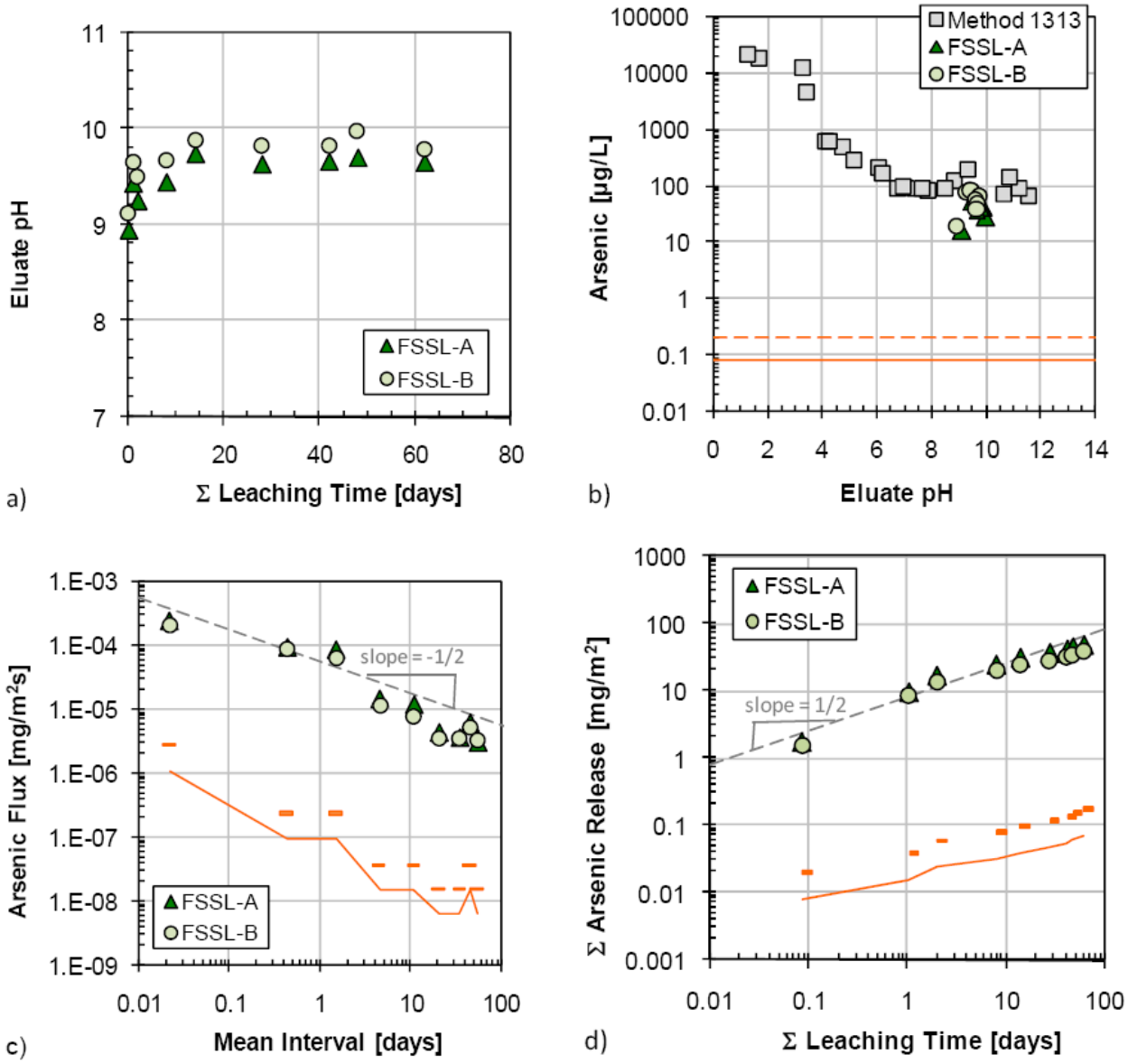
FIGURE 13

DATA REPRESENTATION BY CONSTITUENT (QUAD FORMAT)



NOTE: Orange data represent cumulative release if all eluate extracts were at the quantitation limit (dashes) and detection limit (solid line).

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Document 6

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METHOD 1316[1]

LIQUID-SOLID PARTITIONING AS A FUNCTION OF LIQUID-TO-SOLID RATIO IN SOLID MATERIALS USING A PARALLEL BATCH PROCEDURE

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required methods used for the analysis of method-defined parameters, are intended to be guidance methods that contain general information on how to perform an analytical procedure or technique, which a laboratory can use as a basic starting point for generating its own detailed standard operating procedure (SOP), either for its own general use or for a specific project application. Performance data included in this method are for guidance purposes only and must not be used as absolute quality control (QC) acceptance criteria for purposes of laboratory QC or accreditation.

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[1] This method has been derived from the SR003 procedure (Ref. 4) using Environmental Protection Agency-reviewed and accepted methodologies (see Ref. 3, Ref. 6, and Ref. 7). The method is analogous to batch L/S-dependence method EN12457 (Ref. 5) developed for the Comité Européen de Normalisation (CEN).

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1.0 SCOPE AND APPLICATION

1.1 This method is designed to provide the liquid-solid partitioning (LSP) of inorganic constituents (e.g., metals, radionuclides) and non-volatile organic constituents (e.g., polycyclic aromatic hydrocarbons (PAHs)), dissolved organic carbon) at the natural pH of the solid material as a function of liquid-to-solid ratio (L/S) under conditions that approach liquid-solid chemical equilibrium. Table 1 shows the range of target L/S values tested under this method.

1.2 The eluate concentrations at a low L/S provide insight into pore solution composition either in a granular bed (e.g., soil column) or in the pore space of low-permeability material (e.g., solidified monolithic or compacted granular fill). In addition, analysis of eluates for dissolved organic carbon and of the solid phase for total organic carbon allow for evaluation of the impact of organic carbon release and the influence of dissolved organic carbon on the LSP of inorganic constituents.

1.3 This method is intended to be used as part of environmental leaching assessment for the evaluation of disposal, beneficial use, treatment effectiveness and site remediation. The method is not required by federal regulations to determine whether waste passes or fails the toxicity characteristic as defined at 40 CFR 261.24.

1.4 This method is suitable for assessing the leaching potential of a wide range of solid materials. Examples of solid materials include: industrial wastes, soils, sludges, combustion residues, sediments, stabilized materials, construction materials, and mining wastes.

1.5 This method is a leaching characterization method used to provide intrinsic material parameters that control leaching of inorganic species under equilibrium conditions. This test method is intended as a means for obtaining an extract (i.e., the eluate) of a solid material which may be used to estimate the solubility and release of inorganic constituents under the laboratory conditions described in this method. Extract concentrations may be used in conjunction with information regarding environmental management scenarios to estimate anticipated leaching concentrations, and release rate and extent for individual material constituents in the management scenarios evaluated. Extract concentrations may also be used along with geochemical speciation modeling to infer the mineral phases that control the LSP in the pore structure of the solid material.

1.6 This method is not applicable to characterize the release of volatile organic analytes (e.g., benzene, toluene and xylenes).

1.7 This method provides solutions that are considered to be indicative of leachate under field conditions only where the field leaching pH and L/S ranges are encompassed by the laboratory extract final conditions and the LSP is controlled by aqueous-phase saturation of the constituent of interest. When LSP is controlled by the amount of the constituent present in the solid that may dissolve (i.e., for highly soluble species), the mass released (mg/kg), rather than the concentration, is indicative of field conditions.

1.8 The solvent used in this method is reagent water.

1.9 Analysts are advised to take reasonable measures to ensure that the sample is homogenized to the extent practical prior to employment of this method. Particle size reduction may

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provide additional assurance of sample homogenization. Table 2 designates a minimum dry equivalent mass of sample to be added to each extraction vessel and the associated extraction contact time as a function maximum particle diameter. If the heterogeneity of the sample is suspected as the cause of unacceptable levels of precision in replicate test results or is considered significant based on professional judgment, the sample mass used in the test procedure may be increased to a greater minimum dry equivalent mass than shown in Table 1 with the amount of extractant increased proportionately to maintain the designated L/S.

1.10 In the preparation of solid materials for use in this method, particle size reduction of samples with large grain size is used to enhance the approach towards liquid-solid equilibrium under the designated contact time interval of the extract process. The extract contact time for samples reduced to a finer maximum particle size will be shorter.

1.11 Prior to employing this method, analysts are advised to consult the base method for each type of procedure that may be employed in the overall analysis (e.g., Methods 9040, 9045, and 9050) for additional information on QC procedures, development of QC acceptance criteria, calculations, and general guidance. Analysts also should consult the disclaimer statement at the front of the manual and the information in Chapter Two for: 1) guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and 2) the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is not mandatory in response to federal testing requirements. The information contained in this method is provided by the Environmental Protection Agency (EPA or the Agency) as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives (DQOs) for the intended application.

1.12 This method is restricted to use by, or under supervision of, properly experienced and trained personnel. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

This method consists of five parallel extractions of a particle size-reduced solid material in reagent water over a range of L/S values from 0.5 to 10 mL eluent/g dry material (see Table 1). In addition to the five test extractions, a method blank without solid sample is carried through the procedure in order to verify that analyte interferences are not introduced as a consequence of reagent impurities or equipment contamination. If multiple materials or replicate tests are carried out in parallel, only one set of method blanks is necessary. In total, six bottles (i.e., five test positions and one method blank) are tumbled in an end-over-end fashion for a specified contact time based on the maximum particle size of the solid (see Table 2). At the end of the contact interval, the liquid and solid phases are roughly separated via settling or centrifugation. Extract pH and specific conductance measurements are then taken on an aliquot of the liquid phase. The bulk of the eluate is clarified by pressure or vacuum filtration in preparation for constituent analysis. Analytical aliquots of the extracts are collected and preserved accordingly based on the determinative methods to be performed. The eluate constituent concentrations are plotted as a function of L/S and compared to QC and assessment limits.

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3.0 DEFINITIONS

3.1 Constituent of potential concern (COPC) – A chemical species of interest, which may or may not be regulated, but may be characteristic of release-controlling properties of the sample geochemistry.

3.2 Release – The dissolution or partitioning of a COPC from the solid phase to the aqueous phase during laboratory testing (or under field conditions). In this method, mass release is expressed in units of mg COPC/kg dry solid material.

3.3 Liquid-solid partitioning (LSP) – The distribution of COPCs between the solid and liquid phases at the conclusion of the extraction.

3.4 Liquid-to-solid ratio (L/S) – The fraction of the total liquid volume (including the moisture contained in the "as used" solid sample) to the dry mass equivalent of the solid material. L/S is typically expressed in volume units of liquid per dry mass of solid material (mL/g-dry).

3.5 "As-tested" sample – The solid sample at the conditions (e.g., moisture content and particle-size distribution) present at the time of the start of the test procedure. The "as-tested" conditions will differ from the "as-received" sample conditions if particle-size reduction and drying were necessarily performed.

3.6 Dry-mass equivalent – The mass of "as-tested" (i.e., "wet") sample that equates to the mass of dry solids plus associated moisture, based on the moisture content of the "as-tested" material. The dry-mass equivalent is typically expressed in mass units of the "as-tested" sample (g).

3.7 Eluent – The solution used to contact the solid material in a leaching test. The eluent is usually free of COPCs but may contain other species used to control the test conditions of the extraction.

3.8 Eluate – The solution collected as an extract from a leaching test that contains the eluent plus constituents leached from the solid phase.[2]

3.9 Refer to Chapter One, Chapter Three, and the manufacturers' instructions for definitions that may be relevant to this procedure.

4.0 INTERFERENCES

Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents may be necessary. Refer to each method to be used for specific guidance on QC procedures

[2] The definition of "eluate" is used in this method to differentiate the output solution of a leaching test from the "leachate" solution collected from, or measured in, the field. The distinction between terms is made to minimize confusion when comparing laboratory results to field data (Ref. 5).

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and to Chapters Three and Four for general guidance on glassware cleaning. Also refer to Methods 9040, 9045, and 9050 for a discussion of interferences.

5.0 SAFETY

This method does not address all safety issues associated with its use. The laboratory is responsible for maintaining a safe work environment and a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals specified in this method. A reference file of material safety data sheets (MSDSs) should be available to all personnel involved in these analyses.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for use. The products and instrument settings cited in SW-846 methods represent those products and settings used during the method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

This section does not list all common laboratory glassware (e.g., beakers and flasks) that might be used.

6.1 Extraction vessels

6.1.1 Six wide-mouth bottles (i.e., five for test positions plus one for a method blank) constructed of inert material, resistant to high and low pH conditions and interaction with the constituents of interest, as described in the following sections.

6.1.1.1 For the evaluation of inorganic COPCs, bottles made of high density polyethylene (HDPE) (e.g., Nalgene #3140-0250 or equivalent), polypropylene (PP), or polyvinyl chloride (PVC) are recommended.

6.1.1.2 For the evaluation of non-volatile organic and mixed organic/inorganic COPCs, bottles made of glass or Type-316 stainless steel are recommended. Polytetrafluoroethene (PTFE) is not recommended for non-volatile organics, due to the sorption of species with high hydrophobicity (e.g., PAHs). Borosilicate glass is recommended over other types of glass, especially when inorganic analytes are of concern.

6.1.2. The extraction vessels must be of sufficient volume to accommodate both the solid sample and an extractant volume based on the schedule of L/S values shown in Table 1. For example, a 500-mL bottle is recommended when 100 g dry equivalent mass is contacted with 200 mL of eluent (see T03 in Table 1).

6.1.3 The vessels must have a leak-proof seal that can sustain end-over-end tumbling for the duration of the designated contact time.

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6.1.4 If centrifugation is anticipated to be beneficial for initial phase separation, the extraction vessels should be capable of withstanding centrifugation at 4000 ± 100 rpm for a minimum of 10 ± 2 min. Alternately, samples may be extracted in bottles that do not meet this centrifugation specification (e.g., Nalgene I-Chem #311-0250 or equivalent) and the solid-liquid slurries transferred into appropriate centrifugation vessels for phase separation as needed.

6.2 Balance – Capable of 0.01 g resolution for masses less than 500 g

6.3 Rotary tumbler – Capable of rotating the extraction vessels end-over-end at a constant speed of 28 ± 2 rpm (e.g., Environmental Express, Charleston, SC or equivalent)

NOTE: The holding capacity of tumblers may vary and modifications (e.g., packing or bottle-holding inserts) may be necessary to accommodate the extraction vessels.

6.4 Filtration apparatus – Pressure or vacuum filtration apparatus composed of appropriate materials to maximize collection of extracts and minimize loss of COPCs (e.g., Nalgene #300-4000 or equivalent) (see Sec. 6.1)

6.5 Filtration membranes – Composed of polypropylene or equivalent material with an effective pore size of 0.45 µm (e.g., Gelman Sciences GH Polypro #66548 from Fisher Scientific or equivalent)

6.6 pH meter – Laboratory model capable of temperature compensation (e.g., Accumet 20, Fisher Scientific or equivalent) with a minimum resolution of 0.1 pH units

6.7 pH combination electrode – Composed of chemically resistant materials

6.8 Conductivity meter – Laboratory model (e.g., Accumet 20, Fisher Scientific or equivalent), with a minimum resolution of 5% of the measured value

6.9 Conductivity electrodes – Composed of chemically resistant materials

6.10 Adjustable-volume pipettor – Oxford Benchmate series or equivalent.

The necessary delivery range will depend on the buffering capacity of the solid material and acid/base strength used in the test.

6.11 Disposable pipettor tips

6.12 Centrifuge (recommended) – Capable of centrifuging the extraction vessels at a rate of 4000 ± 100 rpm for 10 ± 2 min

7.0 REAGENTS AND STANDARDS

7.1 Reagent-grade chemicals, at a minimum, should be used in all tests. Unless otherwise indicated, all reagents should conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS), where such specifications are available. Other grades may be used, provided the reagents are of sufficiently high purity to permit use without lessening the accuracy of the determination. Inorganic reagents and extracts should be stored in plastic to prevent interaction

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of constituents from glass containers. Organic reagents should be stored in glass to prevent leaching of contaminants from plastic containers.

7.2 Reagent water must be interference free. All references to water in this method refer to reagent water unless otherwise specified.

7.3 Consult Methods 9040 and 9050 for additional information regarding the preparation of reagents required for pH and specific conductance measurements.

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1 See Chapter Three, "Inorganic Analytes," and Chapter Four, "Organic Analytes," for sample collection and preservation information.

8.2 All solid samples should be collected using an appropriate sampling plan.

8.3 All containers should be composed of materials that minimize interaction with solution COPCs. For further information, see Chapters Three and Four.

8.4 Preservatives should not be added to samples before extraction.

8.5 Samples can be refrigerated, unless refrigeration results in an irreversible physical change to the sample.

8.6 Analytical extracts or leachates should be preserved according to the guidance given in the individual determinative methods for the COPCs.

8.7 Extract holding times should be consistent with the holding times specified in the individual determinative methods for the COPCs.

9.0 QUALITY CONTROL

9.1 Refer to Chapter One for guidance on quality assurance (QA) and quality control (QC) protocols. When inconsistencies exist between QC guidelines, method-specific QC criteria take precedence over both technique-specific criteria and Chapter One criteria, and technique-specific QC criteria take precedence over Chapter One criteria. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a quality assurance project plan (QAPP) or a sampling and analysis plan (SAP), which translates project objectives and specifications into directions for those who will implement the project and assess the results.

Each laboratory should maintain a formal QA program. The laboratory should also maintain records to document the quality of the data generated. Development of in-house QC limits for each method is encouraged. Use of instrument-specific QC limits is encouraged, provided such limits will generate data appropriate for use in the intended application. All data sheets and QC data should be maintained for reference or inspection.

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9.2 In order to demonstrate the purity of reagents and sample contact surfaces, a method blank (e.g., a bottle without solid material but with eluent carried through the extraction, filtration and analytical sample preparation process) should be tested.

9.3 The analysis of extracts should follow appropriate QC procedures, as specified in the determinative methods for the COPCs. Refer to Chapter One for specific QC procedures.

9.4 Solid materials should be tested within one month of receipt unless the project requires that the "as-received" samples are tested sooner (e.g., the material is part of a time-dependent study or the material may change during storage due to oxidation or carbonation).

9.5 Initial demonstration of proficiency (IDP)

Leachate methods are not amenable to typical IDPs when reference materials with known values are not available. However, prior to using this method an analyst should have documented proficiency in the skills required for successful implementation of the method. For example, skill should be demonstrated in the use of an analytical balance, the determination of pH using methods 9040 and 9045 and the determination of conductance using method 9050.

10.0 CALIBRATION AND STANDARDIZATION

10.1 The balance should be calibrated and certified, at a minimum, annually or in accordance with laboratory policy.

10.2 Prior to measurement of eluate pH, the pH meter should be calibrated using a minimum of two standards that bracket the range of pH measurements. Refer to Methods 9040 and 9045 for additional guidance.

10.3 Prior to measurement of eluate conductivity, the meter should be calibrated using at least one standard at a value greater than the range of conductivity measurements. Refer to Method 9050 for additional guidance.

11.0 PROCEDURE

A flowchart of the method is presented in Figure 1. Microsoft Excel® data templates are available to aid in collecting and archiving of laboratory and analytical data.[3]

11.1 Particle size reduction (if required)

11.1.1 In this method, particle size reduction is used to prepare large-grained samples for extraction so that the approach toward liquid-solid equilibrium is enhanced and mass transport through large particles is minimized. A longer extract contact time is required for larger maximum particle size designations. This method designates three maximum particle sizes and associated contact times (see Table 2). The selection of an appropriate maximum

[3] These Excel® templates form the basis for uploading method data into the data management program, LeachXS Lite™. Both the data templates and LeachXS Lite™ are available at http://vanderbilt.edu/leaching.

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particle size from this table should be based on professional judgment regarding the practical effort required to size reduce the solid material.

11.1.2 Particle size reduction of "as received" sample may be achieved through crushing, milling, or grinding with equipment made from chemically inert materials. During the reduction process, care should be taken to minimize loss of sample and potentially volatile constituents in the sample.

11.1.3 If the moisture content of the "as-received" material is greater than 15% (wet basis), air drying or desiccation may be necessary. Oven drying is not recommended for preparation of test samples due to the potential for mineral alteration. In all cases, the moisture content of the "as received" material should be recorded.

NOTE: If the solid material is susceptible to interaction with the atmosphere (e.g., carbonation, oxidation), drying should be conducted in an inert environment.

11.1.4 When the material seems to be of a relatively uniform particle size, calculate the percentage less than the sieve size as follows:

$$\%\ \text{Passing} = \frac{M_{sieved}}{M_{total}} \times 100\%$$

Where: M_{sieved} = mass of sample passing the sieve (g)
M_{total} = mass of total sample (g) (e.g., M_{sieved} + mass not passing sieve)

11.1.5 The fraction retained by the sieve should be recycled for further particle size reduction until at least 85% of the initial mass has been reduced below the designated maximum particle size. Calculate and record the final percentage passing the sieve and the designated maximum particle size. For the uncrushable fraction of the "as received" material, record the fraction mass and nature (e.g., rock, metal or glass shards, etc).

11.1.6 Store the size-reduced material in an airtight container in order to prevent contamination via gas exchange with the atmosphere. Store the container in a cool, dark and dry place prior to use.

11.2 Determination of solids and moisture content

11.2.1 In order to provide the dry mass equivalent of the "as-tested" material, the solids content of the subject material should be determined. Often, the moisture content of the solid sample is recorded. In this method, the moisture content is determined and recorded on the basis of the "wet" or "as-tested" sample.

WARNING: The drying oven should be contained in a hood or otherwise properly ventilated. Significant laboratory contamination or inhalation hazards may result when drying heavily contaminated samples. Consult the laboratory safety officer for proper handling procedures prior to drying samples that may contain volatile, hazardous, flammable or explosive materials.

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11.2.2 Place a 5 to 10-g sample of solid material into a tared dish or crucible. Dry the sample to a constant mass at 105 ± 2 °C. Check for constant mass by returning the dish to the drying oven for 24 hours, cooling to room temperature in a desiccator and re-weighing. The two mass readings should agree within the larger of 0.2% or 0.02 g.

NOTE: The oven-dried sample is not used for the extraction and should be properly disposed of once the dry mass is determined.

11.2.3 Calculate and report the solids content as follows:

$$SC = \frac{M_{dry}}{M_{test}}$$

Where: SC = solids content of "as-tested" material (g-dry/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.2.4 Calculate and report the moisture content (wet basis) as follows:

$$MC_{wet} = \frac{M_{test} - M_{dry}}{M_{test}}$$

Where: $MC_{(wet)}$ = moisture content on a wet basis (g_{H_2O}/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.3 Extraction setup schedule (Microsoft Excel® spreadsheet template available at http://www.vanderbilt.edu/leaching/downloads/test-methods/).

An Excel® template accompanies this method and may be used to set up the extraction schedule. If using the provided template, disregard Sec. 11.3 and proceed to the extraction procedure Sec. 11.4.

11.3.1 Using the schedule shown in Table 1 as a guide, set up five test extractions and one method blank. The mass of solids in an extraction may be scaled to minimize headspace in each extraction vessel. However, the volume of eluent should always be based on the target L/S in Column B of Table 1.

11.3.2 Calculate and record the amount of "as-tested" material equivalent to the dry mass in Column D of Table 1 as follows:

$$M_{test} = \frac{M_{dry}}{SC}$$

Where: M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)
M_{dry} = mass of dry material specified in the method (g-dry)
SC = solids content of "as-tested" material (g-dry/g)

11.3.3 Calculate and record the volume of moisture contained in the "as-tested" sample in Column E of Table 1 as follows:

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$$V_{W,sample} = \frac{M_{test} \times (1 - SC)}{\rho_w}$$

Where: $V_{W,sample}$ = volume of water in the "as tested" sample (mL)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)
SC = solids content of the "as tested" sample (g-dry/g)
ρ_w = density of water (1.0 g/mL at room temperature)

11.3.4 Calculate and record the volume of reagent water required to bring each extraction to the target L/S in Column F of Table 1 as follows:

$$V_{RW} = M_{dry} \times LS - V_{W,sample}$$

Where: V_{RW} = volume of reagent water required to complete L/S (mL)
M_{dry} = mass of dry material specified in the method (g-dry)
LS = liquid-to-dry-solid ratio (10 mL/g)
$V_{W,sample}$ = volume of water in "as tested" sample (mL)

The size of the extraction bottle should be sufficient to contain the combined volume of solid material and eluent, ideally with a minimum amount of headspace.

11.4 Extraction procedure

11.4.1 Label five bottles with test position numbers and an additional bottle as a method blank according to Column A in Table 1.

11.4.2 Place the dry-mass equivalent (± 0.1 g) of "as-tested" sample as shown in Column D in Table 1 into each of the five test position extraction vessels.

NOTE: Do not put solid material in the method blank extraction vessel.

11.4.3 Add the appropriate volume (± 0.5 mL) of reagent water to both the test position and method blank extraction vessels as specified in Column F of Table 1.

11.4.4 Tighten the leak-proof lid on each bottle and tumble all extractions (i.e., test positions and method blanks) in an end-over-end fashion at a speed of 28 ± 2 rpm at room temperature (20 ± 2 °C). The contact time for this method will vary depending on the maximum particle size as shown in Table 2.

NOTE: The length of the contact time is designed to enhance the approach toward liquid-solid equilibrium. Longer contact times are required for larger particles to compensate for the effects of intra-particle diffusion. See Table 2 for required contact times based on the maximum particle size.

11.4.5 Remove the extraction vessels from the rotary tumbler and clarify the extracts by allowing the bottles to stand for 15 ± 5 min. Alternately, centrifuge the extraction vessels at 4000 ± 100 rpm for 10 ± 2 min.

NOTE: If clarification is significantly incomplete after settling or centrifugation, eluate measurements for pH, conductivity, and oxidization-reduction potential (ORP) may be

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taken on filtered samples. In this case, perform the filtration in Sec. 11.4.8 prior to eluate measurement in Sec. 11.4.6 and note the deviation from the written procedure.

CAUTION: Following separation from the solid phase, eluate samples lack the buffering provided by the solid phase and therefore may be susceptible to pH change resulting from interaction with air.

11.4.6 For each extraction vessel, decant a minimum volume (approximately 5 mL) of clear, unpreserved supernatant into a clean container.

11.4.7 Measure and record the pH, specific conductivity, and ORP of the extracts (see Methods 9040, 9045, and 9050).

NOTE: Measurement of pH, conductivity, and ORP should be taken within 15 minutes of eluate processing (Sec. 11.4.8) to avoid neutralization of the solution due to exposure to carbon dioxide, especially when alkaline materials are tested.

NOTE: The measurement of ORP is optional, but strongly recommended, especially when testing materials where oxidation is likely to change the LSP of COPCs.

11.4.8 Separate the solid from the remaining liquid in each extraction vessel by pressure or vacuum filtration through a clean 0.45-µm pore size membrane (Sec. 6.5). The filtration apparatus may be exchanged for a clean apparatus as often as necessary until all liquid has been filtered.

11.4.9 Immediately, preserve and store the volume(s) of eluate required for chemical analysis. Preserve all analytical samples in a manner that is consistent with the determinative chemical analyses to be performed.

12.0 DATA ANALYSIS AND CALCULATIONS (EXCEL® TEMPLATE PROVIDED)

12.1 Data reporting

12.1.1 Figure 2 shows an example of a data sheet that may be used to report the concentration results of this method. This example is included in the Excel® template. At a minimum, the basic test report should include:

a) Name of the laboratory
b) Laboratory technical contact information
c) Date and time at the start of the test
d) Name or code of the solid material
e) Particle size (85 wt% less than designated particle size)
f) Ambient temperature during extraction (°C)
g) Extraction contact time (h)
h) Eluate-specific information (see Sec. 12.1.2 below)

12.1.2 The minimum set of data that should be reported for each eluate includes:

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a) Eluate sample ID

b) Target L/S (mL/g-dry)

c) Mass of "as tested" solid material used (g)

d) Moisture content of material used (g_{H_2O}/g)

e) Volume of eluent used (mL)

f) Measured final eluate pH

g) Measured eluate conductivity (mS/cm)

h) Measured ORP (mV) (optional)

i) Concentrations of all COPCs

j) Analytical QC qualifiers as appropriate

12.2 Data interpretation and presentation (optional)

12.2.1 LSP curve

12.2.1.1 A constituent LSP curve can be generated for each COPC after chemical analysis of all extracts by plotting the constituent concentration in the liquid phase as a function of L/S used for each extraction. The curve indicates the equilibrium concentration of the COPC as a function of L/S at the natural pH.

12.2.1.2 The lower limit of quantitation (LLOQ) for the analytical technique for each COPC may be shown as a horizontal line. COPC concentrations below this line indicate negligible or non-quantitative concentrations.

NOTE: The LLOQ is highly matrix-dependent and should be determined as part of a QA/QC plan.

12.2.1.3 Figure 3 provides example LSP curves as a function of L/S for a coal combustion fly ash and a coal combustion flue gas desulfurization filter cake.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. Performance data must not be used as absolute QC acceptance criteria for purposes of laboratory QC or accreditation.

13.2 Interlaboratory validation of this method was conducted using a coal combustion fly ash (material code EaFA), a contaminated smelter site soil (material code CFS) and a solidified waste analog (material code SWA). The median values and inner quartile ranges (IQRs) for repeatability and reproducibility were determined for eluate concentration results across all study materials and pH target values (see Table 3). More details on the interlaboratory validation may be found in Ref. 2.

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13.3 Ref. 1 and Ref. 4 may provide additional guidance and insight on the use, performance and application of this method.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operations. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction,* a free publication available from the ACS, Committee on Chemical Safety, http://portal.acs.org/portal/fileFetch/C/WPCP_012290/pdf/WPCP_012290.pdf.

15.0 WASTE MANAGEMENT

The EPA requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Laboratories are urged to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available from ACS at the web address listed in Sec. 14.2.

16.0 REFERENCES

1. A.C. Garrabrants, D.S. Kosson, H.A. van der Sloot, F. Sanchez, and O. Hjelmar, "Background Information for the Leaching Environmental Assessment Framework (LEAF) Test Methods," EPA/600/R-10-170, *U.S. Environmental Protection Agency*, Washington, DC, 2010.

2. A.C. Garrabrants, D.S. Kosson, L. Stefanski, R. DeLapp, P.F.A.B. Seignette, H.A. van der Sloot, P. Kariher, and M. Baldwin, "Interlaboratory Validation of the Leaching Environmental Assessment (LEAF) Method 1313 and Method 1316," EPA 600/R-12/623, *Environmental Protection Agency*, Washington DC, 2012.

3. D.S. Kosson, F. Sanchez, P. Kariher, L.H. Turner, R. DeLapp, and P. Seignette, "Characterization of Coal Combustion Residues from Electric Utilities – Leaching and Characterization Data," EPA-600/R-09/151, *U.S. Environmental Protection Agency*, Washington DC, 2009.

4. D.S. Kosson, H.A. van der Sloot, F. Sanchez, and A.C. Garrabrants, "An Integrated Framework for Evaluating Leaching in Waste Management and Utilization of Secondary Materials," *Environmental Engineering Science*, 19(3) 159-204, 2002.

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5. EN12457, "Characterization of Waste – Leaching – Compliance Test for Leaching of Granular Waste Materials and Sludges," *Comité Européen de Normalisation*, Brussels, Belgium, 2001.

6. F. Sanchez, R. Keeney, D.S. Kosson, and R. DeLapp, "Characterization of Mercury-Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control," EPA-600/R-06/008, *U.S. Environmental Protection Agency*, Washington DC, 2006.

7. F. Sanchez, D.S. Kosson, R. Keeney, R. DeLapp, L. Turner, and P. Kariher, "Characterization of Coal Combustion Residues from Electric Utilities Using Wet Scrubbers for Multi-Pollutant Control," EPA-600/R-08/077, *U.S. Environmental Protection Agency*, Washington DC, 2008.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables and figures referenced by this method.

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TABLE 1

EXAMPLE SCHEDULE FOR EXTRACTION SETUP

A	B	C	D	E	F	G
Test Position	Target LS	Minimum Dry Mass (g-dry)	Mass of "As-Tested" Sample (g)	Moisture in "As-Tested" Sample (mL)	Volume of Reagent Water (mL)	Recommended Bottle Size (mL)
T01	10.0	20	22.2	2.2	198	250
T02	5.0	40	44.4	4.4	196	250
T03	2.0	100	111.1	11.1	189	500
T04	1.0	200	222.2	22.2	178	500
T05	0.5	400	444.4	44.4	156	1000
B03	QC	–	–	–	200	250
Total	–	–	844.4	–	1120	–

NOTE: 1) This schedule assumes a target liquid volume of 200 mL.
2) This schedule is based on "as tested" solids content of 0.90 g-dry/g.
3) Test position marked B01 is a method blank of reagent water.

Table data modified from Ref. 4.

TABLE 2

EXTRACTION PARAMETERS AS FUNCTION OF MAXIMUM PARTICLE SIZE

Particle Size (85% less than) (mm)	US Sieve Size	Minimum Dry Mass (g-dry)	Contact Time (h)	Recommended Vessel size (mL)
0.3	50	20 ± 0.05	24 ± 2	250
2.0	10	40 ± 0.1	48 ± 2	500
5.0	4	80 ± 0.1	72 ± 2	1000

TABLE 3

MEDIAN METHOD PRECISION ACROSS STUDY MATERIALS

Analyte	Symbol	Repeatability - Median $\%RSD_r$	Repeatability - IQR $\%RSD_r$	Reproducibility - Median $\%RSD_R$	Reproducibility - IQR $\%RSD_R$
Antimony	Sb	12%	8-13%	21%	17-27%
Arsenic	As	15%	12-28%	31%	23-34%
Barium	Ba	7%	5-9%	16%	13-30%
Boron	B	7%	5-10%	13%	9-34%
Calcium	Ca	6%	3-7%	8%	7-19%
Molybdenum	Mo	7%	6-9%	18%	11-31%
Selenium	Se	8%	4-9%	20%	13-24%
Vanadium	V	6%	4-12%	16%	13-26%
Median of Medians	–	7%	3-28%	17%	7-34%

Data taken from Ref. 2.

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FIGURE 1

METHOD FLOWCHART

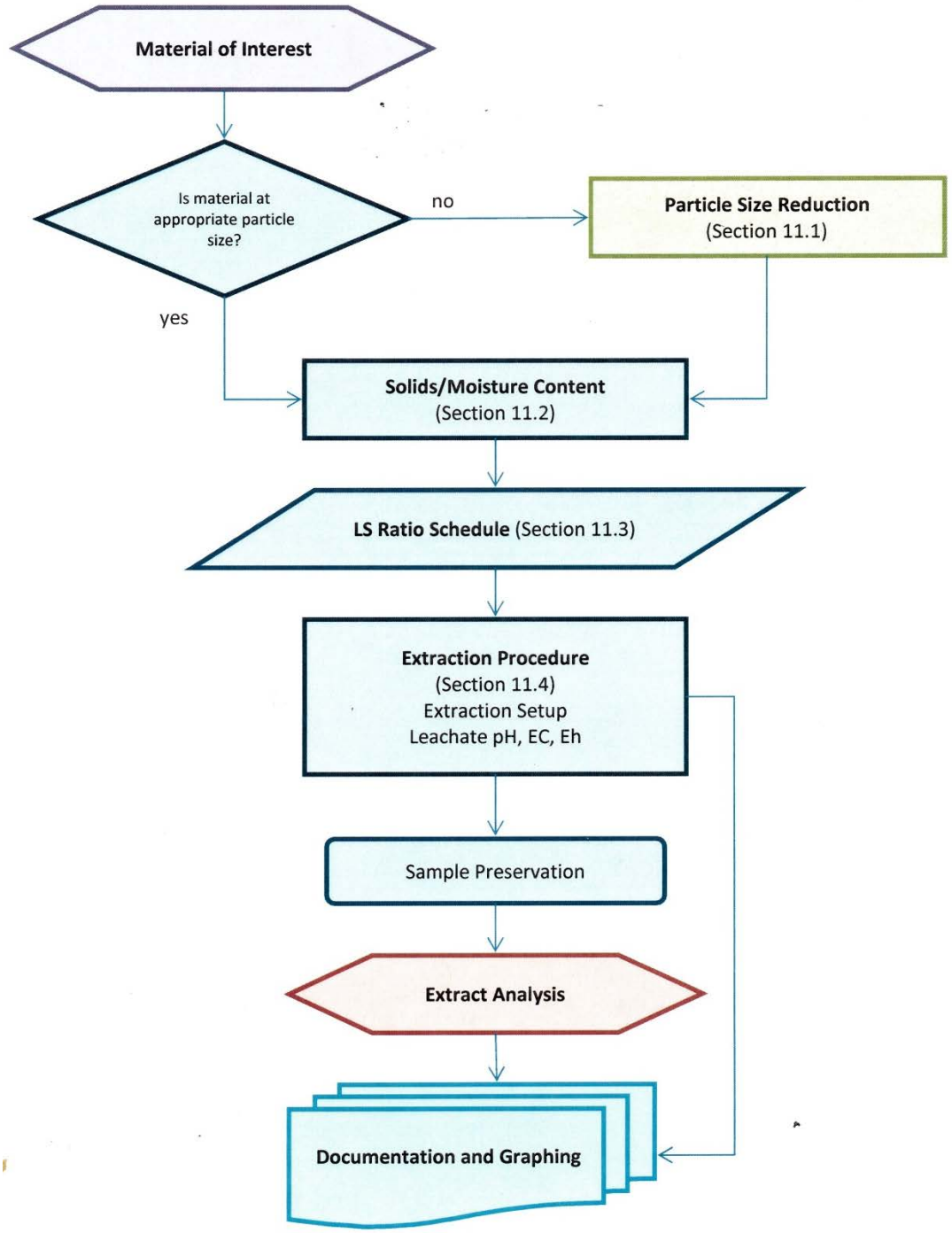

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FIGURE 2

EXAMPLE DATA REPORTING FORMAT

EPA METHOD 1316
Report of Analysis

ABC Laboratories
123 Main Street
Anytown, USA
Contact: John Smith
(555) 111-1111

Client Contact: Susan Jones
(555) 222-2222

Material Code:	**FAX**	Particle Size:	88% passing 2-mm sieve
Material Type:	Coal Combustion Fly Ash	Contact Time:	860 g
Date Received:	10/1/20xx	Lab Temperature:	21 ± 2 °C
Test Start Date:	11/1/20xx	Eluent Used:	ASTM Type II Water
Report Date:	12/1/20xx		

Test Position	Replicate	Value	Units	Method	Note
T01	**A**				
	Eluate Sample ID	**XYZ-1316-T01-A**			
	Solid Material	40.0	g		
	Moisture Content	0.01	g_{H_2O}/g		
	Water Added	386.0	mL		
	Target L/S	10.0	mL/g-dry		
	Eluate pH	1.89	–	EPA 9040	
	Eluate Conductivity	12.6	mS/cm	EPA 9050	
	Eluate ORP	203	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	216.0	mg/L		EPA 6020	11/7/20xx	1000
As	7.64	mg/L		EPA 6020	11/7/20xx	10
Cl	< 4.13	mg/L	U	EPA 9056	11/9/20xx	1

Test Position	Replicate	Value	Units	Method	Note
T02	**A**				
	Eluate Sample ID	**XYZ-1316-T02-A**			
	Solid Material	20.0	g		
	Moisture Content	0.01	g_{H_2O}/g		
	Water Added	400.0	mL		
	Target L/S	5.0	mL/g-		
	Eluate pH	3.86	–	EPA 9040	
	Eluate Conductivity	0.99	mS/cm	EPA 9050	
	Eluate ORP	180	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	449.0	mg/L		EPA 6020	11/7/20xx	1000
As	97.9	mg/L		EPA 6020	11/7/20xx	10
Cl	< 4.13	mg/L	U	EPA 9056	11/7/20xx	1

QC Flag Key: U Value below lower limit of quantitation as reported (<"LLOQ")

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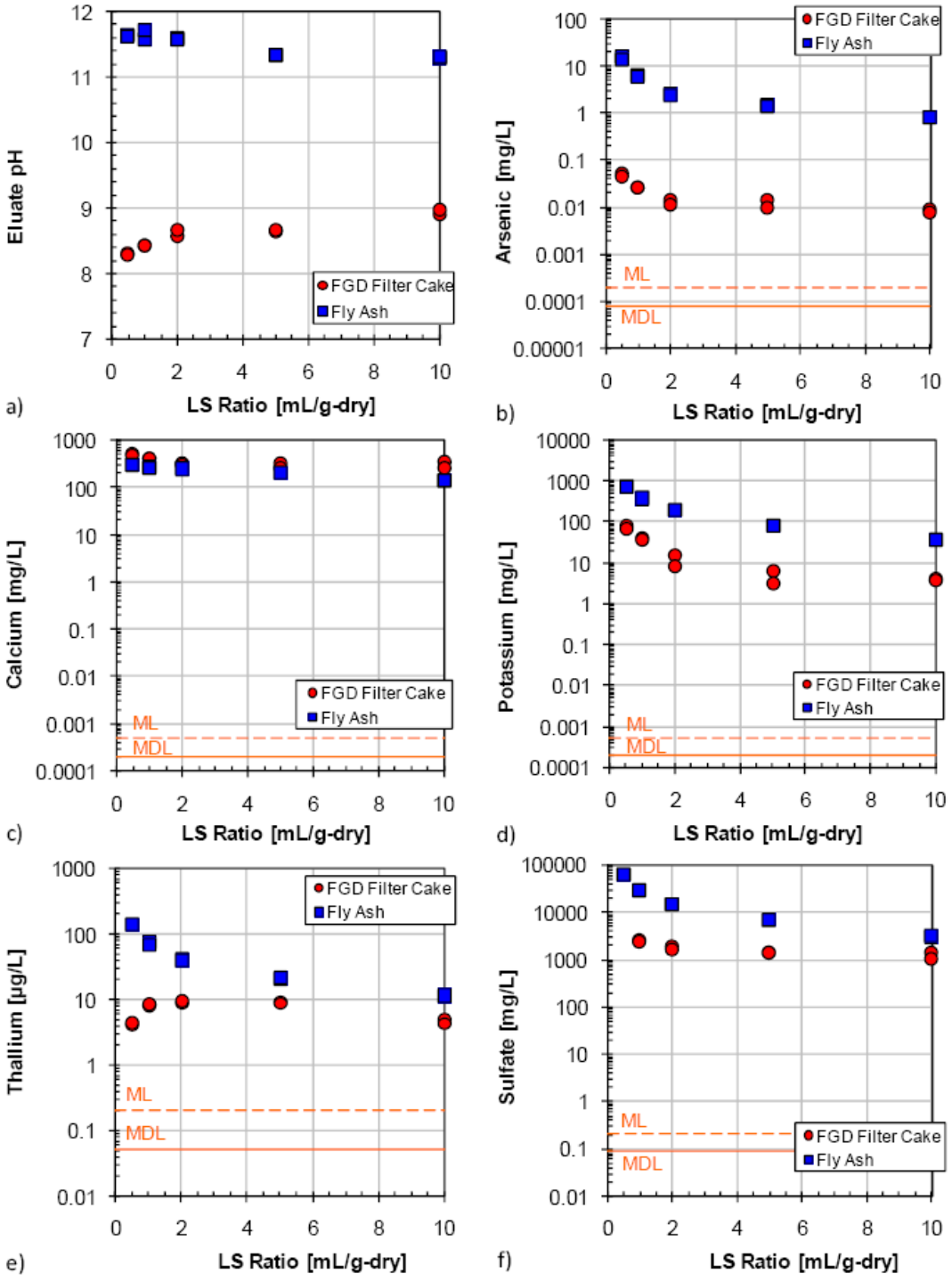
FIGURE 3

EXAMPLE CONCENTRATON RESULTS FROM A COAL COMBUSTION FLY ASH AND FLUE-GAS DESULFURIZATION FILTER CAKE



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Document 7

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U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
11 Technology Drive
North Chelmsford, MA 01863

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Prepared by:_____ _____
(Robert Reinhart, Quality Assurance Unit) Date

Approved by:_____ _____
(John Smaldone, Quality Assurance Unit) Date

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Revision Page

Date	Rev #	Summary of changes	Sections
7/30/96	1	Finalized	
01/19/10	2	Updated	All sections
3/23/17	3	Updated	All sections
9/20/17	4	Updated	Section 7.0

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1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase

liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection

may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in

the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

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6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

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Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume

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cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

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The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the

minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be

changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and

continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods

(e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 μm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

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Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

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Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

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APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

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APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to

the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

Turbidity (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

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All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

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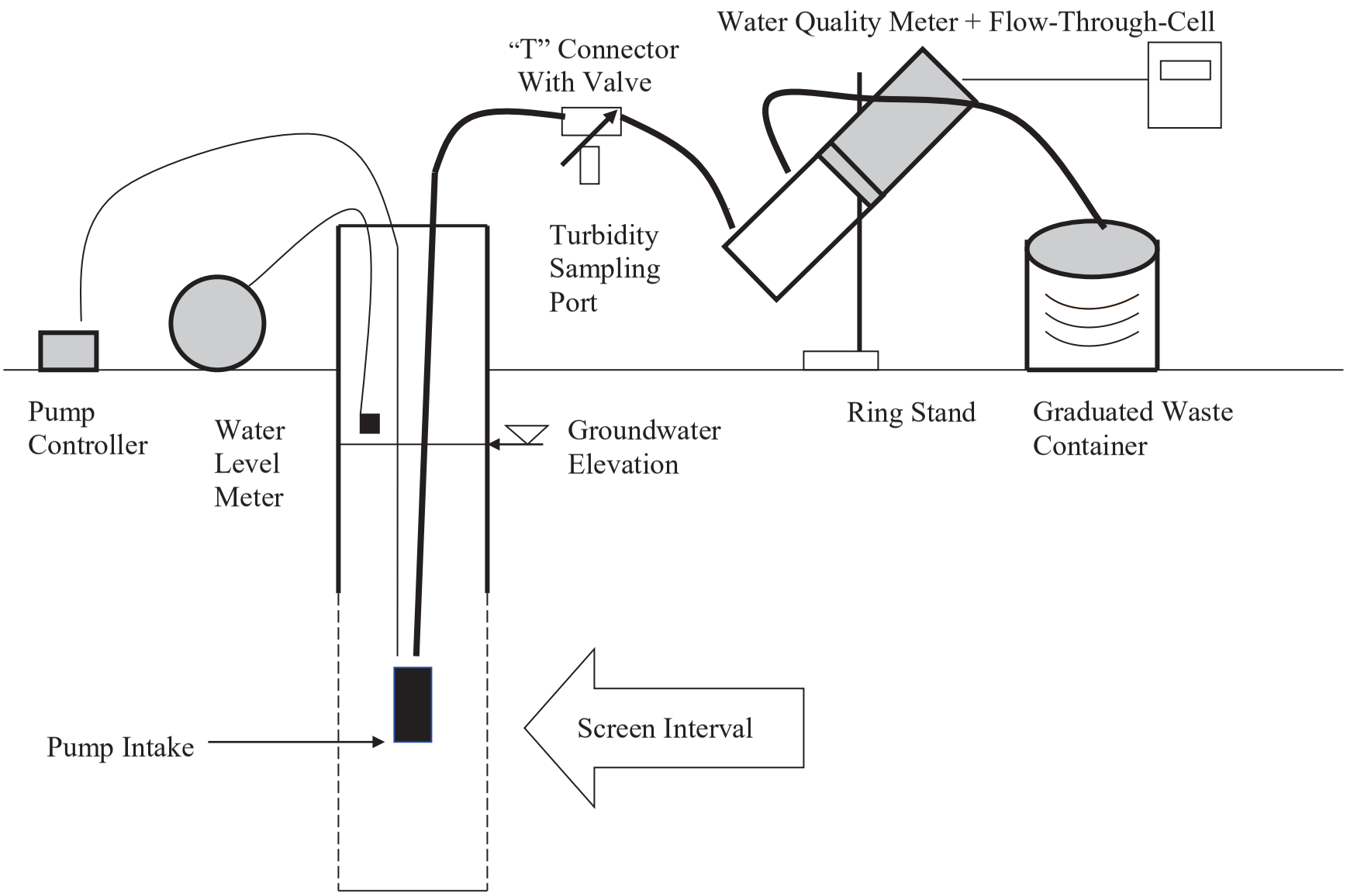
Low-Flow Setup Diagram



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APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)_____ Depth to _____/_____ of screen
Well Number_____ Date_____ (below MP) top bottom
Field Personnel_____ Pump Intake at (ft. below MP)_____
Sampling Organization_____ Purging Device; (pump type)_____
Identify MP_____ Total Volume Purged _____

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	±10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

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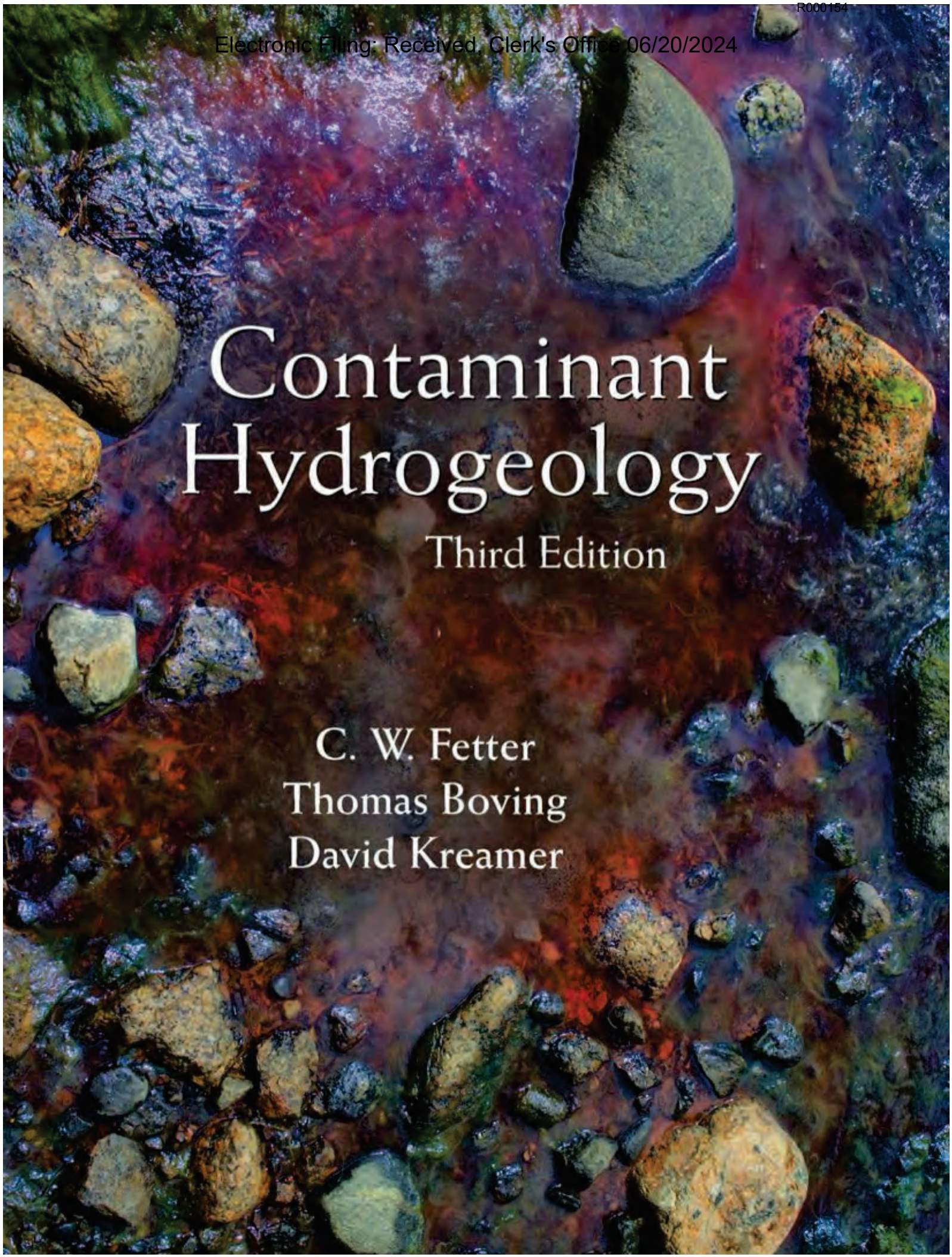

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TABLE 1.3 *Cont'd*

Contaminant	Examples of uses
Other hydrocarbons	
Alkyl sulfonates	Detergents
Cyclohexane	Organic synthesis, solvent, oil extraction
l,3,5,7-Cyclooctatetraene	Organic research
Dicyclopentadiene (DCPD)	Intermediate for insecticides, paints and varnishes, flame retardants
2,3-Dimethylhexane	NA
Fuel oil	Fuel, heating
Gasoline	Fuel
Jet fuels	Fuel
Kerosene	Fuel, heating solvent, insecticides
Lignin	Newsprint, ceramic binder, dyestuffs, drilling fuel additive, plastics
Methylene blue activated substances (MBAS)	Dyestuffs, analytical chemistry
Propane	Fuel, solvent, refrigerants, propellants, organic synthesis
Tannin	Chemical manufacturing, tanning, textiles, electroplating, inks, pharmaceuticals, photography, paper
4,6,8-Trimethyl-1-nonene	NA
Undecane	Petroleum research, organic synthesis
Metals and cations	
Aluminum	Alloys, foundry, paints, protective coatings, electrical industry, packaging, building and construction, machinery and equipment
Antimony	Hardening alloys, solders, sheet and pipe, pyrotechnics
Arsenic	Alloys, dyestuffs, medicine, solders, electronic devices, insecticides, rodenticides, herbicide, preservative
Barium	Alloys, lubricant
Beryllium	Structural material in space technology, inertial guidance systems, additive to rocket fuels, moderator and reflector of neutrons in nuclear reactors
Cadmium	Alloys, coatings, batteries, electrical equipment, fire-protection systems, paints, fungicides, photography
Calcium	Alloys, fertilizers, reducing agent
Chromium	Alloys, protective coatings, paints, nuclear and high-temperature research

(*Cont'd*)

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TABLE 1.3 *Cont'd*

Contaminant	Examples of uses
Cobalt	Alloys, ceramics, drugs, paints, glass, printing, catalyst, electroplating, lamp filaments
Copper	Alloys, paints, electrical wiring, machinery, construction materials, electroplating, piping, insecticides
Iron	Alloys, machinery, magnets
Lead	Alloys, batteries, gasoline additive, sheet and pipe, paints, radiation shielding
Lithium	Alloys, pharmaceuticals, coolant, batteries, solders, propellants
Magnesium	Alloys, batteries, pyrotechnics, precision instruments, optical mirrors
Manganese	Alloys, purifying agent
Mercury	Alloys, electrical apparatus, instruments, fungicides, bactericides, mildew proofing, paper, pharmaceuticals
Molybdenum	Alloys, pigments, lubricant
Nickel	Alloys, ceramics, batteries, electroplating, catalyst
Palladium	Alloys, catalyst, jewelry, protective coatings, electrical equipment
Potassium	Alloys, catalyst
Selenium	Alloys, electronics, ceramics, catalyst
Silver	Alloys, photography, chemical manufacturing, mirrors, electronic equipment, jewelry, equipment, catalyst, pharmaceuticals
Sodium	Chemical manufacturing, catalyst, coolant, nonglare lighting for highways, laboratory reagent
Thallium	Alloys, glass, pesticides, photoelectric applications
Titanium	Alloys, structural materials, abrasives, coatings
Vanadium	Alloys, catalysts, target material for x-rays
Zinc	Alloys, electroplating, electronics, automotive parts, fungicides, roofing, cable wrappings, nutrition
Nonmetals and anions	
Ammonia	Fertilizers, chemical manufacturing, refrigerants, synthetic fibers, fuels, dyestuffs
Boron	Alloys, fibers and filaments, semiconductors, propellants
Chlorides	Chemical manufacturing, water purification, shrink-proofing, flame retardants, food processing

(Cont'd)

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TABLE 1.3 *Cont'd*

Contaminant	Examples of uses
Cyanides	Polymer production (heavy duty tires), coatings, metallurgy, pesticides
Fluorides	Toothpastes and other dentrifices, additive to drinking water, aluminum smelting
Nitrates	Fertilizers, food preservatives
Nitrites	Fertilizers, food preservatives
Phosphates	Detergents, fertilizers, food additives
Sulfates	Fertilizers, pesticides
Sulfites	Pulp production and processing, food preservatives
Microorganisms	
Bacteria (coliform)	
Giardia	
Viruses	
Radionuclides	
Cesium 137	Gamma radiation source for certain foods
Chromium 51	Diagnosis of blood volume, blood cell life, cardiac output, etc.
Cobalt 60	Radiation therapy, irradiation, radiographic testing, research
Iodine 131	Medical diagnosis, therapy, leak detection, tracers (e.g., to study efficiency of mixing pulp fibers, chemical reactions, and thermal stability of additives to food products), measuring film thicknesses
Iron 59	Medicine, tracer
Lead 210	NA
Phosphorus 32	Tracer, medical treatment, industrial measurements (e.g., tire-tread wear and thickness of films and ink)
Plutonium 238, 243	Energy source, weaponry
Radium 226	Medical treatment, radiography
Radium 228	Naturally occurring
Radon 222	Medicine, leak detection, radiography, flow rate measurement
Ruthenium l06	Catalyst
Scandium 46	Tracer studies, leak detection, semiconductors
Strontium 90	Medicine, industrial applications (e.g., measuring thicknesses, density control)

(Cont'd)

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TABLE 1.3 *Cont'd*

Contaminant	Examples of uses
Thorium 232	Naturally occurring
Tritium	Tracer, luminous instrument dials
Uranium 238	Nuclear reactors, mining operations
Zinc 65	Industrial tracers (e.g., to study wear in alloys, galvanizing, body metabolism, function of oil additives in lubricating oils)
Zirconium 95	NA

[a]NA: No information in Standard sources.

Source: Office of Technology Assessment 1984, with additions.

It should be noted that many compounds can have multiple names, making identification of compounds difficult for the environmental practitioner. In one example from Table 1.3, the compound butoxymethylbenzene can also be known by at least 26 other names or numerical distinctions (Chemspider 2015). Nomenclature can be further confused, as there are other names given for the same compound by different suppliers and vendors. Using the same example of butoxymethylbenzene above, a selective list of vendors in 2015 and their designations for the compound would include at least 14 different additional names or numerical distinctions (Zincdocking 2015). This multiple nomenclature for the same compound can be even more confused with the manufacture and use of mixtures of potential groundwater pollutants, some containing unspecified impurities. There are many types of industrial chemical mixtures in use or being developed, with multiple names and descriptions, including tens of thousands of pesticide products. Also, in recent years there has been increased concern over "emerging" organic contaminants, which were previously not yet industrially developed, not yet discovered in the environment often due to analytical limitations, or alternatively, not yet recognized as potential pollutants. These compounds include pharmaceuticals, personal care products, industrial chemicals, and hormones. Table 1.4 lists some of these compounds and their uses.

The occurrence of the substances found on Tables 1.3 and 1.4 can be detected only if a groundwater sample has been collected and analyzed. In low concentrations most of these substances are colorless, tasteless, and odorless. Specific analytical techniques must be employed to detect the presence and concentration of each substance. Some methods can be employed to analyze a sample for all of the compounds of a particular class. For example, certain organic compounds fall into a class called volatile organic compounds. There are analytical methods that could target all compounds of this class. Likewise, there are methods available to analyze for many of the metals in a single sample. However, other compounds require a specific test. With so many potential contaminants, it is possible that a sample could be collected and tested and a specific contaminant still not be found because no analysis was done for that compound or element.

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compounds are potential groundwater contaminants that can leach from soil used for land applications of wastes and wastewater.

1.5.2 Category II: Sources Designed to Store, Treat and/or Dispose of Substances

Landfills Landfills are, by definition, designed to minimize adverse effects of waste disposal (Miller, 1980). However, many were poorly designed and are leaking liquids, generically termed **leachate**, which are contaminating groundwater. Landfills can contain nonhazardous municipal waste, nonhazardous industrial waste, or hazardous waste as defined by the Resource Conservation and Recovery Act. Peterson (1983) reported that there were 12,991 landfills in the United States in the 1980s, including 2,395 open dumps. According to the EPA, by 2009 landfills were much larger, but there were only 1,908 solid waste municipal landfills reported. This does not include landfills for construction and demolition wastes, nonhazardous industrial waste landfills, or hazardous waste landfills. There are an unknown number of abandoned landfills.

Materials placed in landfills include such things as municipal garbage and trash, demolition debris, sludge from wastewater-treatment plants, incinerator ash, foundry sand and other foundry wastes, and toxic and hazardous materials. Although no longer permitted in the United States, liquid hazardous waste was disposed in landfills in the past. The U.S. Environmental Protection Agency (2015) estimated that in 2012 over 250 million tons of municipal waste was generated, which is over a three-fold increase in the last half century. The World Bank (2012) has estimated worldwide municipal waste generation at 1.3 billion tons per year with estimates of expected increase to 2.2 billion tons annually in 2025, and over 11 billion by 2100. Total solid waste generation (beyond just municipal waste) is considerably larger at an estimated 11.2 billion tons in 2011 (United Nations Environmental Programme). Interactive waste atlases have also been developed to summarize worldwide waste data (e.g., http://www.atlas.d-waste.com/).

Leachate is formed from the liquids found in the waste as well as by leaching of the solid waste by rainwater. Table 1.9 contains information on the chemical composition of leachate from municipal landfills. To minimize the amount of leachate generated, modern landfills are built in sections, with a low-permeability cover placed over the waste as soon as possible to limit the infiltration of rainwater. Modern landfills also have low-permeability liner systems and collection pipes to remove the leachate that forms so that it can be taken to a wastewater-treatment plant. A modern landfill that is properly sited with respect to the local geology and that has a properly designed and constructed liner, leachate collection system, and low-permeability cover has limited potential to contaminate groundwater. However, many landfills do not have liners and leachate collection systems. In the past, landfills tended to be placed in any convenient hole or low spot, such as a sand pit, quarry, or marsh. Groundwater contamination from such landfills is highly probable.

Municipal landfills are usually located near urban areas. The trend is toward large landfills that can handle many thousands of tons of waste per year. Hazardous-waste landfills are now regulated under the Resource Conservation and Recovery Act. There is frequently strong local opposition to the siting of either a municipal or a hazardous waste landfill. This is referred to as the NIMBY syndrome: **N**ot **I**n **M**y **B**ack **Y**ard!

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Homeowners may pour waste liquids into ditches or the sanitary sewer; combustibles may be burned in the backyard. These are undesirable practices that can easily result in environmental pollution, including groundwater contamination.

Surface impoundments Pits, ponds, and lagoons are used by industries, farmers, and municipalities for the storage and/or treatment of both liquid nonhazardous and hazardous waste and the discharge of nonhazardous waste. Prior to the passage of the Resource Conservation and Recovery Act, liquid hazardous wastes were also discharged into pits. These pits may be unlined or lined with natural material, such as clay, or artificial materials, such as plastic sheets, rubber membranes, or asphalt.

Impoundments are used to treat wastewater by such processes as settling of solids, biological oxidation, chemical coagulation and precipitation, and pH adjustment. They may also be used to store wastewater prior to treatment. Water from surface impoundments may be discharged to a receiving water course such as a stream or a lake. Unless a discharging impoundment is lined, it will also lose water by seepage into the subsurface. Nondischarging impoundments release water either by evaporation or seepage into the ground or a combination of both. Evaporation ponds are effective only in arid regions, where potential evapotranspiration far exceeds precipitation. Even evaporation ponds that were originally lined may leak and result in groundwater contamination if the liner deteriorates from contact with the pond's contents.

Impoundments are used for wastewater treatment by municipalities and industries such as paper manufacturing, petroleum refining, metals industry, mining, and chemical manufacturing. They are also used for treatment of agricultural waste, such as farm animal waste from feedlots. Power plants use surface impoundments as cooling ponds. Mining operations use surface ponds for the separation of tailings, which is waste rock from the processing of ore that occurs in a slurry mixture of liquid and solid.

Although it is now prohibited, until the 1970s lagoons were used for the disposal of untreated wastewater from manufacturing, ore processing, and other industrial uses into the groundwater. Brine pits were used for many years in the oil patch for the disposal of brines pumped up with the oil. Miller (1980) lists 57 cases of groundwater contamination caused by the leakage of wastewater from surface impoundments. In most of the reported cases water-supply wells had been affected; at the time when use of such impoundments was allowed, groundwater monitoring was not required; usually the only way that leakage was detected was by contamination of a supply well.

In one case in Illinois, up to 500,000 gals per day of mineralized wastewater, containing high total dissolved solids (TDS), which included chloride, sulfate, and calcium, from an ore-processing plant were discharged into waste-disposal ponds excavated in a glacial drift aquifer for a period of about 40 years. Concentrations of chloride, sulfate, TDS, and hardness were elevated in an underlying bedrock aquifer as much as a mile away from the site (U.S. Nuclear Regulatory Commission 1983).

Wastewater from the manufacturing of nerve gas and pesticides at the Rocky Mountain Arsenal at Denver was discharged into unlined evaporation ponds from 1942 until 1956. In 1956 a new pond lined with asphalt was constructed; ultimately that liner failed and the lined pond also leaked. Contamination of nearby farm wells was first detected in 1951 and was especially severe in the drought year of 1954, when irrigated crops died. Groundwater contamination extended at least 8 miles from the ponds and

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was indicated by high chloride content. Ultimately the groundwater under and near the Rocky Mountain Arsenal was found to contain dozens of synthetic organic chemicals, including two that are especially mobile in the subsurface: diisopropylmethylphosphonate (DIMP), a by-product of the manufacture of nerve gas, and dicyclopentadiene (DCPD) a chemical used in the manufacture of pesticides (Konikow and Thompson 1984; Spanggord, Chou, and Mabey 1979). By 2010, after 23 years of active remediation the cleanup of contaminated soil and groundwater at the Rocky Mountain Arsenal, the cost has been $2.1 billion dollars as parcels of the land are taken off the National Priorities list and tracts of land are converted to a National Wildlife Refuge.

There is very little information available on the number of surface impoundments worldwide, nor much up-to-date information from individual countries. Several decades ago the EPA performed a survey of the surface impoundments located in the United States (U.S. EPA 1983). They reported a total of 180,973 impoundments, including 37,185 municipal; 19,437 agricultural; 27,912 industrial; 25,038 mining; 65,688 brine pits for oil and gas; and 5,913 miscellaneous. A later U.S. EPA (2001) survey conducted in the 1990s estimated about 18,000 industrial impoundments. Energy related industrial surface impoundments are of particular concern, as these can hold many sorts of materials including coal combustion residues, water associated with *in situ* uranium leaching, and/or brines associated with deep oil and gas development. The large number of impoundments provides a significant threat to groundwater resources (OTA 1984).

Mine wastes Mining can produce spoils, or unneeded soil, sediment, and rock moved during the mining process, and tailings, or solid waste left over after the processing of ore. These wastes may be piled on the land surface, used to fill low areas, used to restore the land to pre-mining contours, or placed in engineered landfills with leachatecollection systems. Mine wastes can generate leachate as rainwater passes through them. If sulfate or sulfide minerals are present, sulfuric acid can be generated, and the resulting drainage water can be acidic. This is likely to occur with coal-mining wastes, copper and gold ores, and ores from massive sulfide mineralization. Mine-waste leachate may also contain heavy metals and, in the case of uranium and thorium mines, radionuclides. Neutralization of the mine wastes can prevent the formation of acidic leachate and prevent the mobilization of many, but not all, metallic ions and radionuclides. The mine-waste disposal issue is a large one. In the United States, mining is estimated to produce waste material annually with a weight of nearly nine times that of refuse generated by all cities and towns (U.S. EPA 2003). The mining of many metals traditionally requires huge quantities of rock to be removed, for example, the production of a single ton of copper ore typically generates well over 100 times the tonnage of waste rock and about 200 times the tonnage of mined overburden, depending on the local geology. Leachate produced by unneutralized or uncontained mine wastes is a threat to surface and groundwater.

In some cases, *in situ* leach mining is used instead of physical removal of ore-containing rock. In these instances, a chemical mobilizing agent called a lixiviant is pumped down a well where it flows into an ore-bearing formation. After ore is dissolved, the pregnant solution circulating underground is removed using extraction wells. Problems can arise with *in situ* leach mining as the geologic structures associated with many ore

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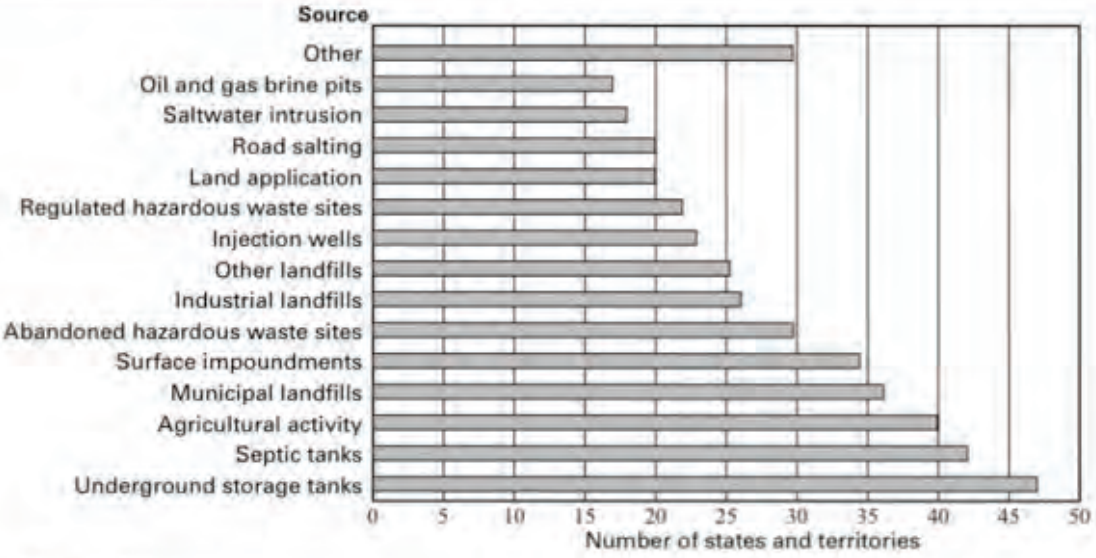
1.6 Relative Ranking of Groundwater-Contamination Sources and Substances

Every site of groundwater contamination is unique in its geology, contaminant mixtures, surrounding human-made structures, and pollutant sources. Therefore the risks associated with different localities and their contaminants can vary greatly, and the approaches for site characterization and remediation are typically tailored to each individual site. Although there are many potential sources of groundwater contamination, some pose much more of a threat to groundwater than others. Section 305(b) of the Federal Clean Water Act requires individual States in the U.S. to submit reports to the Environmental Protection Agency on the sources of groundwater contamination in the state and the type of contaminants observed. The data submitted were used to compile *National Water Quality Inventory—1988 Report to Congress* (U.S. EPA 1990).

The states indicated all the groundwater-contamination sources that they considered to be major threats to groundwater in their state. Figure 1.3 shows that more than half the states and territories listed underground storage tanks, septic tanks, agricultural activities, municipal landfills, and abandoned hazardous-waste sites as major threats to groundwater. Other frequently listed sources include industrial landfills, other landfills, injection wells, regulated hazardous-waste sites, land application, road salt, saltwater intrusion, and brine pits from oil and gas wells.

FIGURE 1.3 Frequency of various contamination sources considered by states and territories of the United States to be major threats to groundwater quality.



Source: UNICEF 2012.

Additionally, every two years the Agency for Toxic Substance and Disease Registry (ATSDR) and the Environmental Protection Agency in the United States prepare a list of hazardous substances most commonly found at facilities on the National Priorities List (NPL), also called the "Superfund" program. The list is a prioritization of harmful substances based on a combination of their frequency of occurrence, their toxicity, and

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compounds that was denser than water and had limited solubility in water. Large volumes of tar were generated and due to routine leaks and spills, leaking tar storage tanks and deliberate disposal, tar was released into the environment. When some of the plants were decommissioned tanks containing tar were just buried in place. Today many of the former manufactured gas plant sites still have soil and groundwater contamination associated with the tar (Luthy et al. 1994).

1.8 Review of Mathematics and the Flow Equation

1.8.1 Derivatives

Soil-moisture movement, groundwater flow, and solute transport may be described by means of partial differential equations. Thus, a brief review is in order.

If a bicyclist is traveling down a highway, we can measure the time that it takes the rider, who has a flying start, to go from a starting point ($S(t_1)$, or the location at the starting time, (t_1), to a point somewhere down the highway ($S(t_2)$, or the location at elapsed time t_2). If we wish to know the average speed of the rider over this distance, we divide the distance from point $S(t_1)$ to point $S(t_2)$ by the elapsed time, $t_2 - t_1$.

$$\frac{\Delta S}{\Delta t} = \frac{S(t_2) - S(t_1)}{t_2 - t_1} \tag{1.1}$$

The rider will be going more slowly uphill and faster downhill. The average speed will thus include a lot of variation. If we were to measure the rider's speed over a shorter part of the course, there would be less variation in speed. As the length of time over which the distance traveled is measured becomes shorter and shorter, the variation in speed decreases. If the time becomes infinitesimally small—for example, the time that it takes the rider to travel a few microns—we obtain an instantaneous speed. This is known as the **first derivative of distance with respect to time** and is defined by

$$\frac{dS(t_1)}{dt} = \lim_{t \to t_1} \frac{S(t) - S(t_1)}{t - t_1} \tag{1.2}$$

where t is any arbitrary time. Figure 1.4 shows a graph of distance traveled by our bicyclist as a function of time. The slope of the line from time t_1 to time t_2 is the average speed over that part of the highway and is expressed as $\Delta S/\Delta t$. *The instantaneous speed at time* t_1 is the slope of the tangent to the curve at that point, which is expressed as dS/dt.

Note that the slope of distance versus time on Figure 1.4 keeps changing. This reflects the changes in speed that occur as the rider goes up and down hills. As the rider goes over the crest of a hill, he or she will perhaps be going rather slowly. As the rider goes downhill, the velocity will increase. We can compare the crest-of-the-hill velocity with the bottom-of the-hill velocity and see that it has increased. This is a measure of the acceleration that occurs as gravity and the leg muscles of the bicyclist combine to increase speed. Figure 1.5 shows the speed of the rider as he or she goes over a hill. At $t = 0$ the rider is coming over the crest of the hill and the speed is 10 mi/hr. At $t = 30$ sec, when the rider is near the bottom of the hill, the speed is 26 mi/hr. The average rate of change in speed is (26 mi/hr–10 mi/hr)/

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FIGURE 1.4 Graph of distance traveled versus time graphically showing speed, which is the first derivative of distance with respect to time.

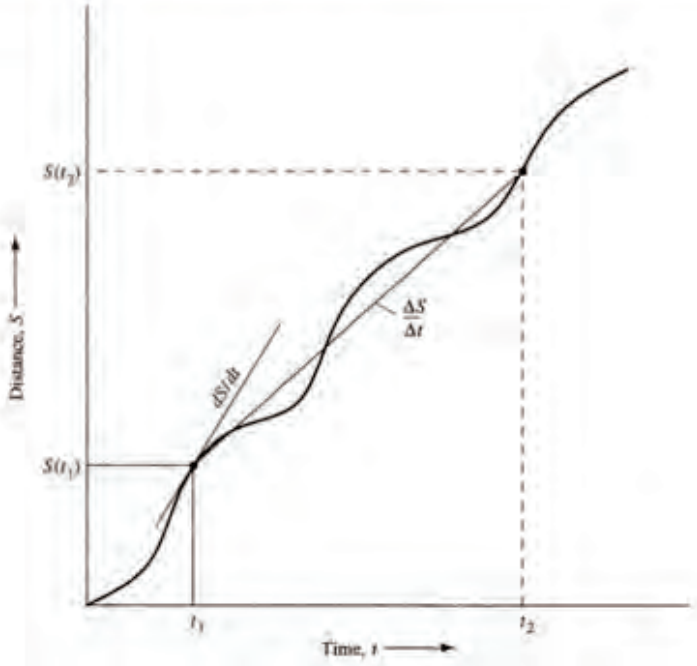
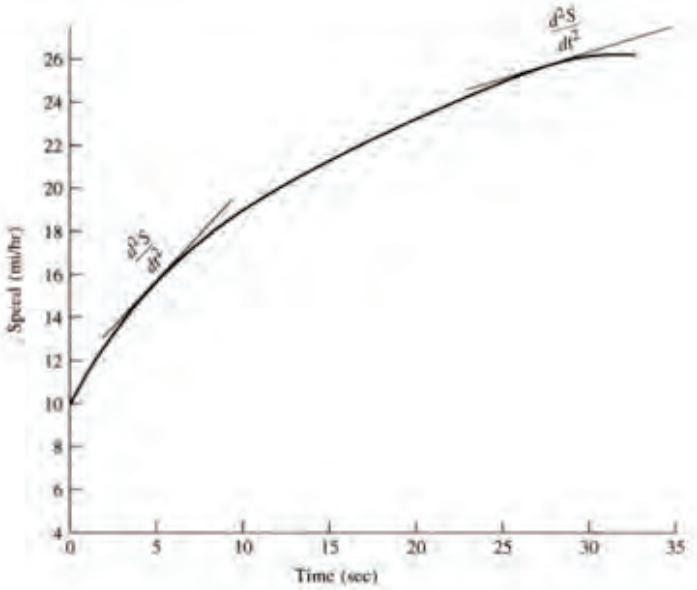


FIGURE 1.5 Graph of speed versus time graphically showing acceleration, which is the second derivative of distance with respect to time.



30 sec, or 0.53 mi/hr/sec. The rate of change is faster near the top of the hill where the slope is steeper and there is less wind resistance, since the rider is moving more slowly. From 0 to 5 sec the speed changes from 10 to 15 mi/hr, or 1.0 mi/hr/sec. Acceleration

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is the rate of change of speed with time, which is a second derivative. It is the slope of a tangent to the curve at a given time. It can be expressed as

$$\frac{d\left(\frac{dS}{dt}\right)}{dt} \quad \text{or} \quad \frac{d^2S}{dt^2}$$

The tangent at 5 sec. can be seen to be steeper than the tangent at 30 sec, where the rate of change is less.

In hydrogeology we have many parameters that are a function of more than one independent variable. For example, hydraulic head is a function of the three space variables: $h = h\,(x, y, z)$. We frequently differentiate head with respect to one of the space variables while holding the other two variables constant. Such derivatives of a parameter with respect to a single variable are called **partial derivatives**. The second derivative of hydraulic head with respect to the space variables is

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} + \frac{\partial^2 h}{\partial z^2}$$

1.8.2 Darcy's Law

The first experimental study of water movement through a porous medium was performed by Henry Darcy (Darcy 1856). He found that the one-dimensional flow of water through a pipe filled with sand was proportional to the cross-sectional area and the head loss along the pipe and inversely proportional to the flow length. Darcy's law can be expressed as

$$Q = -KA\frac{dh}{dl} \tag{1.3}$$

where

Q = volumetric discharge
K = proportionality constant known as hydraulic conductivity
A = cross-sectional area
dh/dl = gradient of hydraulic head

This equation can also be expressed in terms of **specific discharge**, or **Darcy flux**, q, which is the volumetric flow rate, Q, divided by the cross-sectional area, A.

$$q = -K\frac{dh}{dl} \tag{1.4}$$

Darcy's law was obtained for one-dimensional flow. However, as was previously stated, head is a function of all three dimensions: $h = h\,(x, y, z)$.

The hydraulic conductivity is the measure of the ability of the fractured or porous media to transmit water. It can have different values, depending upon the actual

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direction that the water is flowing through the porous media. In such a case the medium is said to be **anisotropic**. The value of the hydraulic conductivity can be measured in three principle directions, K_x, K_y, and K_z. If the hydraulic conductivity is the same in all directions, then $K_x = K_y = K_z = K$ and the medium is said to be **isotropic**.

1.8.3 Scalar, Vector, and Tensor Properties of Hydraulic Head and Hydraulic Conductivity

We first need to define some terms relating to **tensors**. A zero-order tensor, also called a **scalar**, is a quantity characterized only by its size or magnitude. Examples in hydrogeology include hydraulic head, chemical concentration, and temperature. A firstorder tensor, or **vector**, is a quantity that has both a magnitude and a direction. Vectors require three components, each having a magnitude and direction. Velocity, specific discharge, mass flux, and heat flux are examples. A second-order tensor—or, simply, **tensor**—acts like the product of two vectors, requiring nine components to account for all possible products of the three components of each vector. Examples in hydrogeology are intrinsic permeability, hydraulic conductivity, thermal conductivity, and hydrodynamic dispersion.

The hydraulic head is a scalar. However, the gradient of the head is a vector as it has both a magnitude and a direction. The gradient of h is designated as grad h:

$$\text{grad } h = i\frac{\partial h}{\partial x} + j\frac{\partial h}{\partial y} + k\frac{\partial h}{\partial z} \tag{1.5}$$

where **i**, **j**, and **k** are unit vectors in the x, y, and z directions. An equivalent notation is the use of the vector differential operator, del, which has the symbol ∇. This operator is equivalent to

$$i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z} \tag{1.6}$$

Another vector is the specific discharge, **q**. It has three components, q_x, q_y, and q_z, when measured along the Cartesian coordinate axes. Associated with any vector is a positive scalar with a value equal to the magnitude of the vector. If q is the magnitude of the vector **q**, this can be expressed as

$$q = |q| \tag{1.7}$$

A second-order tensor, such as **K**, hydraulic conductivity, can be described by nine components. In matrix form they are expressed as:

$$K = \begin{bmatrix} K_{xx} K_{xy} K_{xz} \\ K_{yx} K_{yy} K_{yz} \\ K_{zx} K_{zy} K_{zz} \end{bmatrix} \tag{1.8}$$

If the tensor is symmetric, $K_{ij} = K_{ji}$; then inspection of (1.8) shows that there are only six independent components of **K**.

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If the coordinate system is oriented along the principal axes, the tensor becomes

$$K = \begin{bmatrix} K_{xx} & 0 & 0 \\ 0 & K_{yy} & 0 \\ 0 & 0 & K_{zz} \end{bmatrix} \tag{1.9}$$

For the special case of an isotropic media—that is, the value of **K** does not depend upon the direction in which it is measured—the tensor becomes

$$K = \begin{bmatrix} K & 0 & 0 \\ 0 & K & 0 \\ 0 & 0 & K \end{bmatrix} \tag{1.10}$$

The three components of the specific discharge vector, **q**, are

$$q_x = -K_{xx}\frac{\partial h}{\partial x} - K_{xy}\frac{\partial h}{\partial y} - K_{xz}\frac{\partial h}{\partial z}$$

$$q_y = -K_{yx}\frac{\partial h}{\partial x} - K_{yy}\frac{\partial h}{\partial y} - K_{yz}\frac{\partial h}{\partial z} \tag{1.11}$$

$$q_z = -K_{zx}\frac{\partial h}{\partial x} - K_{zy}\frac{\partial h}{\partial y} - K_{zz}\frac{\partial h}{\partial z}$$

For the special case where we orient the axes of the x, y, and z coordinate system with the three principal directions of anisotropy, **K** is the matrix shown in (1.9) and the three components of the specific discharge vector are

$$q_x = -K_{xx}\frac{\partial h}{\partial x}$$

$$q_y = -K_{yy}\frac{\partial h}{\partial y} \tag{1.12}$$

$$q_z = -K_{zz}\frac{\partial h}{\partial z}$$

For an isotropic material, **K** is represented by the matrix in (1.10) and

$$q = -K\frac{\partial h}{\partial x} - K\frac{\partial h}{\partial y} - K\frac{\partial h}{\partial z} \tag{1.13}$$

or

$$q = -K \text{ grad } h \tag{1.14}$$

If we multiply two vectors together and the result is a scalar, then the product is called a **dot product**, or **inner product**. For example, the del operator dotted into a vector

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yields a scalar, called the **divergence**. Based on grad h, we can find a velocity vector $\mathbf{v}$ such that the magnitude and direction vary throughout the porous media. If we apply the del operator to $\mathbf{v}$, we obtain the following:

$$\nabla \cdot v = \operatorname{div} v = \frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z} \tag{1.15}$$

If we apply the del operator to grad h, the result is the second derivative of head:

$$\nabla \cdot \operatorname{grad} h = \frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} + \frac{\partial^2 h}{\partial z^2} \tag{1.16}$$

1.8.4 Derivation of the Flow Equation in a Deforming Medium

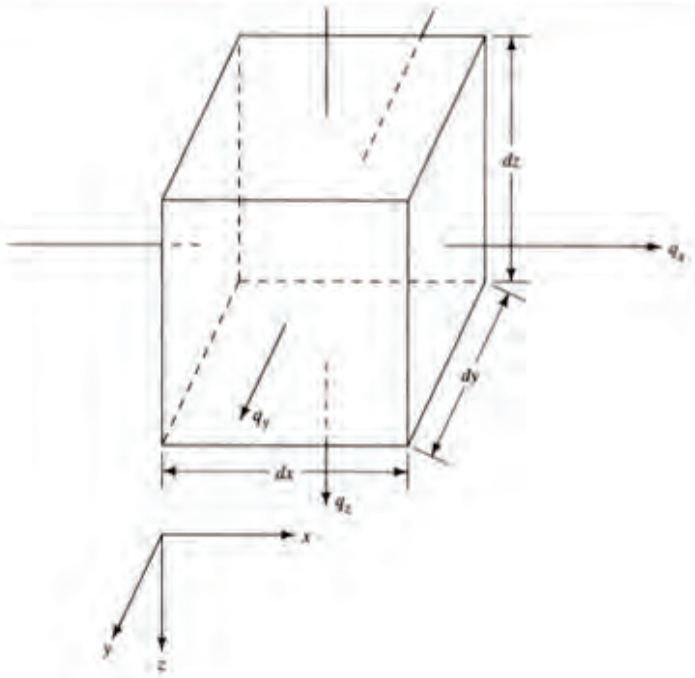
The **law of mass conservation** states that there can be no net change in the mass of fluid in a small representative elementary volume (REV) of a porous medium. In other words, the mass entering the REV less the mass leaving the REV is equal to the change in mass storage with time.

The representative elementary volume is shown on Figure 1.6. The three sides have length dx, dy, and dz, respectively. The area of the two faces normal to the x axis is $dy\,dz$, the area of the faces normal to the y axis is $dx\,dz$, and the area of the faces normal to the z axis is $dx\,dy$.

The component of mass flux into the REV parallel to the x axis is the fluid density times the flux rate:

$$\text{Mass influx along } x \text{ axis} = \rho_w q_x\, dy\, dz \tag{1.17}$$

FIGURE 1.6 Representative elementary volume for fluid flow.



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where

p_w = fluid density (M/L^3)
q_x = specific discharge or volume of flow per cross-sectional area (L/T)
$dy\,dz$ = cross-sectional area (L^2)

The units of mass inflow are mass per unit time (M/T).*
The mass outflow rate will be different than the inflow rate and can be given as:

$$\text{Mass outflow rate parallel to } x \text{ axis} = \left[p_w q_x + \frac{\partial (p_w q_x) dx}{\partial x} \right] dy\,dz \qquad (1.18)$$

The net mass accumulation within the control volume due to the flow component parallel to the x axis is the mass inflow minus the mass outflow, or

$$\frac{-\partial (p_w q_x) dx\,dy\,dz}{\partial x}$$

Similar terms exist for the net mass accumulation due to flow components parallel to the y and z axes:

$$\frac{-\partial (p_w q_y) dy\,dx\,dz}{\partial y}$$

$$\frac{-\partial (p_w q_z) dz\,dx\,dy}{\partial z}$$

These three terms can be summed to find the total net mass accumulation within the control volume.

$$-\left[\left(\frac{\partial}{\partial x}(p_w q_x) + \frac{\partial}{\partial y}(p_w q_y) + \frac{\partial}{\partial z}(p_w q_z) \right) \right] dx\,dy\,dz \qquad (1.19)$$

The mass of water in the REV, M, is the density of water, p_w, times the porosity, n, times the volume, $dx\,dy\,dz$. The change in mass with respect to time is

$$\frac{\partial M}{\partial t} = \frac{\partial}{\partial t}(p_w n\,dx\,dy\,dz) \qquad (1.20)$$

From the law of conservation of mass, Equation 1.19 must equal Equation 1.20.

$$-\left[\frac{\partial}{\partial x}(p_w q_x) + \frac{\partial}{\partial y}(p_w q_y) + \frac{\partial}{\partial z}(p_w q_z) \right] dx\,dy\,dz = \frac{\partial}{\partial t}(p_w n)\,dx\,dy\,dz \qquad (1.21)$$

* The units of a variable can be expressed in terms of their fundamental dimensions. These are length, L, mass, M, and time, T. The fundamental dimensions for density are mass per unit volume. Volume is length cubed, so the shorthand expression for the fundamental dimensions of density is M/L^3. Specific discharge has the dimensions of velocity, so the fundamental dimensions are L/T, and area has fundamental dimensions of L^2.

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We can assume that although density of the fluid may change with time, at any given time it will be the same everywhere in the **REV**. Under this assumption Equation 1.21 can be simplified to

$$-\left[\frac{\partial q_x}{\partial x}+\frac{\partial q_y}{\partial y}+\frac{\partial q_z}{\partial z}\right]=\frac{1}{p_w}\frac{\partial}{\partial t}(p_w n) \tag{1.22}$$

We may substitute Darcy's law for the specific discharge components given on the left side. If the *xyz* coordinate system is aligned with the principal axes of anisotropy, then Equation 1.12 may be used, and the left side of Equation 1.22 becomes

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right) \tag{1.23}$$

The change in mass within the REV is due to changes in the porosity and the density of water as the head changes with time. Thus the change in the volume of water in storage is proportional to the change in head with time. The right side of Equation 1.22 can be expressed as a proportionality constant, *Ss*, the specific storage, times the change in head with time.

$$\frac{1}{p_w}\frac{\partial}{\partial t}(p_w n)=S_s\frac{\partial h}{\partial t} \tag{1.24}$$

Combining Equations 1.22, 1.23, and 1.24 we obtain the main equation for transient flow in an anisotropic medium when the coordinate system is oriented along the principal axes of anisotropy:

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right)=S_s\frac{\partial h}{\partial t} \tag{1.25}$$

1.8.5 Mathematical Notation

In del and tensor notation Equation 1.25 becomes

$$\nabla\cdot K\cdot\nabla h=S_s\frac{\partial h}{\partial t} \tag{1.26}$$

Another form of expression is called Einstein's summation notation. For example, Darcy's law in the familiar, one-dimensional form is

$$q=-K\frac{dh}{dl} \tag{1.27}$$

It is implied in the preceding equation that the specific discharge is parallel to the direction of dh/dl and that the medium is isotropic. In a more general form, specific discharge, **q**, is a vector with components q_1, q_2, and q_3. Grad h is a vector that we will call **h**. This vector also has components h_1, h_2, and h_3. Hydraulic conductivity, **K**, is a

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tensor with nine components. To describe Darcy's law in the most general form, we need three equations.

$$q_1 = K_{11}h_1 + K_{12}h_2 + K_{13}h_3 \tag{1.28a}$$

$$q_2 = K_{21}h_1 + K_{22}h_2 + K_{23}h_3 \tag{1.28b}$$

$$q_3 = K_{31}h_1 + K_{32}h_2 + K_{33}h_3 \tag{1.28c}$$

The inner product can be expressed in index notation as

$$q_i = \sum_j K_{ij}h_i \quad (i,j = 1,2,3) \tag{1.29}$$

In Einstein's summation notation, the Σ is dropped with the understanding that the summation is over the repeated indices:

$$q_i = K_{ij}h_j \quad (i,j = 1,2,3) \tag{1.30}$$

In vector notation this can be expressed as either

$$q = K \cdot \text{grad}\, h \tag{1.31}$$

$$q = K \cdot h \tag{1.32}$$

In del notation this is

$$q = K \cdot \nabla h \tag{1.33}$$

In general, we will use the standard form of differential equations rather than any of the shorthand notation. However, the literature cited in this text often uses the compact forms and the reader should be aware of them.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2015) Priority List of Hazardous Substances. Available from https://www.atsdr.cdc.gov/spl/#modalIdString_myTable2015

Alavanja, M. C. R. 2009. Pesticides use and exposure extensive worldwide. *Reviews on Environmental Health* 24:303–309.

American Cancer Society. 2015. Cancer Facts & Figures 2014. Accessed August 21, 2015 from http://water.epa.gov/drink/contaminants/index.cfm#List

American Water Resources Association. 1975. Status of water borne diseases in the U.S. and Canada. *Journal of American Water Works Association* 67:95–98.

Ames, B. N., L. S. Gold, and W. C. Willett. 1995. The causes and prevention of cancer. *Proceedings of the National Academy of Science* 92:5258–5265.

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2

Mass Transport in Saturated Media

2.1 Introduction

In this chapter we will consider the transport of solutes dissolved in groundwater. This is known as **mass** or **solute transport**. The methods presented in this chapter are based on partial differential equations for dispersion that have been developed for homogeneous media (Ogata and Banks 1961; Ogata 1970; Bear 1972; Bear and Verruijt 1987). These equations are similar in form to the familiar partial differential equations for fluid flow. Since those pioneering developments, much work has been done on the theories of mass transport in response to the great interest in problems of groundwater contamination (e.g., Bedient et al. 1994; Zhang and Bennett 1997; Grathwohl 1998; Domenico and Schwartz 1998; Yoram 2003; Yeh et al. 2015; Essaid et al. 2015). One of the outcomes has been the development of what is essentially a new branch of subsurface hydrology, where the flow of fluid and solutes is treated by statistical models; these models can account for the role of varying hydraulic conductivity and other spatially variable hydraulic parameters that accompany aquifer heterogeneity.

Many of the contaminant transport and fate concepts discussed in this chapter were developed based on tracer tests conducted in the field and at the laboratory scale. While a discussion of how tracer tests should be conducted and how the data can be interpreted is beyond the scope of this book, there are ample references and textbooks devoted to this topic (e.g., Davis et al. 1980; U.S. EPA 1985; Payne et al. 2008; Leibundgut et al. 2009; Suthersan et al. 2014).

2.2 Transport by Concentration Gradients

A solute in water will move from an area of greater concentration toward an area where it is less concentrated. This process is known as **molecular diffusion**, or **diffusion**. Diffusion will occur as long as a concentration gradient exists, even if the fluid is not moving. The mass of fluid diffusing is proportional to the concentration gradient, which can be expressed as **Fick's first law**; in one dimension, Fick's first law is

$$F = -D_d \left(dC / dx \right) \tag{2.1}$$

where

F = mass flux of solute (M/L^2T) per unit area per unit time

D_d = diffusion coefficient (L^2/T)

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TABLE 2.1 Diffusion coefficients in water.

Cations		
H^+	9.31×10^{-9} m²/sec	1.00×10^{-7} ft²/sec
Na^+	1.33×10^{-9} m²/sec	1.43×10^{-8} ft²/sec
K^+	1.96×10^{-9} m²/sec	2.11×10^{-8} ft²/sec
Rb^+	2.06×10^{-9} m²/sec	2.22×10^{-8} ft²/sec
Cs^+	2.07×10^{-9} m²/sec	2.23×10^{-8} ft²/sec
Mg^{2+}	7.05×10^{-10} m²/sec	7.59×10^{-9} ft²/sec
Ca^{2+}	7.93×10^{-10} m²/sec	8.54×10^{-9} ft²/sec
Sr^{2+}	7.94×10^{-10} m²/sec	8.55×10^{-9} ft²/sec
Ba^{2+}	8.48×10^{-10} m²/sec	9.13×10^{-9} ft²/sec
Ra^{2+}	8.89×10^{-10} m²/sec	9.57×10^{-9} ft²/sec
Mn^{2+}	6.88×10^{-10} m²/sec	7.41×10^{-9} ft²/sec
Fe^{2+}	7.19×10^{-10} m²/sec	7.74×10^{-9} ft²/sec
Cr^{3+}	5.94×10^{-10} m²/sec	6.39×10^{-9} ft²/sec
Fe^{3+}	6.07×10^{-10} m²/sec	6.53×10^{-9} ft²/sec
Anions		
OH^-	5.27×10^{-9} m²/sec	5.67×10^{-8} ft²/sec
F^-	1.46×10^{-9} m²/sec	1.57×10^{-8} ft²/sec
Cl^-	2.03×10^{-9} m²/sec	2.19×10^{-8} ft²/sec
Br^-	2.01×10^{-9} m²/sec	2.16×10^{-8} ft²/sec
HS^-	1.73×10^{-9} m²/sec	1.86×10^{-8} ft²/sec
HCO_3^-	1.18×10^{-9} m²/sec	1.27×10^{-8} ft²/sec
SO_4^{2-}	1.07×10^{-9} m²/sec	1.15×10^{-8} ft²/sec
CO_3^{2-}	9.55×10^{-10} m²/sec	1.03×10^{-8} ft²/sec
Organic Compounds		
Tetrachloroethene (PCE)*	7.5×10^{-10} m²/sec	8.07×10^{-9} ft²/sec
Trichloroethene (TCE)*	8.3×10^{-10} m²/sec	8.93×10^{-9} ft²/sec
1,1,1,-Trichloroethane (TCA)*	8.0×10^{-10} m²/sec	8.61×10^{-9} ft²/sec
Benzene**	9.0×10^{-10} m²/sec	9.69×10^{-9} ft²/sec
Toluene**	8.0×10^{-10} m²/sec	8.61×10^{-9} ft²/sec
Ethylbenzene**	7.2×10^{-10} m²/sec	7.75×10^{-9} ft²/sec
1,4-Dioxane***	1.6×10^{-9} m²/sec	1.72×10^{-8} ft²/sec

Source: Y.-H. Li and S. Gregory, 1974. Diffusion of ions in sea water and in deep-sea sediments. Geochemica et Cosmochemica Acta, Vol. 38. © 1974, with the kind permission of Elsevier Science. *Cohen and Mercer, 1993; **U.S.EPA, 2015; ***Mohr 2010. Diffusion coefficients of ions at 25°C; organic compounds are in pure water at 20°C.

C = solute concentration (M/L³)

dC/dx = concentration gradient (M/L³/L)

The negative sign indicates that the movement is from areas of greater concentration to those of lesser concentration. Values of D_d for ions and select organic compounds in water at 25°C can be found in Table 2-1. They do not vary much with concentration, but they are somewhat temperature-dependent, being about 50% less at 5°C (Robinson and Stokes 2002). The values of D_d are only applicable when studying diffusion in aqueous systems. For systems where the concentrations are changing with time, **Fick's second law** applies. In one dimension this is

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$$\partial C / \partial t = D_d \, \partial^2 C / \partial x^2 \tag{2.2}$$

where $\partial C / \partial t$ = change in concentration with time ($M/L^3/T$).

In porous media, diffusion cannot proceed as fast as it can in water because the ions must follow longer pathways as they travel around mineral grains. To account for this, an effective diffusion coefficient, D^*, must be used.

$$D^* = \omega D_d \tag{2.3}$$

where ω is a coefficient that is related to the tortuosity (Bear 1972). **Tortuosity** is a measure of the effect of the shape of the flowpath followed by water molecules in a porous media. If L is the straight-line distance between the ends of a tortuous flowpath of length L_e, the tortuosity, T, can be defined as $T = L_e/L$. Tortuosity in a porous media is always greater than 1, because the flowpaths that water molecules take must diverge around solid particles. Flowpaths across a representative sample of a well-sorted sediment would tend to be shorter than those across a poorly sorted sediment in which the smaller grains were filling the voids between the larger grains. Thus the well-sorted sediment would tend to have a lower value for tortuosity than the poorly sorted sediment. (Tortuosity has also been defined as $(L/L_e)^2$ (Carman 1997; Bear 1972). With this definition, tortuosity always has a value less than 1. This definition will not be used in this text.)

The value of ω, which is always less than 1, can be found from diffusion experiments in which a solute is allowed to diffuse across a volume of a porous medium. Perkins and Johnson (1963) found that ω was equal to 0.7 for sand column studies using a uniform sand. For laboratory studies using limestone and sandstone cores, Boving and Grathwohl (2001) found that ω ranges from 0.35 to 0.098 and that ω is related to the porosity, n, of these rocks by:

$$\omega = n^{1.2}$$

Diffusion will cause a solute to spread away from the place where it is introduced into a porous medium, even in the absence of groundwater advective flow. Figure 2.1 shows the distribution of a solute introduced at concentration C_0, at time t_0, over an interval $(x - a)$ to $(x + a.)$ At succeeding times t_1 and t_2, the solute has spread out, resulting in a lower concentration over the interval $(x - a)$ to $(x + a)$ but increasing concentrations outside of this interval.

The solute concentration follows a normal, or Gaussian, distribution and can be described by two statistical properties, the mean, C and variance, σ_c^2, which are defined in Section 2.12.2.

The effective diffusion coefficient, D^*, can be defined as (De Josselin and De Jong 1958)

$$D^* = \frac{\sigma_c^2}{2t} \tag{2.4}$$

This is an alternative definition of effective diffusion coefficient to the one given in Equation 2.3.

The process of diffusion is complicated by the fact that the ions must maintain electrical neutrality as they diffuse. If we have a solution of NaCl, the Na^+ cannot diffuse faster than the Cl^- unless there is some other negative ion in the region into which

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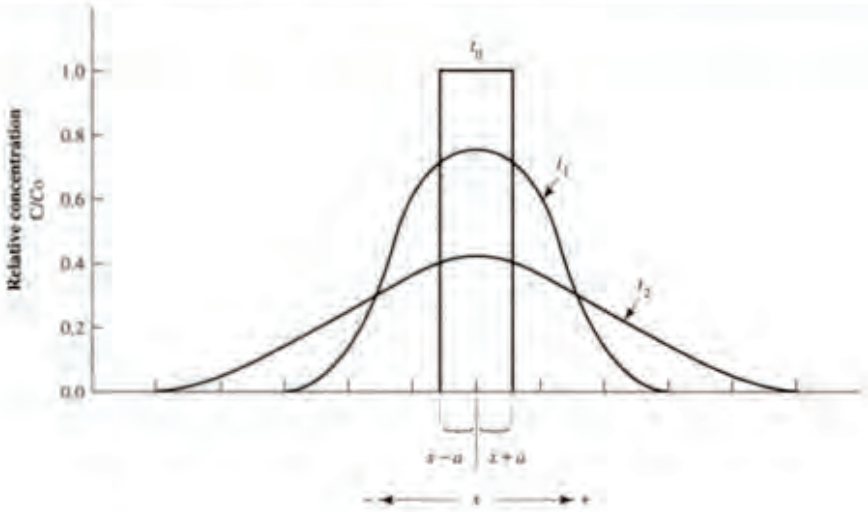
the Na^+ is diffusing. If the solute is adsorbed onto the mineral surfaces of the porous medium, the net rate of diffusion will be obviously less than for a nonadsorbed species.

Figure 2.1 Spreading of a solute slug with time due to diffusion. A slug of solute was injected into the aquifer at time t_0 with a resulting initial concentration of C_0.



Diffusion can occur when the concentration of a chemical species is greater in one stratum than in an adjacent stratum. For example, solid waste containing a high concentration of chloride ion may be placed directly on the clay liner of a landfill. The concentration of chloride in the leachate contained in the solid waste is so much greater than the concentration of chloride in the pore water of the clay liner that the latter may be considered to be zero as a simplifying assumption in determining a conservative estimate of the maximum diffusion rate. If the solid waste and the clay are both saturated, the chloride ion will diffuse from the solid waste, where its concentration is greater, into the clay liner, even if there is no fluid flow. The concentration of chloride in the solid waste, C_0, will be assumed to be a constant with time, as it can be replaced by dissolution of additional chloride. The concentration of chloride in the clay liner, $C_i(x, t)$, at some distance x from the solid waste interface and sometime t after the waste was placed, can be determined from Equation 2.5 (Crank 1956). This is a solution to Equation 2.2 for the appropriate boundary and initial conditions.

$$C_i(x,t) = C_0 \operatorname{erfc} \frac{x}{2\left(D^* t\right)^{0.5}} \tag{2.5}$$

where

C_i = the concentration at distance x from the source at time t since diffusion began

C_0 = the original concentration, which remains a constant

erfc = the complementary error function (Appendix A)

The complementary error function, erfc, is a mathematical function that is related to the normal, or Gaussian, distribution. This means that the solution described by Equation 2.5 is normally distributed, as is expected for a diffusional process. Figure 2.2

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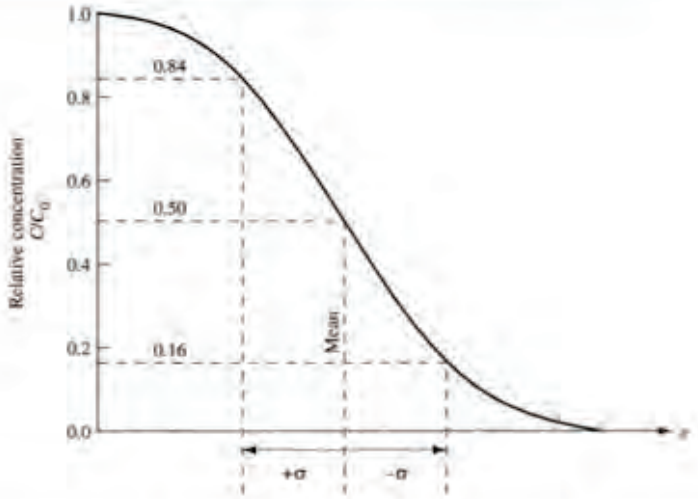
shows the profile of relative concentration for a solute diffusing from a region where the concentration is C_0 to a region where it was initially zero. Because the profile is normally distributed, 84% of the values will be less than the value that is one standard deviation more than the mean and 16% of the values will be less than the value that is one standard deviation less than the mean. The standard deviation is the square root of the variance.

Figure 2.2 The profile of a diffusing front as predicted by the complementary error function.



The complementary error function is tabulated in Appendix A or it can be calculated in the spreadsheet program Excel using the syntax: ERFC(x). It is related to the error function, erf, by

$$\text{erfc}(B) = 1 - \text{erf}(B)$$

The value of erfc(B) is 0 for all positive values of B greater than 3.0 and 1.0 for a B of 0. For some applications it may be necessary to find erfc of a negative number. Appendix A does not give values for erfc(B) for negative values of B. These must be computed from the relationship

$$\text{erfc}(-B) = 1 + \text{erf}\, B$$

The error function, erf(B) is defined as:

$$\text{erf}\,(B) = \frac{2}{\sqrt{\pi}} \int_0^B e^{-t^2}\, dt$$

The above equation cannot be solved analytically. However, it is tabulated in Appendix A. It can also be approximated by the analytical expression:

$$\text{erf}\,(B) = \sqrt{1 - \exp\left(\frac{-4B^2}{\pi}\right)}$$

Thus values of erfc(B) range from 0 to +2, since the maximum value of erf(B) is 1.0 for 3.0 and all greater numbers.

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EXAMPLE PROBLEM

Assume a D of 1×10^{-9} m²/sec and an ω of 0.5, to give a D^* of 5×10^{-10} m²/sec. Find the value of the concentration ratio, C_i/C_0, at a distance of 5m after 100 yr of diffusion.

1. Convert 100 yr to seconds:

$$100\,\text{yr} \times 365\,\text{da/yr} \times 1440\,\text{min/da} \times 60\,\text{sec/min} = 3.15 \times 10^9\,\text{sec}$$

2. Insert values into Equation 2.5:

$$\frac{C_i}{C_0} = \text{erfc}\frac{5}{2(5 \times 10^{-10}\,\text{m}^2/\text{sec} \times 3.15 \times 10^9\,\text{sec})^{0.5}}$$

3. Solve:

$$\frac{C_i}{C_0} = \text{erfc}\left(\frac{5}{2.51}\right) = \text{erfc}\,1.99 = 0.005$$

In 100 yr, diffusion over a 5-m distance would yield a concentration that is 0.5% of the original.

From the preceding example problem it is obvious that diffusion is not a particularly rapid means of transporting dissolved solutes. Diffusion is the predominant mechanism of transport only in low-permeability hydrogeologic regimes. However, it is possible for solutes to move through a porous or a fractured medium by diffusion even if the groundwater is not flowing.

2.3 Transport by Advection

Dissolved solids are carried along with the flowing groundwater. This process is called **advective transport,** or **advection.** The amount of solute that is being transported is a function of its concentration in the groundwater and the quantity of the groundwater flowing. For one-dimensional flow normal to a unit cross-sectional area of the porous media, the quantity of water flowing is equal to the *average linear velocity* times *the effective porosity.* **Average linear velocity**, v_x, is the rate at which the flux of water across the unit cross-sectional area of pore space occurs. It is not the average rate at which the water molecules are moving along individual flowpaths, which is greater than the average linear velocity due to tortuosity. The **effective porosity**, n_e, is the porosity through which flow can occur. Noninterconnected and dead-end pores are not included in the effective porosity, so that $n_e < n$.

$$v_x = \frac{K\ dh}{n_e\ dl} \tag{2.6}$$

where

v_x = average linear velocity (L/T)
K = hydraulic conductivity (L/T)

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n_e = effective porosity
dh/dl = hydraulic gradient (L/L)

Note that the abbreviation n is used in the context of flow and transport under saturated conditions. When discussing unsaturated flow, θ is preferred because it refers to the water content of the porous matrix, as defined in Chapter 4. When the matrix is fully saturated n equals θ. The one-dimensional mass flux, F_x, due to advection is equal to the quantity of water flowing times the concentration of dissolved solids and is given by Equation 2.7:

$$F_x = v_x n_e C \tag{2.7}$$

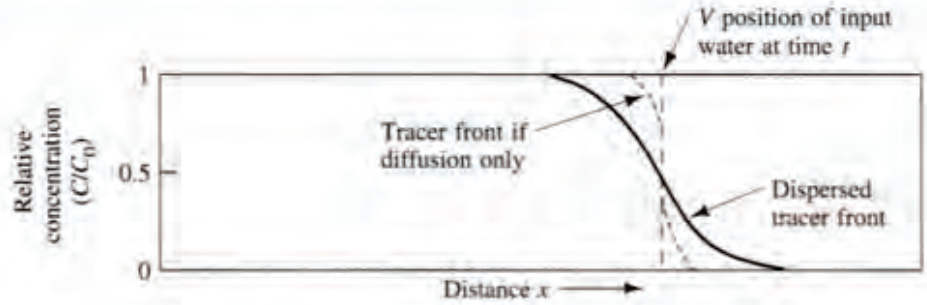
The one-dimensional advective transport equation is

$$\frac{\partial C}{\partial t} = -v_x \frac{\partial C}{\partial x} \tag{2.8}$$

(The derivation of this equation is given in Section 2.6.)

Solution of the advective transport equation yields a sharp concentration front. On the advancing side of the front, the concentration is equal to that of the invading groundwater, whereas on the other side of the front it is unchanged from the background value. This is known as **plug flow**, with all the pore fluid being replaced by the invading solute front. The sharp interface that results from plug flow is shown in Figure 2.3. The vertical dashed line at V represents an advancing solute front due to advection alone.

Figure 2.3 Advective transport and the influence of longitudinal dispersion and diffusion on the transport of a solute in one-dimensional flow.



Source: C.W. Fetter. 1994. *Applied Hydrogeology*, 3rd ed. Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Due to the heterogeneity of geologic materials, advective transport in different strata can result in solute fronts spreading at different rates in each stratum. If one obtains a sample of water for purposes of monitoring the spread of a dissolved contaminant from a borehole that penetrates several strata, the water sample will be a composite of the water from each stratum. Due to the fact that advection will transport solutes at different rates in each stratum, the composite sample may be a mixture of water containing the transported solute coming from one stratum and uncontaminated groundwater coming

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from a different stratum where the average linear velocity is lower. The concentration of the contaminant in the composite sample would thus be less than in the source.

EXAMPLE PROBLEM

Dissolved nitrate in a concentration of 18.0 mg/L is being advected with flowing groundwater at a velocity of 0.331 m/day in an aquifer with a porosity of 0.225. Groundwater from the aquifer discharges into a stream. What is the mass flux of nitrate into the stream if the aquifer is 1.80 m thick and 123 m wide where it discharges into the stream?

From Equation 2.7 the one dimensional mass flux is

$$F_x = v_x n_e C$$

Given: $v_x = 0.331$ m/da

$n_e = 0.225$

$C = 18.0$ mg/L

For consistent units the concentration should be in gm/m^3.

$C = 18.0$ mg/L $\times$ 1/1000 gm/mg $\times$ 1000 L/m^3

$C = 18.0$ gm/m^3

The one dimensional mass flux is:

$F_x = 0.331$ m/da $\times$ 0.225 $\times$ 18.0 gm/m^3

$F_x = 1.34$ gm/da-m^2

The flux into the stream is the one dimensional mass flux times the cross sectional area where the aquifer discharges into the stream.

Total flux = 1.34 gm/da-m^2 $\times$ 123 m $\times$ 1.80 m

Total flux = 297 gm/da

2.4 Mechanical Dispersion

Groundwater is moving at rates that are both greater and less than the average linear velocity. At the macroscopic scale—that is, over a domain including a sufficient volume that the effects of individual pores are averaged (Bear 1972)—there are three basic causes of this phenomenon: (1) As fluid moves through the pores, it will move faster in the center of the pores than along the edges. (2) Some of the fluid particles will travel along longer flow paths in the porous media than other particles to go the same linear distance. (3) Some pores are larger than others, which allows the fluid flowing through these pores to move faster. These factors are illustrated in Figure 2.4.

If all groundwater containing a solute were to travel at exactly the same rate, it would displace water that does not contain the solute and create an abrupt interface between the two waters. However, because the invading solute-containing water is not all traveling at the same velocity, mixing occurs along the flowpath. This mixing is called **mechanical dispersion**, and it results in a dilution of the solute at the advancing edge of flow. The mixing that occurs along the direction of the flowpath is called **longitudinal dispersion**.

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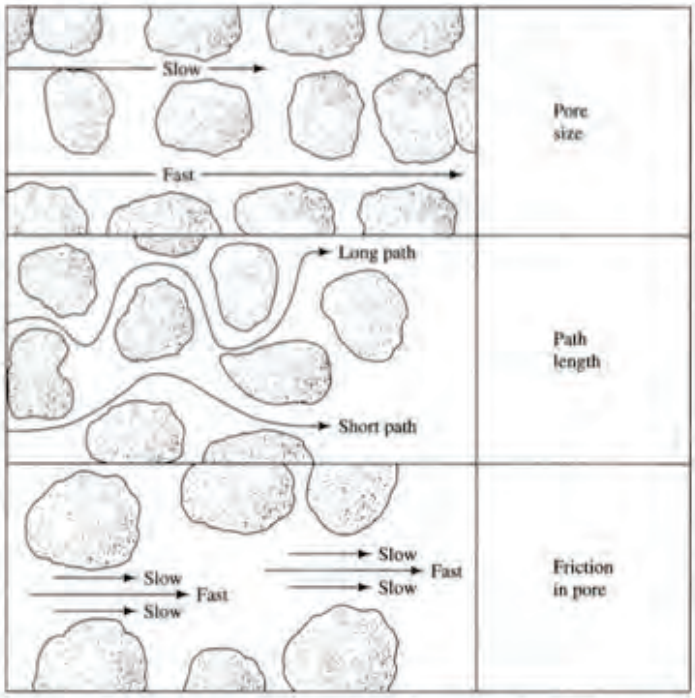
An advancing solute front will also tend to spread in directions normal to the direction of flow because at the pore scale the flowpaths can diverge, as shown in Figure 2.5. The result of this is mixing in directions normal to the flow path called **transverse dispersion**.

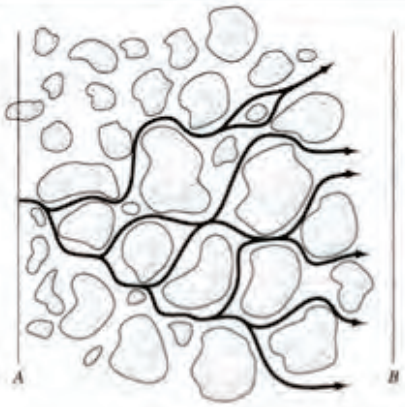
If we assume that mechanical dispersion can be described by Fick's law for diffusion (Equations 2.1 and 2.2) and that the amount of mechanical dispersion is a function of the average linear velocity, then we can introduce a coefficient of mechanical dispersion. This is equal to a property of the medium called *dynamic dispersivity*, or

FIGURE 2.4 Factors causing longitudinal dispersion at the scale of individual pores.



Source: C. W. Fetter. 1994. *Applied Hydrogeology, 3d ed.* Upper Saddle River, New Jersey: Prentice-Hall, Inc.

FIGURE 2.5 Flowpaths in a porous medium that cause lateral (transverse) hydrodynamic dispersion.



Source: C. W. Fetter. 1994. *Applied Hydrogeology, Third Edition.* Upper Saddle River, New Jersey: Prentice-Hall, Inc.

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simply *dispersivity*, α, times the average linear velocity. If i is the principle direction of flow, the following definitions apply:

$$\text{Coefficient of longitudinal mechanical dispersion} = \alpha_i v_i \tag{2.9}$$

where

v_i = the average linear velocity in the i direction (L/T)
α_i = the dynamic dispersivity in the i direction (L)

and

$$\text{Coefficient of transverse mechanical dispersion} = \alpha_j v_i \tag{2.10}$$

where

v_i = the average linear velocity in the i direction (L/T)
α_j = the dynamic dispersivity in the j direction (L)

2.5 Hydrodynamic Dispersion

The process of molecular diffusion cannot be separated from mechanical dispersion in flowing groundwater. The two are combined to define a parameter called the **hydrodynamic dispersion coefficient**, D. It is represented by the following formulas:

$$D_L = \alpha_L v_i + D^* \tag{2.11a}$$

$$D_T = \alpha_T v_i + D^* \tag{2.11b}$$

where

D_L = hydrodynamic dispersion coefficient parallel to the principal direction of flow (longitudinal)
D_T = hydrodynamic dispersion coefficient perpendicular to the principal direction of flow (transverse)
α_L = longitudinal dynamic dispersivity
α_T = transverse dynamic dispersivity

Figure 2.3 shows the effect of diffusion and mechanical dispersion on the relative concentration (C/C_0) of a solute acting as a tracer that has been injected into a porous medium under one-dimensional flow conditions. The vertical line at V represents the advective transport without dispersion. Effects of diffusion and mechanical dispersion are shown.

The process of hydrodynamic dispersion can be illustrated by Figure 2.6. A mass of solute is instantaneously introduced into the aquifer at time t_0 over the interval $x = 0 + a$. The resulting initial concentration is C_0. The advecting groundwater carries the mass of solute with it. In the process the solute slug spreads out, so that the maximum concentration decreases with time, as shown for times t_1 and t_2. The diffusional model of hydrodynamic dispersion predicts that the concentration curves will have a Gaussian distribution that is described by the mean and the variance. With this distribution the coefficients of longitudinal and transverse hydrodynamic dispersion can be defined as

$$D_L = \frac{\sigma_L^2}{2t} \tag{2.12a}$$

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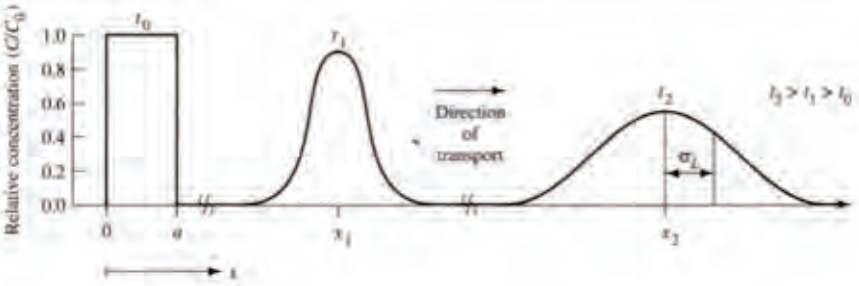
FIGURE 2.6 Transport and spreading of a solute slug with time due to advection and dispersion. A slug of solute was injected at $x = 0 + a$ at time t_0 with a resulting concentration of C_0. The groundwater flow is to the right.



$$D_T = \frac{\sigma_T^2}{2t} \tag{2.12b}$$

where

t = time

σ_T^2 = variance of the transverse spreading of the plume

σ_L^2 = variance of the longitudinal spreading of the plume

2.6 Derivation of the Advection-Dispersion Equation for Solute Transport

This derivation of the advection-dispersion equation is based on work by Freeze and Cherry (1979), Bear (1972), and Ogata (1970). Working assumptions are that the porous medium is homogeneous, isotropic, and saturated with fluid and that flow conditions are such that Darcy's law is valid.

The derivation is based on the conservation of mass of solute flux into and out of a small representative elementary volume (REV) of the porous media. The REV is the smallest volume that is representative for the entirety of whole medium. A measurement made at the REV scale will yield a value typically of the whole (Hill 1963). The REV concept serves as a cornerstone in the continuum modeling of transport phenomena in porous media (Bachmat and Bear 1987). The flow is at a macroscopic scale, which means that it accounts for the differences in flow from pore to pore. A representative elementary volume is illustrated in Figure 1.6.

The average linear velocity, v, has components v_x, v_y, and v_z. The concentration of solute, C, is mass per unit volume of solution. Mass of solute per unit volume of aquifer is the product of the effective porosity, n_e, and C. Porosity is considered to be a constant because the aquifer is homogeneous.

The solute will be transported by advection and hydrodynamic dispersion. In the i direction the solute transport is given by

$$\text{Advective transport} = v_i n_e C\, dA \tag{2.13}$$

$$\text{Dispersive transport} = n_e D_i \frac{\partial C}{\partial i} dA \tag{2.14}$$

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where dA is the cross-sectional area of the element and the i direction is normal to that cross-sectional face.

The total mass of solute per unit cross-sectional area transported in the i direction per unit time, F_i, is the sum of the advective and the dispersive transport and is given by

$$F_i = v_i n_e C - n_e D_i \frac{\partial C}{\partial i} \tag{2.15}$$

The negative sign indicates that the dispersive flux is from areas of greater to areas of lesser concentration.

The total amount of solute entering the representative elementary volume is

$$F_x\,dz\,dy + F_y\,dz\,dx + F_z\,dx\,dy$$

The total amount of solute leaving the representative elementary volume is

$$\left(F_x + \frac{\partial F_x}{\partial x}dx\right)dz\,dy + \left(F_y + \frac{\partial F_y}{\partial y}dy\right)dz\,dx + \left(F_z + \frac{\partial F_z}{\partial z}dz\right)dx\,dy$$

The difference between the mass of the solute entering the representative elementary volume and the amount leaving it is

$$-\left(\frac{\partial F_x}{\partial x} + \frac{\partial F_y}{\partial y} + \frac{\partial F_z}{\partial z}\right)dx\,dy\,dz$$

The rate of mass change in the representative elementary volume is

$$n_e \frac{\partial C}{\partial t}dx\,dy\,dz$$

By the law of mass conservation, the rate of mass change in the representative elementary volume must be equal to the difference in the mass of the solute entering and the mass leaving.

$$\frac{\partial F_x}{\partial x} + \frac{\partial F_y}{\partial y} + \frac{\partial F_z}{\partial z} = -n_e \frac{\partial C}{\partial t} \tag{2.16}$$

Equation 2.15 can be used to find the values of F_x, F_y, and F_z. These are substituted in Equation 2.16, which becomes, after cancellation of n_e from both sides,

$$\left[\frac{\partial}{\partial x}\left(D_x \frac{\partial C}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_y \frac{\partial C}{\partial y}\right) + \frac{\partial}{\partial z}\left(D_z \frac{\partial C}{\partial z}\right)\right]$$

$$-\left[\frac{\partial}{\partial x}(v_x C) + \frac{\partial}{\partial y}(v_y C) + \frac{\partial}{\partial z}(v_z C)\right] = \frac{\partial C}{\partial t} \tag{2.17}$$

Equation 2.17 is the three-dimensional equation of mass transport for a *conservative* solute—that is, one that does not interact with the porous media or undergo biological or radioactive decay.

In a homogeneous medium, D_x, D_y, and D_z do not vary in space. However, because the coefficient of hydrodynamic dispersion is a function of the flow direction, even in an isotropic, homogeneous medium, $D_x \neq D_y \neq D_z$. For those domains where the

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average linear velocity, v_x, is uniform in space, Equation 2.17 for one-dimensional flow in a homogeneous, isotropic porous media is

$$D_L \frac{\partial^2 C}{\partial x^2} - v_x \frac{\partial C}{\partial x} = \frac{\partial C}{\partial t} \tag{2.18}$$

In a homogeneous medium with a uniform velocity field, Equation 2.17 for two-dimensional flow with the direction of flow parallel to the x axis is

$$D_L \frac{\partial^2 C}{\partial x^2} + D_T \frac{\partial^2 C}{\partial y^2} - v_x \frac{\partial C}{\partial x} = \frac{\partial C}{\partial t} \tag{2.19}$$

where

D_L = the longitudinal hydrodynamic dispersion (L^2/T)
D_T = the transverse hydrodynamic dispersion (L^2/T)

Equation 2.17 for radial flow from a well can be written in polar coordinates (Ogata 1970) as

$$\frac{\partial}{\partial r}\left(D\frac{\partial C}{\partial r}\right) + \frac{D}{r}\frac{\partial C}{\partial r} - u\frac{\partial C}{\partial r} = \frac{\partial C}{\partial t} \tag{2.20}$$

where

r = radial distance to the well
u = average pore velocity of injection, which is found from

$$u = \frac{Q}{2\pi n_e R r^2}$$

where

Q = the rate of injection into the well
n_e = effective porosity
R = length of well screen or open bore hole

2.7 Diffusion versus Dispersion

In the previous section the mass transport equation was derived on the basis of hydrodynamic dispersion, which is the sum of mechanical dispersion and diffusion. It would have been possible to separate the hydrodynamic dispersion term into the two components and have separate terms in the equation for them. However, as a practical matter, under most conditions of groundwater flow, diffusion is insignificant and is neglected.

It is possible to evaluate the relative contribution of mechanical dispersion and diffusion to solute transport. A **Peclet number**, P_e, is a dimensionless number that can relate the effectiveness of mass transport by advection to the effectiveness of mass transport by either dispersion or diffusion. Peclet numbers have the general form of $v_x d/D_d$ or $v_x L/D_L$, where v_x is the advective velocity, d and L are characteristic flow lengths, D_d is the coefficient of molecular diffusion, and D_L is the longitudinal hydrodynamic dispersion coefficient. The column Peclet number, which defines the ratio of transport

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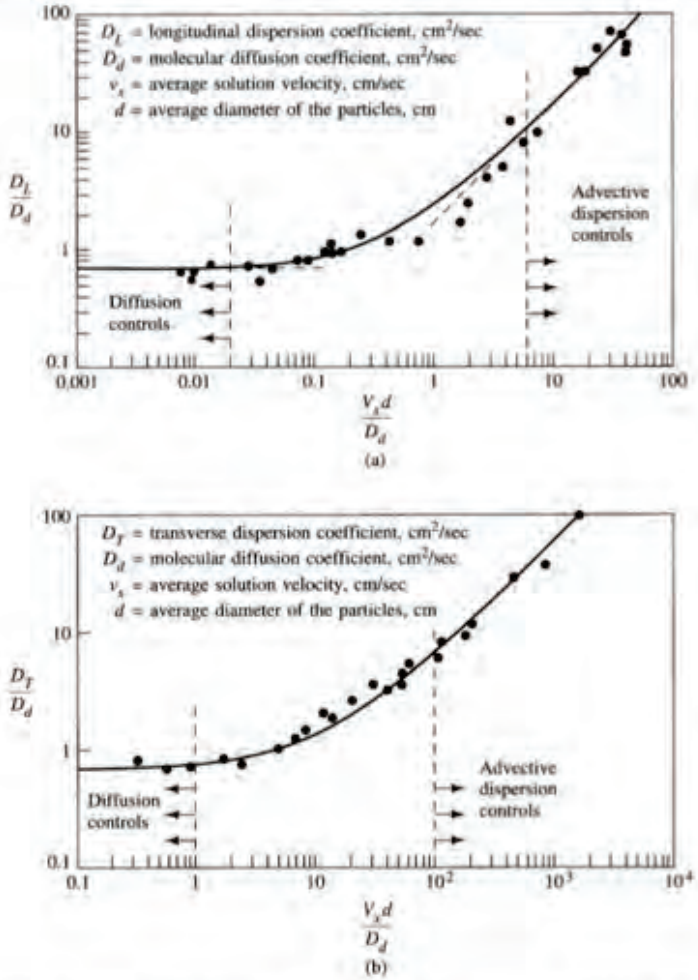
by advection to the rate of transport by molecular diffusion in column studies, is a dimensionless parameter defined as $v_x d/D_d$, where d is the average grain diameter and D_d is the coefficient of molecular diffusion. A plot of the ratio of D_L/D_d versus the Peclet number is given in Figure 2.7a. Shown on this figure are the results of a number of experimental measurements using sand columns and tracers as well as some experimental curves from several investigators (Perkins and Johnson 1963). Delgado (2007) presents empirical correlations for the prediction of the dispersion coefficients (D_T and D_L) based Peclet number and Schmidt number (S_c). The dimensionless Schmidt number relates the viscous diffusion rate to the molecular diffusion rate. S_c is defined as:

$$S_c = \frac{\mu}{\rho D}$$

where μ and ρ are the dynamic viscosity (M/LT) and density of the fluid, respectively. D is the diffusion coefficient.

FIGURE 2.7 Graph of dimensionless dispersion coefficients versus Peclet number, $P_e = v_x d/D_d$. (a) D_L/D_e versus P_e and (b) D_T/D_e versus P_e.



Source: T. K. Perkins and O. C. Johnson. 1963. *Society of Petroleum Engineers Journal* 3:70–84. Society of Petroleum Engineers.

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At zero flow velocity D_L is equal to D^*, since $D_L = a_L v_x + D^*$. In this manner the value of ω, the tortuosity factor, can be experimentally determined as $D^* = \omega D_d$. At very low velocities, the ratio of D_L/D_d is a constant with a value of about 0.7, which is the experimentally determined value of ω for uniform sand. This shows up on the left side of Figure 2.7(a) as a horizontal line. In this zone diffusion is the predominant force, and dispersion can be neglected. Between a Peclet number of about 0.4 to 6 there is a transition zone, where the effects of diffusion and longitudinal mechanical dispersion are more or less equal.

Figure 2.7(b) shows the plot of D_T/D_d as a function of Peclet number. Although the curve has the same shape as in (a), it occurs at Peclet numbers roughly 100 times greater. This means that diffusion has more control over transverse dispersion at higher Peclet numbers than it does for longitudinal dispersion. Higher Peclet numbers occur with higher velocities and/or longer flow paths. At higher Peclet numbers mechanical dispersion is the predominant cause of mixing of the contaminant plume (Perkins and Johnson 1963; Bear 1972; Bear and Verruijt 1987) and the effects of diffusion can be ignored. Under these conditions D_i can be replaced with $a_i v_i$ in the advection-dispersion equations.

2.8 Moment Analysis

Contaminant hydrogeologists, like other scientists, have to work with a lot of data, such as periodic measurements of pollutant concentrations in monitoring wells or hydraulic values that determine the flow and transport of these pollutants. If writing a report or publishing data in peer reviewed manuscripts, one is expected to back up the significance of the data with a proper statistical analysis. A review of statistical concepts and methods is not the focus of this book, but excellent introductions into groundwater statistics are provided by Helsel and Hirsch (2002) or Interstate Technology and Regulatory Council (2013).

One statistical method, however, that is quite useful for the analysis of contaminant fate and transport data, especially results from laboratory or field-scale tracer tests, warrants a more detailed discussion. The method is known as moment analysis. This method can be an important tool for calculating mass recoveries in tracer experiments, travel velocities of a plume, and the description of the shape of the plume in terms of dispersivity, skewness, and kurtosis. Both temporal and spatial data can be used for this analysis. The relationship between the spatial and temporal moments and the properties of an evolving solute plume are based on work by Aris (1956) and subsequent modifications by Goltz and Roberts (1987), who developed moment concepts for the analysis of three-dimensional solute transport data. The spatial moment technique was utilized by Marle et al. (1967), Ghüven et al. (1984) and Valocchi (1989) to study solute transport in steady horizontal flow in a perfectly stratified aquifer. Valocchi (1990) provides an overview of the usefulness of temporal moment analysis for studying reactive solute transport in aggregated porous media.

The method of moment was employed for the analysis of many natural gradient field tracer tests. For instance, the spatial moments of the bromide tracer distribution were used to calculate the tracer mass, velocity, and dispersivity during the large-scale tracer test at the Canadian Air Force Base (CFB) in Borden, Ontario (Freyberg 1986; Farrell and Woodbury 1994) or the transport of nonreactive and reactive tracers in a sand and gravel aquifer on Cape Cod, Massachusetts (Leblanc et al. 1991; Garabedian et al. 1991) or at the Twin Lake aquifer test site within the property of the Chalk River

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Nuclear Laboratories, where in 1982 and 1983 a pulse of groundwater labeled with ^{131}Iodine was injected (Moltyaner and Killey 1988; Moltyaner and Wills 1991).

The analysis of moments ordinarily is accomplished by numerically solving one or more triple integrals of tracer concentration in the three-dimensional space of the test domain (Freyberg 1986; Glotz and Roberts 1987; Valochhi 1989; Garabedian et al. 1991). The absolute moments (M) in three dimensions are defined as follows:

$$M_{j\,k\,n} = \int_{-\infty}^{\infty}\int\int\int C x^j y^k z^n dx\, dy\, dz$$

where C is the solute concentration at the spatial coordinates x, y, and z. For one-dimensional data sets, the moment analysis can be simplified to the temporal and spatial forms summarized in Table 2.2.

Temporal moments can be interpreted with the help of breakthrough curves (BTC) (Figure 2.8). A BTC is a graph of concentration versus time. This format of depiction is appropriate when the position of the observer is fixed (Eulerian approach). A BTC

TABLE 2.2 One-dimensional moments.

Moment	Temporal Moments	Spatial Moments
Zeroth Absolute Moment	$M_t^0 = \int_0^\infty C\, dt$	$M_s^0 = \int_0^\infty C\, dx$
First Normalized Moment	$M_t^1 = \frac{\int_0^\infty Ct\, dt}{\int_0^\infty C\, dt} = \frac{\int_0^\infty Ct\, dt}{M_t^0}$	$M_s^1 = \frac{\int_0^\infty Cx\, dx}{\int_0^\infty C\, dx} = \frac{\int_0^\infty Cx\, dx}{M_x^0}$
Adjusted First Temporal Moment	$M_{adj}^1 = \frac{\int_0^x Ct\, dt}{M_t^0} - \frac{1}{2}T_0$	Not defined
Second Central Moment	$M_t^2 = \frac{\int_0^\infty \left(t - M_t^1\right)^2 C\, dt}{M_t^0}$	$M_s^2 = \frac{\int_0^\infty \left(x - M_s^1\right)^2 C\, dx}{M_s^0}$
Third Central Moment	$M_t^3 = \frac{\int_0^\infty \left(t - M_t^1\right)^3 C\, dt}{M_t^0}$	$M_s^3 = \frac{\int_0^\infty \left(x - M_s^1\right)^3 C\, dx}{M_s^0}$
Fourth Central Moment	$M_t^4 = \frac{\int_0^\infty \left(t - M_t^1\right)^4 C\, dt}{M_t^0}$	$M_s^4 = \frac{\int_0^\infty \left(x - M_s^1\right)^4 C\, dx}{M_s^0}$

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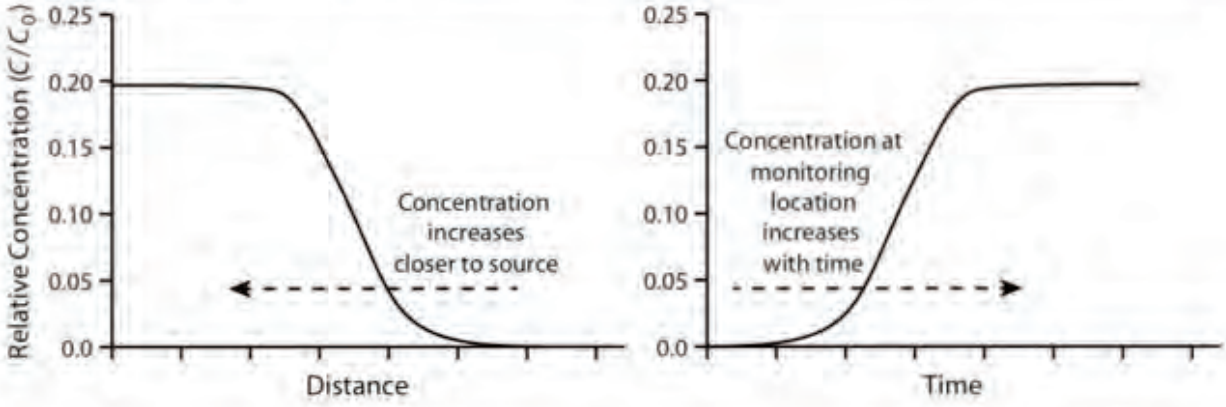
FIGURE 2.8 Representation of concentration data resulting from a continuous contaminant release scenario: (a) concentration versus distance and (b) concentration versus time. The concentration-time graph is called a breakthrough curve (BTC).



is typically used to report solute concentrations in column effluent during of tracer experiment or at the location of a specific monitoring well. In contrast, a graph of concentration versus distance is not a BTC. It represents a snapshot of concentration data collected more or less simultaneously at various locations within the test domain (Lagrangian approach). Such a graph is useful, for example, for reporting the tracer concentration in groundwater samples collected along the principal axis of a contaminant plume.

It is convenient to normalize the higher order temporal and spatial moments by scaling them to the zeroth temporal moment (M_t^0) or zeroth spatial moment (M_s^0), respectively. Higher moments are centralized by subtracting the first normalized temporal or spatial moment ($M_{t,s}^1$) from the elapsed time (t) or distance (x), respectively, since the start of the measurements.

The significance of M_t^0 is that it integrates the area under the concentration versus distance curve (Figure 2.8) and thus presents the mass of solute and a measure for calculating the solute mass recovery and mass balance. The M_s^0 aides in determining the amount of mass passing by a sampling point (i.e., monitoring well). A constant value of M_s^0 at different distances from the origin indicates that no mass loss occurred and therefore suggests a recalcitrance of a compound to sorption of degradation processes. The M_s^1 calculates the mean, i.e., the location of the center of mass of a plume and thus aides in calculating the plume travel velocity. M_t^1 describes the travel time of a dissolved compound (Figure 2.9). While not defined for spatial coordinate data, the adjusted first temporal moment, M_{adj}^1, is:

$$M_{adj}^1 = \frac{\int_o^x C\ t\ dt}{M^0} - \frac{1}{2}T_0$$

where T_0 is the pulse length, i.e., the duration of the tracer slug injection. M_{adj}^1 permits the calculation of the tracer front travel time (Figure 2.11) and therefore M_{adj}^1 can be used to calculate the retardation factor from the inflection point of the BTC, i.e., where $C/C_{max} = 0.5$. The parameter C_{max} is the maximum concentration measured during the tracer test (Figure 2.9).

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FIGURE 2.9 Ideal breakthrough curve (BTC). The arrival time is the time for the center of mass to arrive at the monitoring location. The travel time is the breakthrough time of the tracer front.

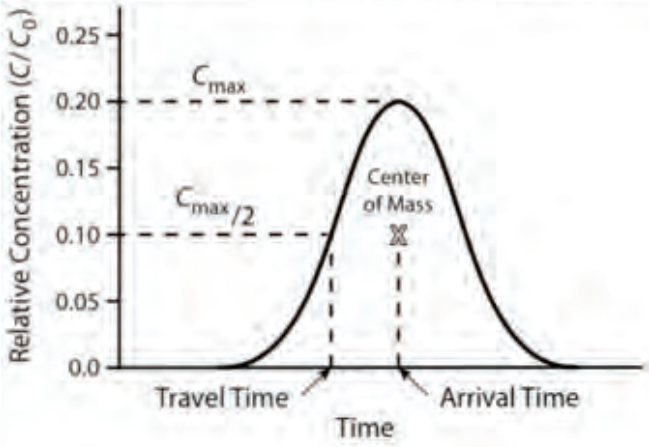
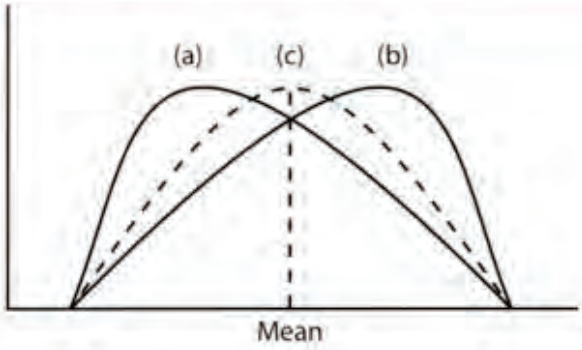


FIGURE 2.10 Skewness: (a) positive, (b) negative and (c) not skewed around the mean ($M^3 = 0$).



The second temporal moment (M_t^2) is the variance (σ^2) and provides a measure for the spread of a plume about the location of the center of mass. The analysis of the second spatial moment (M_x^2) can be used to determine the longitudinal dispersion coefficient, D_L, in either temporal or spatial coordinates:

$$D_L = \frac{\sigma_L^2}{2t}$$

$$D_L = \frac{\sigma_L^2 v}{2x}$$

where σ_L^2 is the variance, t is time since the start of the tracer test and v is the linear flow velocity (constant).

The skewness of a curve is described by the third moment (M^3). A positive value indicates that the graph is skewed to the right, whereas a negative value means skewness to the left (Figure 2.10). A value of approximately zero suggests that the data is normally distributed. The fourth moment (M^4) is a measure of kurtosis (Figure 2.11). For a conservative tracer, both M^3 and M^4 should be approximately zero. Deviations

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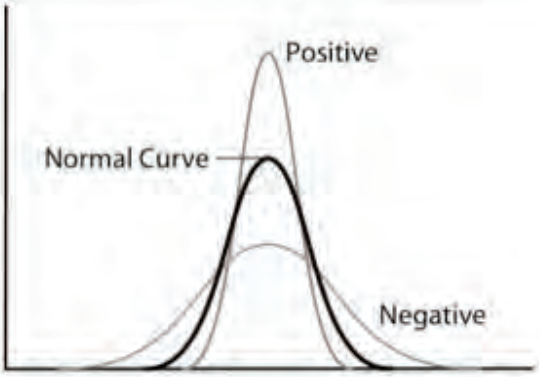
FIGURE 2.11 Negative and positive kurtosis. The M^4 is zero for when the tracer concentration data is normally distributed.



from that value indicate non-ideal transport conditions. Other applications of moment analysis are discussed in Suthersan et al. 2017.

EXAMPLE

A tracer test was conducted and concentration measurements have been collected downgradient from the injection location and at three different times ($t_1 = 30$ *d*, $t_2 = 60$ *d*, and $t_3 = 90$ *d*). Figure 2.12 shows the concentration versus distance data in terms of dimensionless concentration (C/C_0) at three observations points.

In this example, the tracer is nonreactive because the area under the curves (M^0) remains the same for all three data sets. Had the value of M^0 decreased however, it

FIGURE 2.12 The spatial position of the tracer concentrations profiles at times t_1, t_2, and t_3.

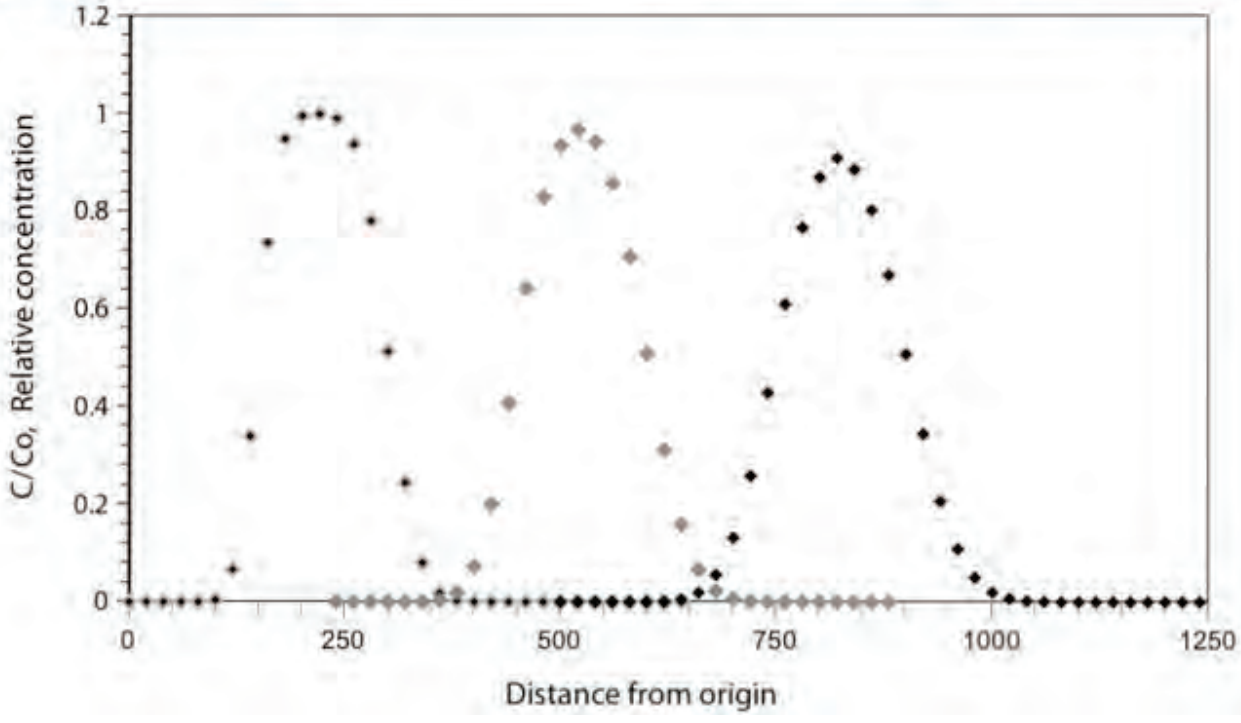


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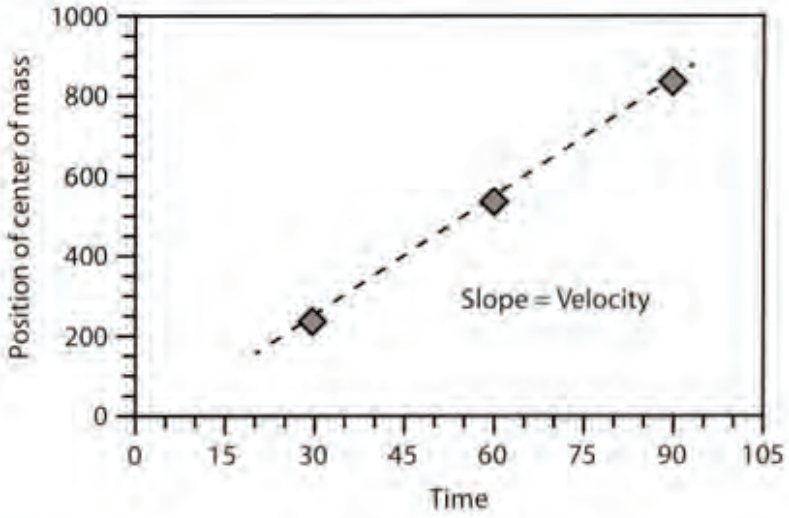
FIGURE 2.13 The velocity of a migrating plume can be estimated from the location of the center of mass (First spatial moment).



would have indicated that a fraction of the tracer was lost during the experiment. In that case, a plot of M^0 versus distance would reveal if the rate of loss is linear or nonlinear.

The velocity of a migrating plume was estimated from the location of the center of mass (M^1) at different times (Figure 2.12). In this example, the velocity remained constant throughout the experiment, which is expected for a nonreactive tracer. If the flow velocity is identical to the groundwater flow velocity, the tracer can be considered "conservative," i.e., its flow is not retarded. By comparing the M^1 of a conservative tracer with that of other tracers that might have been co-injected at the start of the tracer test, one can calculate the relative travel times or relative travel distances and thus the retardation factors for each tracer.

When plotting M^2 for each of the three data sets against the time of measurement, the slope of the regression line is equal to $2D_L$. The M^3 and M^4 values indicate that the three data sets are not skewed and that they do not show kurtosis; once again indicating that the tracer was nonreactive.

■ 2.9 Analytical Solutions of the Advection-Dispersion Equation

2.9.1 Methods of Solution

The advection-dispersion equations can be solved by either numerical or analytical methods. Analytical methods involve the solution of the partial differential equations using calculus based on the initial and boundary value conditions. They are limited to simple geometry and in general require that the aquifer be homogeneous. A number of analytical solutions are presented in this chapter. They are useful in that they can be solved with spreadsheet, like EXCEL, or even a pencil and paper, if one is so inclined.

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Numerical methods involve the solution of the partial differential equation by numerical methods of analysis. They are more powerful than analytical solutions in the sense that aquifers of any geometry can be analyzed and aquifer heterogeneities can be accommodated. However, there can be other problems with numerical models, such as numerical errors, which can cause solutions to show excess spreading of solute fronts or plumes that are not related to the dispersion of the tracer that is the subject of the modeling. Bear and Verruijt (1987) present a good introduction to the use of numerical models to solve mass transport equations. These solutions are normally found by methods of computer modeling, a topic beyond the scope of this text. Instead, the reader is referred to Bear and Cheng (2010), who offer an overview about the methodology and procedures for constructing conceptual and mathematical models for groundwater flow and the fate and transport of contaminants in both saturated and unsaturated zones. Also, Kuzmin (2010) provides a guide to numerical methods for solving transport equations with particular focus on finite element models.

2.9.2 Boundary and Initial Conditions

In order to obtain a unique solution to a differential equation it is necessary to specify the initial and the boundary conditions that apply. The **initial conditions** describe the values of the variable under consideration, in this case concentration, at some initial time equal to 0. The **boundary conditions** specify the interaction between the area under investigation and its external environment.

There are three types of boundary conditions for mass transport. The boundary condition of the first type is a **fixed concentration.** The boundary condition of the second type is a **fixed gradient. A variable flux** boundary constitutes the boundary condition of the third type.

Boundary and initial conditions are shown in a shorthand form. For one-dimensional flow we need to specify the conditions relative to the location, x, and the time, t. By convention this is shown in the form

$$C(x,t) = C(t)$$

where C(t) is some known function.

For example, we can write

$$C(0,t) = C_0, \quad t \geq 0$$
$$C(x,0) = 0, \quad x \geq 0$$
$$C(\infty,t) = 0, \quad t \geq 0$$

The first statement says that for all time t equal to or greater than zero, at $x = 0$ the concentration is maintained at C_0. This is a fixed-concentration boundary condition located at $x = 0$ (first-type boundary). The second statement is an initial condition that says at time $t = 0$, the concentration is zero everywhere within the flow domain, that is, where x is greater than or equal zero. As soon as flow starts, solute at a concentration of C_0 will cross the $x = 0$ boundary.

The third condition shows that the flow system is infinitely long and that no matter how large time gets, the concentration will still be zero at the end of the system (first-type boundary condition at $x = \infty$).

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We could also have specified an initial condition that within the domain the initial solute concentration was C_i. This would be written as

$$C(x,0) = C_i, \quad x \geq 0$$

Other examples of concentration (first-type) boundary conditions are exponential decay of the source term and pulse loading at a constant concentration for a period of time followed by another period of time with a different constant concentration.

Exponential decay for the source term can be expressed as

$$C(0, t) = C_0 e^{-it}$$

where i = a decay constant.

Pulse loading where the concentration is C_0 for times from 0 to t_0 and then is 0 for all time more than t_0 is expressed as

$$C(0,t) = C_0 \qquad 0 < t \leq t_0$$

$$C(0,t) = 0 \qquad t > t_0$$

Fixed-gradient boundaries are expressed as

$$\left.\frac{dC}{dx}\right|_{x=0} = f(t) \quad \text{or} \quad \left.\frac{dC}{dx}\right|_{x=\infty} = f(t)$$

where $f(t)$ is some known function. A common fixed-gradient condition is $dC/dx = 0$, or a no-gradient boundary.

The variable-flux boundary, a third type, is given as

$$-D\frac{\partial C}{\partial x} + v_x C = v_x C(t)$$

where $C(t)$ is a known concentration function. A common variable-flux boundary is a constant flux with a constant input concentration, expressed as

$$\left.\left(-D\frac{dC}{dx} + vC\right)\right|_{x=0} = C_0$$

2.9.3 One-Dimensional Step Change in Concentration (First-Type Boundary)

Sand column experiments have been used to evaluate both the coefficients of diffusion and dispersion at the laboratory scale. A tube is filled with sand and then saturated with water. Water is made to flow through the tube at a steady rate, creating, in effect, a permeameter. A solution containing a tracer is then introduced into the sand column in place of the water. The initial concentration of the solute in the column is zero, and the concentration of the tracer solution is C_0. The tracer in the water exiting the tube is analyzed, and the ratio of C, the tracer concentration at time t, over C_0, the injected tracer concentration, is plotted as a function of time. This is called a **fixedstep function.**

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The boundary and initial conditions are given by

$$C(x,0)=0 \qquad x\geq 0 \qquad \text{Initial condition}$$

$$\left.\begin{aligned} C(0,t)&=C_0 \qquad t\geq 0\\ C(\infty,t)&=0 \qquad t\geq 0 \end{aligned}\right\} \quad \text{Boundary conditions}$$

The solution to Equation 2.18 for these conditions is (Ogata and Banks 1961)

$$C=\frac{C_0}{2}\left[\operatorname{erfc}\left(\frac{L-v_x t}{2\sqrt{D_L t}}\right)+\exp\left(\frac{v_x L}{D_L}\right)\operatorname{erfc}\left(\frac{L+v_x t}{2\sqrt{D_L t}}\right)\right] \tag{2.21}$$

This equation may be expressed in dimensionless form as

$$C_R\left(t_R,P_e\right)=0.5\left\{\operatorname{erfc}\left[\left(\frac{P_e}{4t_R}\right)^{1/2}\times(1-t_R)\right]+\exp(P_e)\operatorname{erfc}\left[\left(\frac{P_e}{4t_R}\right)^{1/2}(1+t_R)\right]\right\} \tag{2.22}$$

where

t_R = $v_x t/L$
C_R = C/C_0
P_e = Peclet number when flow distance, L, is chosen as the reference length ($P_e = v_x L/D_L$)
erfc = complementary error function

Equation 2.21 can be solved in Microsoft Excel after installing the *Plume1D()* add-in (Renshaw 2015a).

2.9.4 One-Dimensional Continuous Injection into a Flow Field (Second-Type Boundary)

In nature there are not many situations where there would be a sudden change in the quality of the water entering an aquifer. A much more likely condition is that there would be leakage of contaminated water into the groundwater flowing in an aquifer. For the one-dimensional case, this might be a canal that is discharging contaminated water into an aquifer as a line source (Figure 2.14).

The rate of injection is considered to be constant, with the injected mass of the solute proportional to the duration of the injection. The initial concentration of the solute in the aquifer is zero, and the concentration of the solute being injected is C_0. The solute is free to disperse both up-gradient and down-gradient.

The boundary and initial conditions are

$$C(x,0)=0 \qquad -\infty<x<+\infty \qquad \text{Initial condition}$$

$$\left.\begin{aligned} \int_{-\infty}^{+\infty} n_e C(x,t)\,dx &= C_0 n_e v_x t \qquad t>0\\ C(\infty,t)&=0 \qquad t\geq 0 \end{aligned}\right] \quad \text{Boundary conditions}$$

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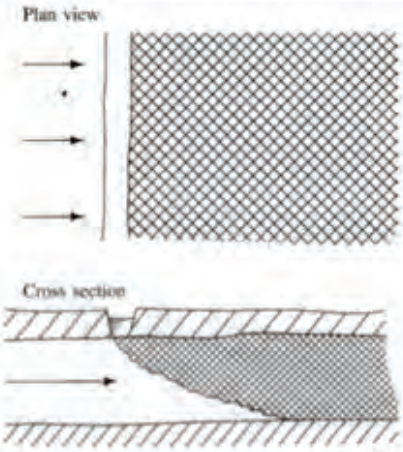
FIGURE 2.14 Leakage from a canal as a line source for injection of a contaminant into an aquifer.



Source: J. P. Sauty. 1980. *Water Resources Research* 16:145–58. Copyright by the American Geophysical Union. Reproduced with permission.

The second boundary condition states that the injected mass of contaminant over the domain from $-\infty$ to $+\infty$ is proportional to the length of time of the injection.

The solution to this flow problem (Sauty 1980) is

$$C = \frac{C_0}{2}\left[\operatorname{erfc}\left(\frac{L - v_x t}{2\sqrt{D_L t}}\right) - \exp\left(\frac{v_x L}{D_L}\right)\operatorname{erfc}\left(\frac{L + v_x t}{2\sqrt{D_L t}}\right)\right] \tag{2.23}$$

In dimensionless form this is

$$C_R\left(t_R, P_e\right) = 0.5\left\{\operatorname{erfc}\left[\left(\frac{P_e}{4t_R}\right)^{1/2}\left(1 - t_R\right)\right]\right. \tag{2.24}$$

$$\left. - \exp(P_e)\operatorname{erfc}\left[\left(\frac{P_e}{4t_R}\right)^{1/2}\left(1 + t_R\right)\right]\right\}$$

It can be seen that Equations 2.21 and 2.23 are very similar, the only difference being that the second term is subtracted rather than added in 2.23.

Sauty (1980) gives an approximation for the one-dimensional dispersion equation as

$$C = \frac{C_0}{2}\left[\operatorname{erfc}\left(\frac{L - v_x t}{2\sqrt{D_L t}}\right)\right] \tag{2.25}$$

In dimensionless form this is

$$C_R\left(t_R, P_e\right) = 0.5\operatorname{erfc}\left[\left(\frac{P_e}{4t_R}\right)^{1/2}\left(1 - t_R\right)\right] \tag{2.26}$$

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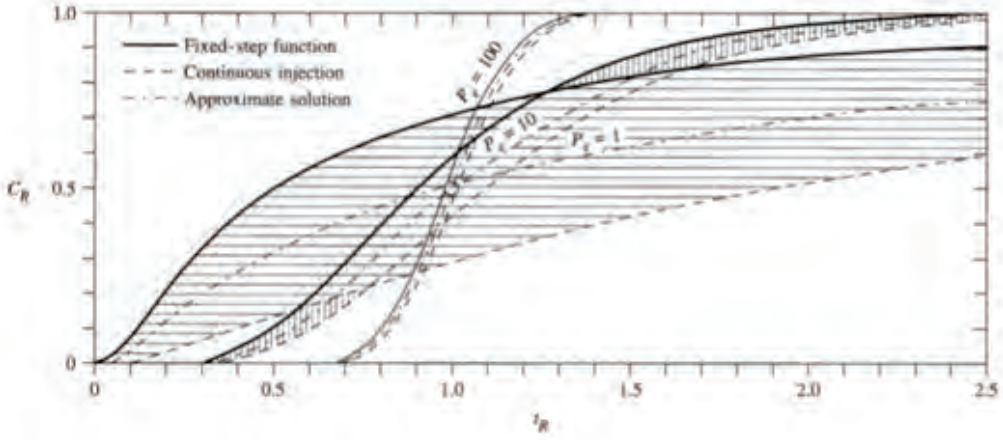
This approximation comes about because for large Peclet numbers, the second term of Equations 2.21 and 2.23 is much smaller than first term and can be neglected. Figure 2.15 demonstrates under what conditions this approximation is valid. In Figure 2.15 the dimensionless concentration, C_R, is plotted as a function of dimensionless time, t_R, for continuous tracer injection using the fixed-step function, Equation 2.22, the continuous-injection function, Equation 2.24, and the approximate solution, Equation 2.26. Curves are plotted for three Peclet numbers, 1, 10, and 100 (Section 2.7). The Peclet number defines the rate of transport by advection to the rate of transport by hydrodynamic dispersion. For Peclet number 1, the fixedstep function and the continuous-injection function give quite different results, whereas for Peclet number 100 they are almost identical. The approximate solution lies midway between the other two. This figure suggests that for Peclet numbers less than about 10, the exact solutions need to be considered, whereas for Peclet numbers greater than 10, the approximate solution is probably acceptable, especially as the Peclet number approaches 100. This Peclet number increases with flow-path length as advective transport becomes more dominant over dispersive transport. Thus for mass transport near the inlet boundary, it is important to use the correct equation, but as one goes away from the inlet boundary, it is less important that the correct form of the equation is employed.

FIGURE 2.15 Dimensionless-type curves for the continuous injection of a tracer into a one-dimensional flow field.



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EXAMPLE PROBLEM

Pickles are made in large wooden vats. At the Happy Gherkin Pickle Factory one of the vats has been leaking brine directly into the water table. The concentration of chloride in the brine is 1575 mgL^{-1}. The flow in the aquifer that receives the brine is essentially one-dimensional and has the following characteristics.

Hydraulic conductivity = 2.93×10^{-4} ms^{-1}

Hydraulic gradient = 0.00678

Effective porosity = 0.259

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The estimated effective diffusion coefficient for chloride is $2 \times 10^{-9}\ m^2s^{-1}$.

Calculate the concentration of chloride above any background value at a distance 125 m from the leaking vat 0.50 years after the leak began.

We will apply equation 2.25 to this problem. Note that this is an approximate solution as the second term of equation 2.23 has been dropped.

$$C = \frac{C_0}{2}\left[\text{erfc}\left(\frac{L - v_x t}{2\sqrt{D_L t}}\right)\right]$$

1. Calculate v_x

$$v_x = \frac{K}{n_e}\frac{dh}{dl}$$

$$v_x = \frac{2.93 \times 10^{-4} ms^{-1}}{0.259} \times 0.00678$$

$$v_x = 7.67 \times 10^{-6} ms^{-1}$$

2. Find the value of the coefficient of longitudinal hydrodynamic dispersion, D_L. This can be found from equation 2.11a.

$$D_L = \alpha_L v_x + D^*$$

   a. The first step is to find the value of α_L. This can be estimated from equation 2.48, which will be introduced in a later section.

$$\alpha_L = 0.83(\log L)^{2.414}$$

$$\alpha_L = 0.83(\log 125)^{2.414}\ m$$

$$\alpha_L = 4.96\ \text{m}$$

   b. The next step is to calculate D_L.

$$D_L = 4.96\text{m} \times 7.67 \times 10^{-6} \text{ms}^{-1} + 2 \times 10^{-9} \text{m}^2\text{s}^{-1}$$

$$D_L = 3.80 \times 10^{-5} \text{m}^2\text{s}^{-1} + 2 \times 10^{-9} \text{m}^{2-1}$$

The second term reflecting the effective diffusion coefficient can be neglected as it is so much smaller than the first term.

3. In order to have consistent units, the time must be expressed in seconds.

$$0.5\text{ y} \times 365\text{ d/y} \times 1440\text{ min/d} \times 60\text{ s/min} = 1.578 \times 10^7\text{ s}.$$

4. The values of the variables are then substituted into Equation 2.25.

$$C_0 = 1575\ \text{mgL}^{-1}$$

$$v_x = 7.67 \times 10^{-6} \text{ms}^{-1}$$

$$L = 125\text{m}$$

$$D_L = 3.80 \times 10^{-5} \text{m}^2\text{s}^{-1}$$

$$t = 1.578 \times 10^7 \text{s}$$

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$$C = \frac{1575\text{mgL}^{-1}}{2}\text{erfc}\left(\frac{125\text{m} - (7.67\times10^{-6}\text{ms}^{-1}\times1.578\times10^{7}\text{s})}{2\sqrt{3.80\times10^{-5}\text{m}^2\text{s}^{-1}\times1.578\times10^{7}\text{s}}}\right)$$

$$C = 787.5\text{erfc}\left(\frac{125\text{m} - 121.0\text{m}}{2\sqrt{5.99\times10^{2}\text{m}^2}}\right)\text{mgL}^{-1}$$

$$C = 787.5\text{erfc}\left(\frac{4.0\text{m}}{2\times24.49\text{m}}\right)\text{mgL}^{-1}$$

$$C = 787.5\text{erfc}(0.0816)\text{ mg/L}$$

$$C = 787.5\times0.908\text{mgL}^{-1} = 715\text{mgL}^{-1}$$

2.9.5 Third-Type Boundary Condition

A solution for Equation 2.18 for the following boundary condition was given by van Genuchten (1981).

$$C(x,0) = 0 \qquad \text{Initial condition}$$

$$\left(-D\frac{\partial C}{\partial x} + v_x C\right)\Big|_{x=0} = v_x C_0 \qquad \text{Boundary conditions}$$

$$\left.\frac{\partial C}{\partial x}\right|_{x\to\infty} = (\text{finite})$$

The third condition specifies that as x approaches infinity, the concentration gradient will still be finite. Under these conditions the solution to Equation 2.18 is:

$$C = \frac{C_0}{2}\left[\text{erfc}\left[\frac{L - v_x t}{2\sqrt{D_L t}}\right] + \left(\frac{{v_x}^2 t}{\pi D_L}\right)^{1/2}\exp\left[-\frac{(L - v_x t)^2}{4D_L t}\right]\right. \qquad (2.27)$$

$$\left. -\frac{1}{2}\left(1 + \frac{v_x L}{D_L} + \frac{{v_x}^2 t}{D_L}\right)\exp\left(\frac{v_x L}{D_L}\right)\text{erfc}\left[\frac{L - v_x t}{2\sqrt{D_L t}}\right]\right]$$

This equation also reduces to the approximate solution, Equation 2.25, as the flow length increases.

2.9.6 One-Dimensional Slug Injection into a Flow Field

If a slug of contamination is instantaneously injected into a uniform, one-dimensional flow field, it will pass through the aquifer as a pulse with a peak concentration, C_{max}, at some time after injection, t_{max}. The solution to Equation 2.18 under these conditions (Sauty 1980) is in dimensionless form:

$$C_R = (t_R, P_e) = \frac{E}{(t_R)^{1/2}}\exp\left(-\frac{P_e}{4t_R}(1 - t_R)^2\right) \qquad (2.28)$$

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with

$$E = \left(t_{R\max}\right)^{1/2} \cdot \exp\left(\frac{P_e}{4t_{R\max}}\left(1 - t_{R\max}\right)^2\right) \tag{2.29}$$

where

$t_{R\max}$ = $(1 + P_e^{-2})^{1/2} - P_e^{-1}$ (dimensionless time at which peak concentration occurs)

C_R = $C/C_{\max}$

In Figure 2.16, C_R ($C/C_{\max}$) for a slug injected into a uniform one-dimensional flow field is plotted against dimensionless time, t_R, for several Peclet numbers. It can be seen that the time for the peak concentration ($C_{\max}$) to occur increases with the Peclet number, up to a limit of $t_R = 1$. Breakthrough becomes more symmetric with increasing P_e.

2.9.7 Continuous Injection into a Uniform Two-Dimensional Flow Field

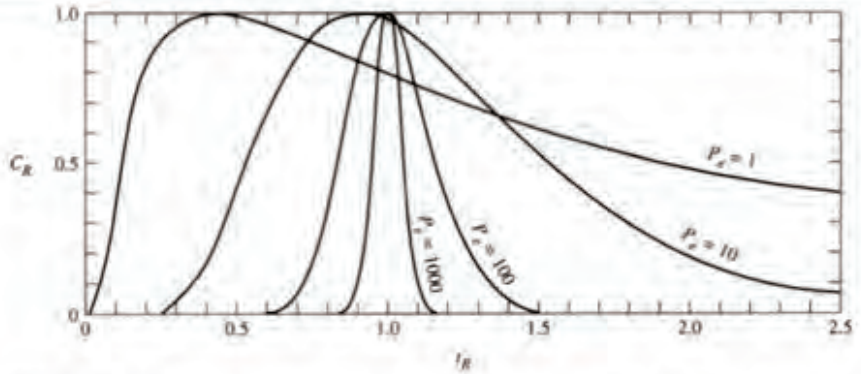
If a tracer is continuously injected into a uniform flow field from a single point that fully penetrates the aquifer, a two-dimensional plume will form that looks similar to Figure 2.16. It will spread along the axis of flow due to longitudinal dispersion and normal to the axis of flow due to transverse dispersion. This is the type of contamination that would spread from the use of an injection well, which would be a point source.

Flow is governed by Equation 2.19, the mass transport equation in two dimensions. The well is located at the origin ($x = 0$, $y = 0$), and there is a uniform flow velocity at a rate v_x parallel to the x axis. There is a continuous injection at the origin, of a solute with a concentration C_0 at a rate Q over the aquifer thickness, b.

The solution of Equation 2.19 can be found from a Green function (Bear 1972; Fried 1975) for the injection of a unit amount of a contaminant as:

$$C(x,y,t) = \frac{1}{4\pi t\left(D_L D_T\right)^{0.5}} \exp\left[-\frac{\left(x - v_x t\right)^2}{4D_L t} - \frac{y^2}{4D_T t}\right]$$

FIGURE 2.16 Dimensionless-type curve for the injection of a slug of a tracer into a one-dimensional flow field.



Source: J. P. Sauty. 1980. *Water Resources Research* 16:145–158. Copyright by the American Geophysical Union. Reproduced with permission.

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Since the Green function is for a unit injection, and we have an injection rate that can be defined as $C_0(Q/b)$, the solution to the above is:

$$C(x,y,t) = \frac{C_0(Q/b)dt}{4\pi t(D_L D_T)^{0.5}} \exp\left[-\frac{(x-v_x t)^2}{4D_L t} - \frac{y^2}{4D_T t}\right]$$

If the injection rate, Q/b, is continuous then the solution at time t is:

FIGURE 2.17 Plume resulting from the continuous injection of a tracer into a two-dimensional flow field. (Source: C.W. Fetter. 1994. *Applied Hydrogeology, Third Edition*. Upper Saddle River, New Jersey: Prentice-Hall, Inc.)



$$C(x,y,t) = \frac{C_0(Q/b)}{4\pi(D_L D_T)^{0.5}} \int_{\theta=0}^{\theta=t} \exp\left[-\frac{(x-v_x\theta)^2}{4D_L\theta} - \frac{y^2}{4D_T\theta}\right]\frac{d\theta}{\theta} \qquad \textbf{(2.30)}$$

Steady-state conditions are obtained when time approaches infinity. Therefore equation 2.30 is integrated from 0 to ∞. The result is:

$$C(x,y) = \frac{C_0(Q/b)}{2\pi(D_L D_T)^{1/2}} \exp\left(\frac{v_x x}{2D_L}\right) K_0\left[\left(\frac{v_x^2}{4D_L}\left(\frac{x^2}{D_L} + \frac{y^2}{D_T}\right)\right)^{1/2}\right] \qquad \textbf{(2.30a)}$$

where

K_0 = the modified Bessell function of the second kind and zero order (values are tabulated in Appendix B)

Q = the rate that the contaminant is injected

b = the thickness of the aquifer over which the contaminant is injected

Equation 2.30a can be solved in EXCEL after installing the Plume2DSS() add-in (Renshaw 2015b).

EXAMPLE PROBLEM

A waste liquid containing fluoride at a concentration of 133 mg/L was pumped into a shallow disposal pit located above a thin, 1.75 m thick, (two-dimensional) aquifer at a rate of 3.66 m^3/day for many years. The average linear velocity of the groundwater was 0.187 m/day. Assume that the transverse dispersion is 10% of the longitudinal dispersion. If the disposal pit is assumed to be at a location of $x_0 = 0$ and $y_0 = 0$, what would the concentration of fluoride be in a monitoring well located at $x = 123$ m and $y = 16$ m? Assume that the fluoride is non-reactive and non-adsorbed by the aquifer.

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1. First the value of α_L must be calculated using equation 2.48.

   $\alpha = 0.83(\log(L))^{2.414}$

   L is equal to $x - x_0$ or 123 m.

   $\alpha_L = 0.83(\log(123))^{2.414}$

   $\alpha_L = 4.919$ m

2. Next the value of D_L and D_T must be found.

   $D_L = v_x \alpha_L$

   $D_L = 0.187 \text{ m/da} \times 4.919 \text{ m} = 0.920 \text{ m}^2/\text{da}$

   $D_T = 0.10\ D_L$

   $D_T = 0.092 \text{ m}^2/\text{da}$

   The variables are then inserted into equation 2.30a.

   $C_0 = 133$ mg/L

   $Q = 3.66 \text{ m}^3/\text{da}$

   $b = 1.75$ m

$$C = \frac{C_0(Q/b)}{2\pi(D_L D_T)^{1/2}} \exp\left(\frac{v_x x}{2D_L}\right) K_0\left[\left(\frac{v_x^2}{4D_L}\left(\frac{x^2}{D_L} - \frac{y^2}{D_T}\right)\right)^{1/2}\right]$$

$$C = \frac{133\text{mg/L} \times (3.66\text{m}^3/\text{da}/1.75\text{m})}{2 \times \pi \times (0.92\text{m}^2/\text{da} \times 0.092\text{m}^2/\text{da})^{1/2}} \times \exp\left(\frac{0.187\text{m/da} \times 123\text{m}}{2 \times 0.92\text{m}^2/\text{da}}\right)$$

$$K_0\left[\left(\frac{0.187^2\text{m}^2/\text{da}^2}{4 \times 0.92\text{m}^2/\text{da}}\left(\frac{123^2\text{m}^2}{0.92\text{m}^2/\text{da}} + \frac{16^2\text{m}^2}{0.092\text{m}^2/\text{da}}\right)\right)^{1/2}\right]$$

$$C = \frac{278.0\text{mg/L}}{1.828} \exp\left(\frac{23.0}{1.84}\right) K_0\left[[0.0095 \times (16445 + 2783)]^{1/2}\right]$$

$$C = 152.1 \exp(12.5) K_0(13.52)\text{mg/L}$$

$$C = 152.1 \times 268337 \times 4.544 \times 10^{-7}\text{mg/L}$$

Note: Although K_0, a modified Bessell function of the zero order and second kind, can be obtained from Appendix B for a limited range of values, the table did not contain K_0 of 13.52. The value listed above, 4.54×10^{-7} was generated by a EXCEL function BESSELK(x,n).

According to Equation 2.30, as the value of D_L approaches zero, the concentration will approach infinity. As this is a physical impossibility, if the value of D_L is very small, then the one-dimensional equation, 2.23, should be used with a large value for time.

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Equation 2.30 can also be solved for a specific value of time, so that the spread of a two-dimensional plume with time can be determined. In order to solve for time, Equation 2.30 can be written thusly:

$$C(x,y,t)=\frac{C_0(Q/b)}{4\pi(D_L D_T)^{1/2}}\exp\left(\frac{v_x x}{2D_L}\right)\int_{\theta=0}^{\theta=t}\exp\left[-\frac{\theta}{4D_L}-\left(\frac{x^2}{4D_L}+\frac{y^2}{4D_T}\right)\frac{1}{\theta}\right]\frac{d\theta}{\theta}$$

If we set $t_D = v_x^2/4\,D_L$, then the above becomes:

$$C(x,y,t)=\frac{C_0(Q/b)}{4\pi(D_L D_T)^{1/2}}\exp\left(\frac{v_x x}{2D_L}\right)\int_{t_{D=0}}^{t_{D=t}}\exp\left[-t_D-\frac{B^2}{4t_D}\right]\frac{dt_D}{t_D}$$

with

$$B^2=\frac{v_x{}^2x^2}{4D_L{}^2}+\frac{v_x{}^2y^2}{4D_L D_T}$$

The integral in the above equation was solved by Hantush (1956). This solution is

$$C(x,y,t)=\frac{C_0(Q/b)}{4\pi(D_L D_T)^{1/2}}\exp\left(\frac{v_x x}{2D_L}\right)\left[W(0,B)-W(t_D,B)\right] \qquad \textbf{(2.31)}$$

with t_D and B as defined above.

It should be noted that in effect t_D is a dimensionless form of time. The values of $W[t_D, B]$ can be found in Hantush (1956) and a limited series is tabulated in Appendix C. It can also be determined in EXCEL after installing the Leaky() add-in (Renshaw 2015c). In well hydraulics this is known as the leaky well function, $W[u, r/b]$.

EXAMPLE PROBLEM

An underground tank which formerly held benzene but now holds water is leaking at a rate of 1.93m³/year. However, the water still contains some benzene at a concentration of 12,950 µg/L. The groundwater which flows beneath the leaking tank goes directly north. A drinking water supply well is located at a spot that can be located by going 123.5m due north of the leaking tank and then 7.2m due east. Assume that the average linear velocity of the groundwater is 0.235 m/day and the longitudinal dispersivity is 12m and the lateral dispersivity is 1.2m and the aquifer thickness is 1.00m. What would the benzene concentration be after 2.00 years?

This is an example of a continuous leakage into a two dimensional flow field; equation 2-31.

1. The values of D_L and D_T must be calculated from equations 2-11a and 2-11b. We will ignore the effective diffusion coefficient as it is so much smaller than dispersivity.

$$D_L = \alpha_L v_X = 12\text{ m} \times 0.235\text{ m/day} = 2.82\text{ m}^2\text{/day}$$

$$D_T = \alpha_T v_X = 1.2\text{ m} \times 0.235\text{ m/day} = 0.282\text{ m}^2\text{/day}$$

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2. The value of B must be calculated.

$$B = \left[\frac{(v_x x)^2}{4D_L{}^2} + \frac{(v_x y)^2}{4D_L D_T}\right]^{\frac{1}{2}}$$

$$B = \left[\frac{(0.235\text{m/da} \times 123.5\text{m})^2}{4 \times (2.8\text{m}^2/\text{da})^2} + \frac{(0.235/\text{da} \times 7.2\text{m})^2}{4 \times 2.8\text{m}^2/\text{da} \times 0.28\text{m}^2/\text{da}}\right]^{\frac{1}{2}}$$

$$B = \left[\frac{842\text{m}^4/\text{da}^2}{31.4\text{m}^4/\text{da}^2} + \frac{2.86\text{m}^4/\text{da}^2}{3.14\text{m}^4/\text{da}^2}\right]^{\frac{1}{2}}$$

$$B = \sqrt{26.8 + 0.91}$$

$$B = 5.26$$

3. The next step is to find t_D. Convert time in years to time in days by multiplying by 365 days per year.

$$t_D = \frac{v_x{}^2 t}{4D_L}$$

$$t_D = \frac{(0.235\text{m/da})^2 \times 730\text{da}}{4 \times 2.82\text{m}^2/\text{da}}$$

$$t_D = 3.57$$

4. One must now find W[0, B] and W[t_D, B] from Appendix C.

W[0, B] = W[0, 5.26] = 0.0098

W[t_D, B] = W[3.57, 5.26] = 0.0019

5. The values are then substituted into Equation 2.31. The rate of leakage, Q, is converted into cubic meters per day by dividing by 365. The aquifer thickness is 1.00m.

$Q = 1.93\ \text{m}^3/\text{year}/365\ \text{da/year} = 0.0053\ \text{m}^3/\text{da}$

$$C(x,y,t) = \frac{C_0 Q/b}{4\pi(D_L D_T)^{1/2}} \exp\left(\frac{v_x x}{2D_L}\right)\left[W(0,B) - W(t_D,B)\right]$$

$$C(x,y,t) = \frac{12{,}950\,\mu\text{g/L} \times 0.0053\text{m}^3/\text{da}/1\text{m}}{4\pi(2.82\text{m}^2/\text{da} \times 0.28\text{m}^2/\text{da})^{1/2}} \exp\left(\frac{0.236\text{m/da} \times 123.5\text{m}}{2 \times 2.82\text{m}^2/\text{da}}\right)[0.0098 - 0.0019]$$

$$C(x,y,t) = 0.0061\ \exp(5.16)[0.0079]\,\mu\text{g/L}$$

$$C(x,y,t) = 0.0061 \times 174 \times 0.0079\,\mu\text{g/L}$$

$$C(x,y,t) = 0.0084\,\mu\text{g/L}$$

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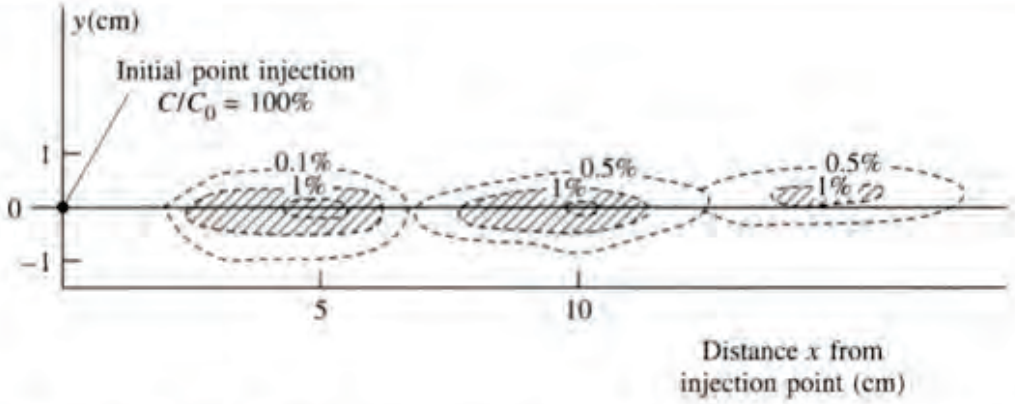
2.9.8 Slug Injection into a Uniform Two-Dimensional Flow Field

If a slug of contamination is injected over the full thickness of a two-dimensional uniform flow field in a short period of time, it will move in the direction of flow and spread with time. This result is illustrated by Figure 2.18 and represents the pattern of contamination at three increments that result from a one-time spill. Figure 2.18 is based on the results of a laboratory experiment conducted by Bear (1961). Figure 2.19 shows the spread of a plume of chloride that was injected into an aquifer as a part of a large-scale field test (Mackay et al. 1986). The plume that resulted from the field test is more complex than the laboratory plume due to the heterogeneities encountered in the real world and the fact the plume may not be following the diffusional model of dispersion.

FIGURE 2.18 Injection of a slug of a tracer into a two-dimensional flow field shown at three time increments.



Experimental results from J. Bear. 1961. *Journal of Geophysical Research* 66:2455–2467. Copyright by the American Geophysical Union. Reproduced with permission.

De Josselin and De Jong (1958) derived a solution to this problem on the basis of a statistical treatment of lateral and transverse dispersivities. Bear (1961) later verified it experimentally. If a tracer with concentration C_0 is injected into a two-dimensional flow field over an area A at a point (x_0, y_0), the concentration at a point (x, y), at time t after the injection is

$$C(x,y,t) = \frac{C_0 A}{4\pi t (D_L D_T)^{1/2}} \exp\left[-\frac{((x-x_0)-v_x t)^2}{4D_L t} - \frac{(y-y_0)^2}{4D_T t} \right] \quad (2.32)$$

EXAMPLE PROBLEM

A tank truck, which is carrying water containing 1275 mg/L of dissolved benzene overturns and spills a volume of water sufficient to saturate a thin aquifer over an area of 5 m^2. The aquifer contains groundwater flowing with an average linear velocity of 0.45 m/day. Assume that the values of D_L and of D_T are 2.1 m^2/day and 0.21 m^2/day respectively.

There is a nearby private well at a seasonal cottage. If the center of the spill is at location $x_0 = 0$ and $y_0 = 0$, then the location of the well is $x = 72$ m and $y = 5.5$ m. The owners of the private well are away for the season and will not return for another 200 days.

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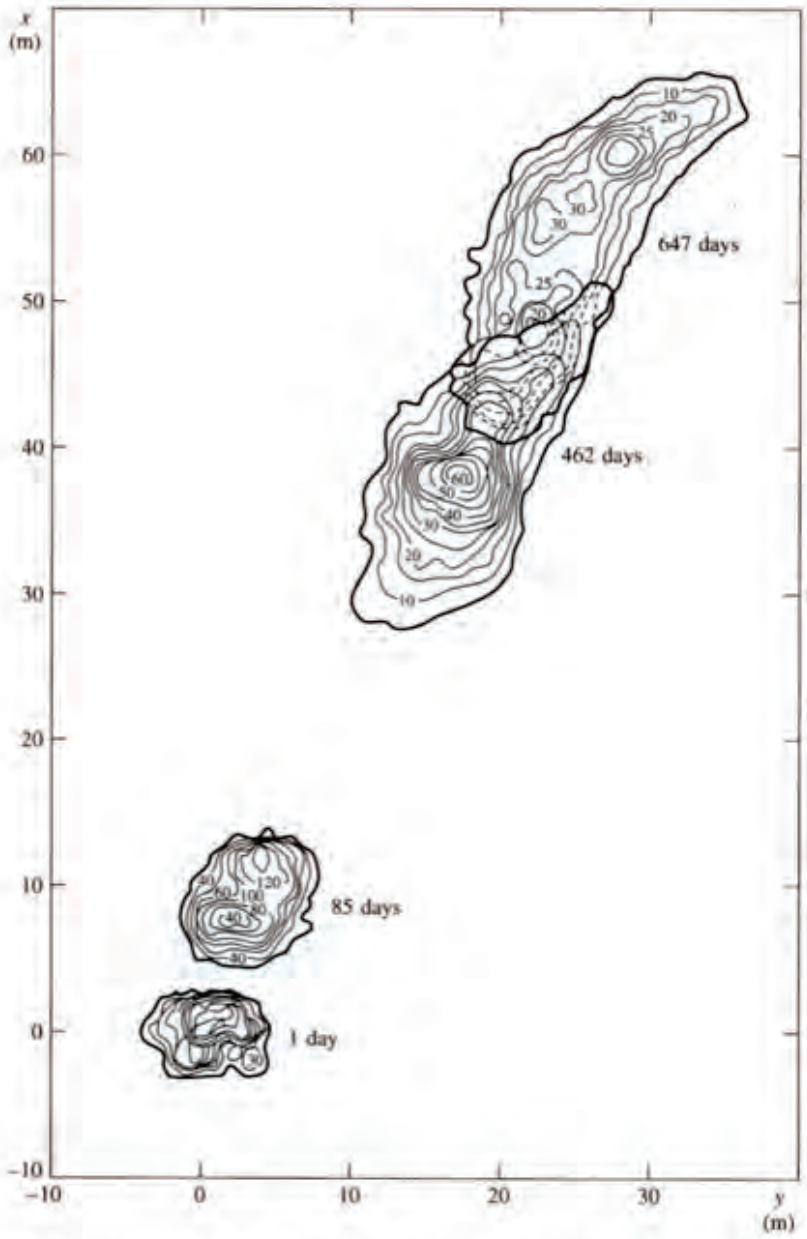
If there is no degradation or retardation of the benzene as it moves through the aquifer, what will the concentration of benzene be in the private well when the owner returns.

The correct equation to use is 2.32 for a slug injection of contamination into a two dimensional aquifer.

FIGURE 2.19 Vertically averaged chloride concentration at 1 day, 85 days, 462 days, and 647 days after the injection of a slug into a shallow aquifer.



Source: D. M. Mackay et al. 1986. *Water Resources Research* 22:2017–2029. Copyright by the American Geophysical Union. Reproduced with permission.

$$C = \frac{C_0 A}{4\pi t\sqrt{D_L D_T}} \exp\left[-\frac{((x-x_0)-v_x t)^2}{4D_L t} - \frac{(y-y_0)^2}{4D_T t}\right]$$

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$$C = \frac{1275\text{mgL}^{-1} \times 5\text{m}^2}{4 \times \pi \times 200\text{da} \times \sqrt{2.1\text{m}^2\text{da}^{-1} \times 0.21\text{m}^2\text{da}^{-1}}} \times$$

$$\exp\left[-\frac{((72\text{m} - 0) - (0.45\text{mda}^{-1} \times 200\text{da}))^2}{4 \times 2.1\text{md}^{-1} \times 200\text{da}} - \frac{(5.5\text{m})^2}{4 \times 0.21\text{m}^2\text{da}^{-1} \times 200\text{da}} \right]$$

$$C = \frac{6375\text{mgL}^{-1} \times \text{m}^2}{4 \times \pi \times 200\text{da} \times 0.664\text{m}^2\text{da}^{-1}} \exp[-\frac{(72 - 90)^2\text{m}^2}{1680\text{m}^2} - \frac{30.25\text{m}^2}{168\text{m}^2}]$$

$$C = 3.82\text{mgL}^{-1} \exp[-0.192 - 0.180]$$

$$C = 3.82\exp(-0.372) = 3.82 \times 0.6892 = 2.63\text{mgL}^{-1}$$

The maximum concentration of a contaminant from a slug injection is found in the center of the plume, or the *center of mass*. If the flow is in the direction of the x axis, and the spill was at location $x_0 = 0$ and $y_0 = 0$, the center of mass of a conservative substance at any time t since the spill will be at a location where $x = v_x t$ and $y = 0$. If we substitute these values into equation 2–32, we obtain:

$$C_{max} = \frac{C_0 A}{4t\pi\sqrt{D_T D_L}} \exp\left[-\frac{((v_x t - 0) - v_x t))^2}{4D_L t} - \frac{(0 - 0)^2}{4D_T t} \right]$$

$$C_{max} = \frac{C_0 A}{4t\pi\sqrt{D_T D_L}} \exp(0)$$

$$C_{max} = \frac{C_0 A}{4t\pi\sqrt{D_T D_L}} \qquad \textbf{(2.32a)}$$

The distribution of contamination in the plume will follow a normal or Gaussian distribution. From equations 2-12a and 2-12b the standard deviation of the distribution is given by:

$$\sigma_x = \sqrt{2D_L t} \qquad \sigma_y = \sqrt{2D_T t}$$

By definition, 99.7% of the mass of contamination will be contained within an area represented by three standard deviations away from the center of mass of the plume. Thus the plume can be defined by the location of the center of mass, $3\sigma_x$ and $3\sigma_y$.

EXAMPLE PROBLEM

A truck carrying dilute brine with 2130 mg/L chloride from the cleanup of a pond containing waste from a producing oil well overturns and spills the dilute brine over an area of 455 square feet. The underlying thin aquifer has an average linear groundwater velocity of 1.23 ft/day. Where would the center of mass of the plume be in

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133 days, what would the maximum concentration be and how far beyond and to the side of the center of mass would the plume spread?

1. The plume would be advected by the flowing groundwater so that the center of mass would be at $x = v_x t$.

$$x = 1.23 \text{ ft/da} \times 133 \text{ da} = 164 \text{ feet.}$$

2. The maximum concentration at the center of mass can be found from equation 2.32a.

$$C_{max} = \frac{C_0 A}{4t\pi\sqrt{D_T D_L}}$$

a. We need to find the values of D_L and D_T. This can be done using equations 2.11a and 2.11b; but, first we need to use equation 2.82 to estimate α_L

$$\alpha_L = 0.83(\log(L))^{2.414}$$
$$= 5.66 \text{ ft}$$
$$D_L = \alpha_L v_x$$
$$= 5.66 \text{ ft} \times 1.23 \text{ ftda}^{-1}$$
$$= 6.96 \text{ ft}^2\text{da}^{-1}$$

We can assume D_T to be 10% of D_L

$$D_T = 0.696 \text{ ft}^2\text{da}^{-1}$$

The appropriate variables are substituted into equation 2.32.

$$C_{max} = \frac{2130 \, mgL^{-1} \times 455 \, ft^2}{4 \times \pi \times 133da\sqrt{6.96 \, ft^2 da^{-1} \times 0.696 \, ft^2 da^{-1}}}$$

$$C_{max} = 263 \, mgL^{-1}$$

3. The size of the plume can be determined from the standard deviations.

$$\sigma_x = \sqrt{2D_L t} \qquad \sigma_y = \sqrt{2D_T t}$$
$$\sigma_x = \sqrt{2 \times 6.96 \text{ ft}^2\text{da}^{-1} \times 133 \text{ da}} \qquad \sigma_y = \sqrt{2 \times 6.96 \text{ ft}^2\text{da}^{-1} \times 133 \text{ da}}$$
$$\sigma_x = 43.0 \text{ ft} \qquad \sigma_y = 13.6 \text{ ft}$$

The leading edge of the plume is $3\sigma_x$ feet ahead of the center of mass or 129 feet and the plume had spread out $3\sigma_y$ feet on either side of the center of the mass or 40.8 feet.

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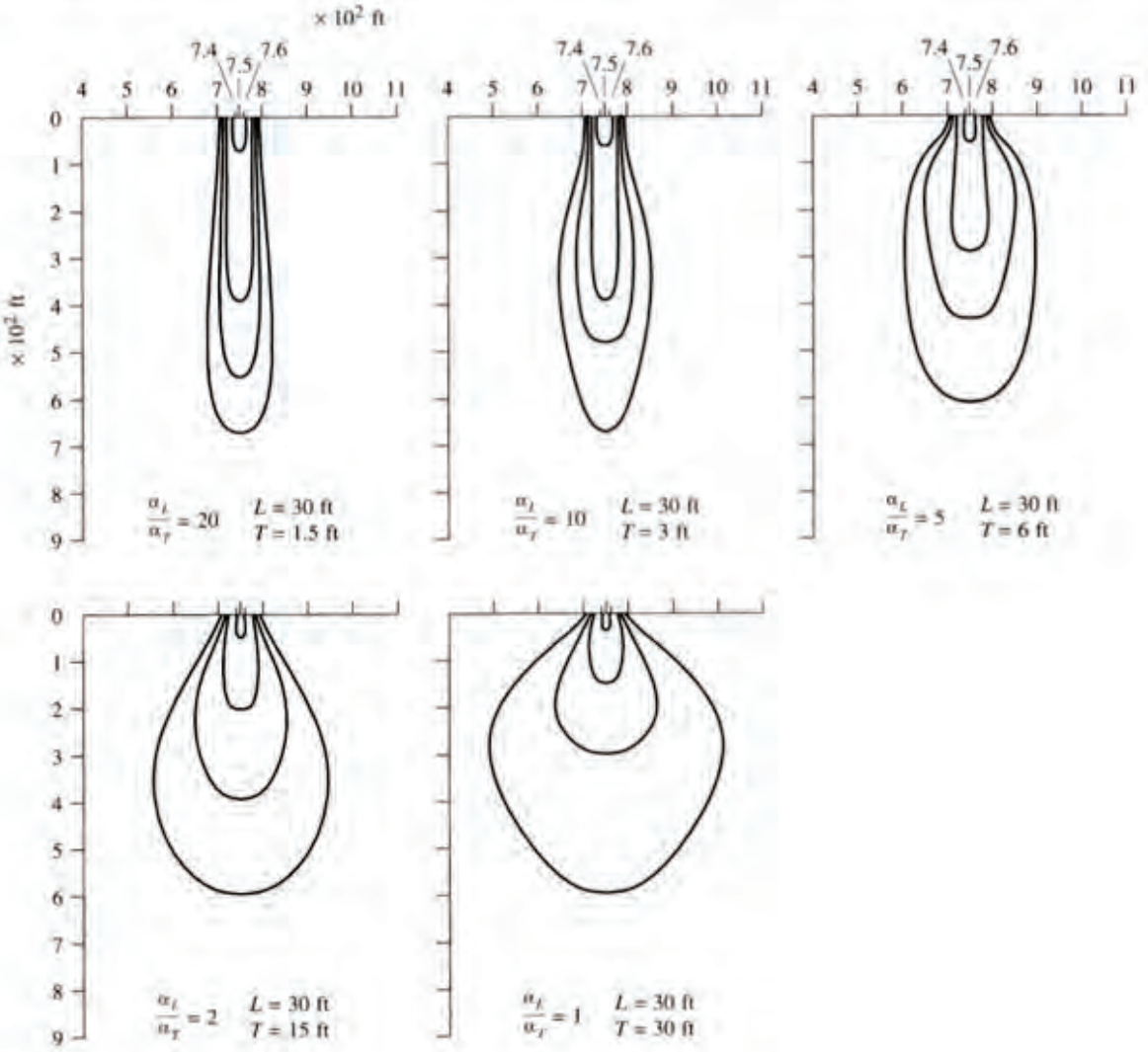
2.10 Effects of Transverse Dispersion

The ratio of longitudinal to transverse dispersivity (α_L/α_T) in an aquifer is an important control over the shape of a contaminant plume in two-dimensional mass transport. The lower the ratio, the broader the shape of the resulting plume will be. Figure 2.20 shows various two-dimensional shapes of a contaminant plume, where the only factor varied was the ratio of longitudinal to transverse dispersivity. This illustrates the fact that it is important to have some knowledge of the transverse dispersivity in addition to the longitudinal dispersivity. There is a paucity of data in the literature on the relationships of longitudinal to transverse dispersivities. From the few field studies available, α_L/α_T is in the range of 6 to 20 (Anderson 1979; Klotz et al. 1980). In addition, dispersivity ratios based on field studies are based on fitting the diffusional model of dispersion to cases where it might not be applicable.

FIGURE 2.20 The effect of changing dispersivity ratio on the spread of a contaminant plume from a continuous source.



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chloride was 48 mgL^{-1} and after 4000 seconds, t_2, it was 252 mgL^{-1}. What is the dispersivity of the sand in the soil column?

The number of pore volumes at a given time can be calculated from Equation 2.33:

$$PV = v_x t / L$$

For the first measurement at t_1:

$$PV = 1.35 \times 10^{-2}\ cms^{-1}\ \ 500\ s/40\ cm = 0.17\ pore\ volumes$$

For the second measurement at t_2:

$$PV = 1.35 \times 10^{-2}\ cms^{-1} \times 4000\ s/40\ cm = 1.35\ pore\ volumes$$

At t_1, C/C_0 is 48/300, which equals 0.16. With a pore volume of 0.17

$$(PV - 1)/PV^{1/2} = (0.17 - 1)/(0.17)^{1/2} = -2.01$$

At t_2, C/C_0 is 252/300, which equals 0.84. With a pore volume of 1.32

$$(PV - 1)/PV^{1/2} = (1.32 - 1)/(1.32)^{1/2} = 0.28$$

Since C/C_0 at t_1 is conveniently equal to 0.16, then $(PV - 1)/PV^{1/2}$ for t_1 turns out to be $J_{0.16}$. Likewise C/C_0 at t_2 is 0.84 so that $(PV - 1)/PV^{1/2}$ for t_2 is $J_{0.84}$.

The value of D_L can be found from Equation 2.35:

$$D_L = \left(\frac{v_x L}{8}\right)(J_{0.84} - J_{0.16})^{1/2}$$

$$D_L = (1/8) \times (1.35 \times 10^{-2}\ cms^{-1} \times 40\ cm) \times (0.28 - -2.01)^{1/2}$$

$$= 6.75 \times 10^{-2} \times 1.51 cm^2 s^{-1}$$

$$= 0.102\ cm^2 s^{-1}$$

2.11.2 Quantifying Dispersivity in the Field

A value for dispersivity can be determined in the field by two means. If there is a contaminated aquifer, the plume of known contamination can be mapped and the advection-dispersion equation solved with dispersivity as the unknown. Pinder (1973) used this approach in a groundwater modeling study of a plume of dissolved chromium in a sand and gravel aquifer on Long Island, New York. He started with initial guesses of α_L and α_T and then varied them during successive model runs until the computer model yielded a reasonable reproduction of the observed contaminant plume. One of the difficulties of this approach is that the concentration and volume of the contaminant source are often not known.

A much more common approach is the use of a tracer that is injected into the ground via a well. There are a variety of variations to this approach. **Natural gradient tests** involve the injection of a tracer into an aquifer, followed by the measurement of the plume that developed under the prevailing water table gradient (e.g., Sudicky and Cherry 1979;

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Gillham et al. 1984; Mackay et al. 1986; LeBlanc et al. 1991; Garabedian et al. 1991; Olsen and Tenbus 2004). The plume is measured by means of small amounts of water withdrawn from down-gradient observation wells and multilevel piezometers. Many of these field tests showed that thin plumes with less than expected transverse dispersivity often occur in field situations. This underlines a growing acceptance of the need for high resolution, vertically discrete, multilevel aquifer monitoring. Multilevel monitoring will be discussed in Chapter 8. One and two-well tests have also been used in which a tracer is pumped into the ground and then groundwater containing the tracer is pumped back out of the ground (e.g., Fried 1975; Grove and Beetem 1971; Sauty 1978; Pickens et al 1981; Pickens and Grisak, 1981). These so-called **forced hydraulic gradient tests** have the advantage that they can be completed in much shorter time relative to natural gradient tests. However, these tests require treatment if the pumped groundwater is contaminated. Also, the results of forced hydraulic gradient tests do not truly reflect the natural groundwater flow conditions. Ptak et al. (2004) reviewed the advantages and disadvantages of natural or forced hydraulic gradient tests for both nonreactive and reactive tracer compounds can be used.

2.11.3 Single-Well Tracer Test

A single-well tracer test involves the injection of water containing a conservative tracer into an aquifer via an injection well and then the subsequent pumping of that well to recover the injected fluid. The fluid velocities of the water being pumped and injected are much greater than the natural groundwater gradients.

Equation 2.20 can be written (Hoopes and Harleman 1967) as

$$\frac{\partial C}{\partial t} + u\frac{\partial C}{\partial r} = \alpha_L u\frac{\partial^2 C}{\partial r^2} + \frac{D^*}{r}\frac{\partial}{\partial r}\left(r\frac{\partial C}{\partial r}\right) \tag{2.37}$$

Gelhar and Collins (1971) derived a solution to Equation 2.37 for the withdrawal phase of an injection-withdrawal well test in which the diffusion term is neglected because it is very much smaller than the dispersion term. The relative concentration of the water being withdrawn from the injection well is

$$\frac{C}{C_0} = \frac{1}{2}\operatorname{erfc}\left(\frac{(U_p - U_i) - 1}{\{\frac{16}{3}(\alpha_L / R_f)[2 - (1 - U_p / U_i)]^{1/2}[1 - (U_p / U_i)]\}^{1/2}}\right) \tag{2.38}$$

where

U_p = cumulative volume of water withdrawn during various times
U_i = total volume of water injected during the injection phase
R_f = average frontal position of the injected water at the end of the injection period, which is defined by

$$R_f = \left(\frac{Qt}{\pi bn}\right)^{1/2} \tag{2.39}$$

where

Q = rate of injection
t = total time of injection

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b = aquifer thickness

n = porosity

EXAMPLE PROBLEM

Pickens and Grisak (1981) performed a single-well injection-withdrawal tracer test into a confined sand aquifer about 8.2 m thick with an average hydraulic conductivity of 1.4×10^{-2} cm/sec and a porosity of 0.38. The sediment tested in the column study described in the dispersivity example problem above came from this aquifer.

The injection well was 5.7 cm in diameter and the full thickness of the aquifer was screened. Clear water was injected at a constant rate for 24 hr prior to the start of the test to establish steady-state conditions. The tracer used during the tests was ^{131}I, a radioactive iodine isotope, which was added to the injected water. All measurements were corrected for the radioactive decay that occurred during the test.

Two tests were performed on the well. The first test, SWI, had an injection rate of 0.886 L/sec and injection continued for 1.25 da. A total volume of 95.6 m^3 of water was injected, and the injection front reached an average radial distance away from the well of 3.13 m. Water was then pumped for 2.0 da at the same rate, so that a total of 153 m^3 of water was withdrawn. The second test, SW2, was longer. Water with the tracer was added at a rate of 0.719 L/sec for 3.93 da. A total of 244 m^3 of water was added, and the average position of the injection front reached to 4.99 m from the well. During the withdrawal phase a total of 886 m^3 of water was pumped over a period of 16.9 da at an average rate of 0.606 L/sec.

The results of the test are shown in Figure 2.22. Relative concentration, C/C_0, is plotted against U_p / U_i. The dots represent field values and the solid lines are curves, which were computed using Equation 2.38. Various curves were computed for different values of α_L, and the curves with the best fit to the field data were plotted on the graphs. In Figure 2.22(a) the calculated curve was based on a longitudinal dispersivity of 3.0 cm, whereas for curve 2.22(b) the best-fit curve was based on a longitudinal dispersivity of 9.0 cm. This test illustrates the scale-dependent nature of dispersion. The second test, in which a larger volume of water was injected, tested a larger volume of the aquifer than the first test and yielded a higher dispersivity value.

■ 2.12 Scale Effect of Dispersion

The two example problems derived from Pickens and Grisak (1981) illustrate what has been called the **scale effect of dispersion** (Fried 1975). At the laboratory scale the mean value of α_L was determined to be 0.035 cm (0.014 in) when the flow length was 30 cm (12 in). With the single-well injection-withdrawal test, α_L was 3 cm (1.2 in) when the solute front traveled 3.1 m (10.2 ft) and 9 cm (3.5 in) when the solute front traveled 5.0 m (16.4 ft). In a two-well recirculating withdrawal-injection tracer test with wells located 8 m (26.2 ft) apart α_L was determined to be 50 cm (19.6 in). All these values were obtained from the same site. The greater the flow length, the larger the value of longitudinal dispersivity needed to fit the data to the advection-dispersion equation.

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spread. In this region the variance of the plume will grow proportionally to the time or mean travel distance, as it does at the laboratory column scale. The advective-dispersion model is based on the assumption that dispersion follows Fick's law. Some authors contend that dispersion follows Fick's law only at the laboratory scale, where it is caused by local mechanical dispersion, and for very long flow paths, where the effects of advection through heterogeneous materials and local transverse dispersion create macroscale dispersion that follows Fick's law (e.g., Gelhar 1986; Dagan 1988). The contention that macroscale dispersion becomes Fickian (i.e., follows Fick's law) at long travel times and distances is somewhat controversial, especially if the flow is through geological formations that are heterogeneous at different scales (Anderson 1990).

2.13 Stochastic Models of Solute Transport

2.13.1 Introduction

The normal manner of determining a field-scale dispersion coefficient is to look for a natural tracer or inject a tracer into an aquifer and observe the resulting development of a plume. A solute-transport model is then constructed and the computed solute distribution is fitted to the observed field data by adjusting the dispersion coefficients. Dispersion coefficients obtained in this manner are fitted curve parameters and do not represent an intrinsic property of the aquifer. This is especially true when the aquifer is assumed to be homogeneous and is described by a single value for hydraulic conductivity and porosity. It is apparent that flow and transport modeling based on a single value for porosity and hydraulic conductivity is a gross simplification of the complexity of nature. For analytical solutions, we are constrained to use of a single value for average linear velocity, and for numerical models we often use a single value because that is all we have.

A **deterministic model** is one where a partial differential equation is solved, either numerically or analytically, for a given set of input values, aquifer parameters, and boundary conditions. The resulting output variable has a specific value at a given place in the aquifer. It is assumed that the distribution of aquifer parameters is known. The equations given earlier in this chapter are examples of deterministic models.

A **stochastic model** is a model in which there is a statistical uncertainty in the value of the output variables, such as solute distribution. The probabilistic nature of this outcome is due to the fact that there is uncertainty in the value and distribution of the underlying aquifer parameters, such as the distribution and value of hydraulic conductivity and porosity (Freeze 1975; Dagan 1988).

A widespread misconception about stochastic and deterministic models is that the latter use physical laws, while the stochastic models are largely empirical and based entirely on statistical data-analysis. In reality, any physically-based model becomes a stochastic model once its inputs, parameters, or outputs are treated as random (Bierkens and van Geer; 2014).

The idea behind stochastic modeling is very attractive. It is obvious that it takes a great effort to determine hydraulic conductivity and porosity at more than a few locations in an aquifer system. If we could determine the distribution of aquifer properties with a high degree of detail, then a numerical solution of a deterministic model would yield results with a high degree of reliability. However, with limited knowledge of aquifer

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parameters, a deterministic model makes only a prediction of the value of an output variable at a given point and time in the aquifer. The stochastic model is based on a probabilistic distribution of aquifer parameters. At the outset it is recognized in the stochastic model that the result will be only some range of possible outcomes. The stochastic model thus recognizes the probabilistic nature of the answer, whereas the deterministic model suggests that there is only one "correct" answer. Of course, the experienced hydrogeologist recognizes the uncertainty even in the deterministic answer. There have been literally hundreds of papers written on various aspects of stochastic modeling of groundwater flow and solute transport. Textbooks like Zhang (2001), Rubin (2003), and Dagan and Neuman (2005) provide insights into analyzing and modeling subsurface heterogeneity using stochastics concepts and models for managing water resources, preserving subsurface water quality, storing energy and wastes, besides other applications.

2.13.2 Stochastic Descriptions of Heterogeneity

Stochastic hydrology is about combining deterministic model outcomes with a probability distribution of the errors, or alternatively, considering the hydrological variable as random and determining its probability distribution and some "best prediction" (Bierkens and van Geer 2014). The greatest uncertainty in the input parameters of a model is the value of hydraulic conductivity, because it varies over such a wide range for geologic materials. If we make a measurement of hydraulic conductivity at a given location, the only uncertainty in its value at that location is due to errors in measuring its value. However, at all locations where hydraulic conductivity is not measured, additional uncertainty exists. If we make a number of measurements of the value of hydraulic conductivity, we can estimate this uncertainty using certain statistical techniques.

Let us define Y as the log of the hydraulic conductivity, K, and assume that the log value Y is normally distributed. We will assume a one-dimensional series of Y values $\{Y_1, Y_2, Y_3, Y_4, \ldots Y_n\}$ (Freeze et al. 1990). Therefore,

$$Y_i = \log K_i \tag{2.40}$$

The population that consists of all of the values of Y has a mean value, μ_y, and a standard deviation, σ_y. The only way to obtain precise values of μ_y and σ_y would be to sample the aquifer everywhere, clearly an impossible task, but we can find estimates of their values based on the locations where we have actually measured K. If we have a series of Y values $\{Y_1, Y_2, Y_3, \ldots Y_n\}$, as in Figure 2.27(a), based on measured value of K, then our estimate of the population mean is obtained from the mean value of the sampled values, Y, which can be found from

$$\overline{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i \tag{2.41}$$

The estimate of the variance of the population is also obtained by the variance of the sampled values, S_y^2, which is found from the following equation:

$$S_Y{}^2 = \frac{1}{n}\sum_{i=1}^{n} (Y_i - \overline{Y})(Y_i - \overline{Y}) \tag{2.42}$$

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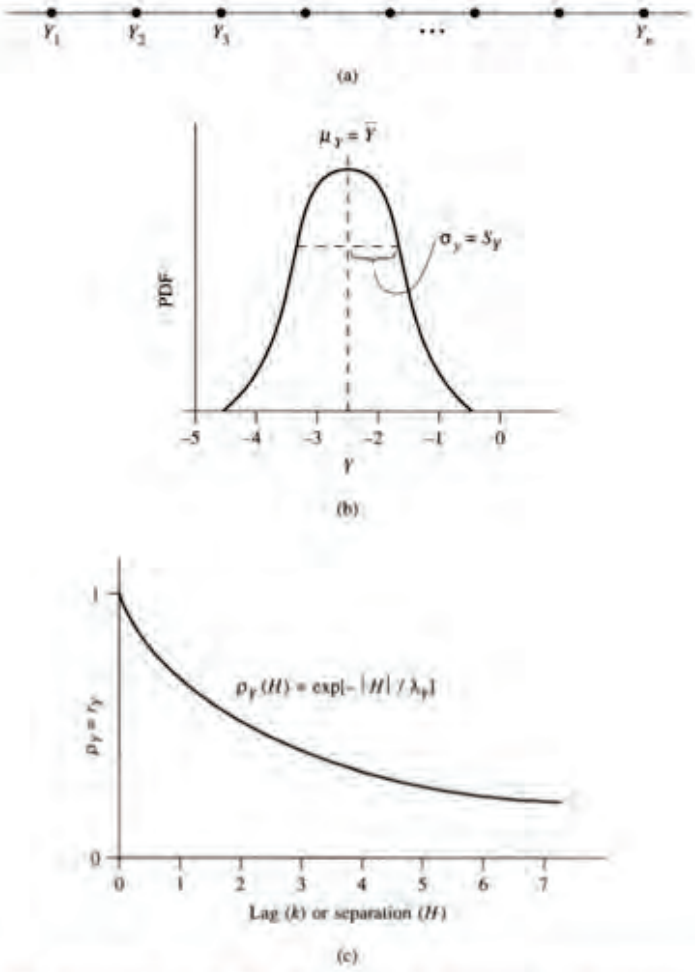
For a normally distributed population, the probabilistic value is called a probability density function (PDF) and is described by the mean and the variance. The variance is a measure of the degree of heterogeneity of the aquifer. The greater the value, the more heterogeneous the aquifer. The PDF can be represented as a bell-shaped curve with the peak equal to the mean, as in Figure 2.27(b), and the spread of the bell can be defined by either the variance or the standard deviation, S_Y, which is the square root of the variance.

If we have measured the value of Y_i at a number of locations and wish to estimate the value Y_j at some other location j that is not close to any of the measured values, how can we estimate the value of Y_j? One approach is to say that the most likely estimate of Y_j is the mean of the measured values of Y_i, and the uncertainty in this value is normally distributed with a standard deviation equal to the standard deviation of the measured values, S_Y. In doing so we have accepted the **ergodic hypothesis**. This means that there is a 16% chance that the value of Y_j is greater than $\overline{Y} - S_Y$, a 50% chance that it is greater than Y, and an 84% chance that it is greater than $\overline{Y} - S_Y$. In broad terms ergodicity describes a dynamic system which has the same behavior averaged over time as averaged over space.

FIGURE 2.27(a) One-dimensional sequence of log hydraulic conductivity values, Y; (b) probability distribution function for Y; (c) autocorrelation function for Y.



Source: R. A. Freeze et al. 1990. *Ground Water* 28:738–766. Used with permission. Copyright Ground Water Publishing Co.

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Hydraulic conductivity values measured at locations close to each other are likely to be somewhat similar. The farther apart the measurements, the less likely that the values will be similar. This is due to the fact that as distances become greater, the chance that there will be a change in geologic formation increases. The function that describes this is the **autocorrelation function**, ρ_Y. The value of the autocorrelation function decreases with the distance between two measurements. An estimate of the autocorrelation function, r_Y, can be obtained from the measured sample values by the following equation:

$$r_Y(k) = \frac{1}{S_Y{}^2}\frac{1}{n}\sum_{i=1}^{n}(Y_i - \bar{Y})(Y_{i-k} - \bar{Y}) \tag{2.43}$$

with k, the **lag**, being a whole number representing a position in the sequence away from the i position. Figure 2.27(c) shows an autocorrelation function plotted against the lag. If the lag is zero, then Equation 2.43 reduces to $r_Y = S_Y{}^2 / S_Y{}^2 = 1$. This means that a Y value is perfectly correlated with itself.

The autocorrelation factor can be expressed in terms of either lag, ρ_{Yk} or distance, $\rho_Y(H)$. When a measurement of Y_i is made at position X_i and a measurement of Y_{i-k} is made at position X_{i-k}, the absolute value of $X_i - X_{i-k}$ is called the **separation**, H.

If the autocorrelation function has an exponential form, then it can be expressed as

$$\rho_Y(H) = \exp[-|H| / \lambda_Y] \tag{2.44}$$

where λ_Y, the **correlation length**, is representative of the length over which Y is correlated. It is the distance over which $\rho_Y(H)$ decays to a value of e^{-1}. The **integral scale**, ε_Y, is the area under the curve.

$$\varepsilon_Y = \int_0^\infty \rho_Y(H)\,dH \tag{2.45}$$

Integration of Equation 2.45 will show that $\varepsilon_Y = \lambda_Y$, so that the correlation structure can be described by either the correlation length or the integral scale.

The **autocovariance**, τ_{Yk} or $\tau_Y(H)$, is equal to the autocorrelation times the variance.

$$\tau_Y(H) = \sigma_Y{}^2 \rho_Y(H) \tag{2.46}$$

We can describe the distribution of heterogeneity of Y by the use of three stochastic functions, μ_Y, σ_Y (or $\sigma_Y{}^2$), and λ_Y. If a stochastic process is said to be stationary, the values of μ_Y, σ_Y (or $\sigma_Y{}^2$), and λ_Y do not vary in space in the region being studied. If the hydraulic conductivity of an aquifer can be described as a stationary stochastic process, the aquifer is uniformly heterogeneous.

2.13.3 Stochastic Approach to Solute Transport

If we accept the idea that we don't know the value of the hydraulic conductivity and the porosity everywhere, then we must accept the idea that it is not possible to predict the actual concentration of a solute that has undergone transport through an aquifer. The best estimate of the concentration is the **ensemble mean concentration**, $\langle C \rangle$, or the mean of all the means of an ensemble of all possible random but equivalent populations, and the associated variance. The movement of a solute body may be described by

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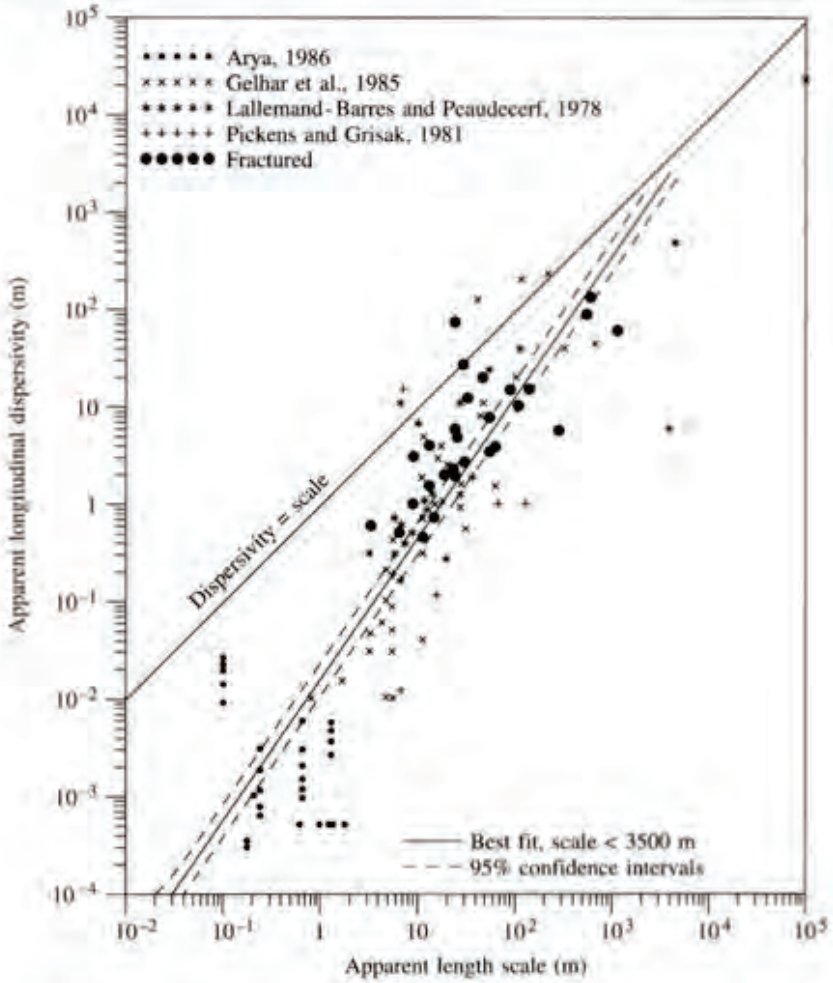
FIGURE 2.28 Apparent longitudinal dispersivity from field and laboratory studies as a function of the scale of the study. Results from the calibration of numerical models are not included.



Source: S. Neuman. 1990. *Water Resources Research* 26:1749–1758. Copyright by the American Geophysical Union. Used with permission.

the motion of the center of mass of the body and the second-order spatial moment, or the moment of inertia (Dagan 1988). Hence, from the variance of the log transformed hydraulic conductivity distribution and the correlation length, a simple stochastic model allows predicting an asymptotic macrodispersivity value. However, it is important to note that the process of advective transport dominates macrodispersion. This means that whether one uses a deterministic model or a stochastic model, the large picture of solute transport will emerge, since both account primarily for advective transport, with the dispersion factor tending to smear the leading edge of the plume.

2.14 Regression Analysis of Relationship between Apparent Longitudinal Dispersivity and Field Scale

Neuman (1990) plotted the apparent longitudinal dispersivity as measured in field and lab studies, α_{ap}, as a function of the travel distance, L_s, or apparent length scale

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(Figure 2.28). Dispersivities that are measured in the field were considered apparent dispersivities because they were obtained by calculations that depend upon the theory that the observer was using. Also, Neuman (1990) excluded for theoretical reasons all data with an apparent length scale greater than 3500 m (approximately 11,500 ft). Regression analysis showed that although the data are widely scattered, a best-fit line with narrow 95% confidence bands could be obtained. The equation for the line is

$$\alpha_m = 0.0175 L_s^{1.46} \tag{2.47}$$

This line of best fit has a regression coefficient, r^2, of 0.74, which means that it accounts for 74% of the variation about the mean. The other 26% may be due to experimental and interpretive errors or may represent deviation of the real system from that described by Equation 2.47. The 95% confidence intervals about the coefficient of 0.0175 are 0.0113and 0.0272 and the 95% confidence intervals about the exponent of 1.46 are 1.30 and 1.61.

Equation 2.47 obtained by Neuman (1990) was based on data that he considered to be highly reliable. In doing so he discarded data that were less reliable, such as that obtained by the calibration of numerical models. Neuman recognized that as the flow path grew longer, the same equation relating apparent longitudinal dispersivity to field scale could not be used, so that he used two linear equations, one for flow distances less than 100m (328 ft) and one for flow distances greater than 100m (328 ft) (Equation 2.47). However, a discontinuity occurs in his method at 100m (328 ft); i.e., the two equations give different answers. Neuman and Di Federico (2003) demonstrated experimentally and theoretically that the scaling behavior of hydrogeologic variables is impacted strongly by their scale of spatial resolution.

Xu and Eckstein (1995) have overcome these problems by assigning different degrees of reliability to data: low, medium and high. They were then able to obtain a nonlinear relationship based on a regression analysis using all available data. The resulting equation had a correlation coefficient of 0.72, which is similar to that obtained by Neuman (1990) using only highly reliable data. Neuman (1990) also did not consider any data with a flow field longer than 3500m (~11,500 ft) because he did not consider it to be reliable, while Xu and Eckstein (1995) included these data.

The equation of Xu and Eckstein is:

$$\alpha_m = 0.83(\log L_s)^{2.414} \tag{2.48}$$

If one examines Figure 2.24, which includes data of low reliability, it appears that as the field scale increases, the rate of change of dispersion decreases. Being nonlinear as plotted on log-log paper, Equation 2.48 also has a decreasing rate of change of dispersion with increasing field scale. At a field scale of greater than a few thousand meters there is very little change in apparent dispersion with distance.

By analyzing jointly dispersivity values derived from models having variable scales of spatial resolution, Schulze-Makuch (2005) proposed a power law relationship that empirically best described the dispersivity data in regard to scale of measurement:

$$\alpha_L = cL^m$$

where c is a parameter characteristic for a geological medium, m is a scaling exponent, and L is the flow distance. The scaling exponent for consolidated and unconsolidated

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geological media varied between 0.40 and 0.92, and 0.44 and 0.94, respectively. For example, an unconsolidated sandy aquifer: $c = 0.20$ and $m = 0.44$. For a distance of 100 m (328 ft), the longitudinal dispersivity value is $\alpha L = 1.6$ m. Similar equations exist for other types of aquifers. No upper bound on the relationships was apparent for a flow distance up to ~10,000 m (~6 miles) for all media except for granites where this relation currently can only be extended to a flow distance of 100 m (328 ft). However, the relationship proposed by Schulze-Makuch (2005) was criticized by Neuman (2006) for neglecting the spatial resolution scales of the models from which the dispersion data had been derived. A theoretical interpretation of the scaling behavior has been summarized in a nonmathematical way in the review paper of Neuman and Di Federico (2003).

2.15 Deterministic Models of Solute Transport

Although workers in stochastic theory have asserted that the theoretical basis for the deterministic advective-dispersive solute transport equation is suspect except for long times and large distances (Anderson 1984), it has been used with a great deal of success in many field and model applications. Today, mathematical transport and fate modeling of contaminants in groundwater and soils has become an important tool for the interpretation of contaminated sites, the development of remedial strategies, and the human health risk assessment process.

Over the past decades, many papers and textbooks have been written about deterministic models for contaminant transport modeling (e.g., Anderson and Woessner 1991; Zheng and Bennet 2002). In general, a deterministic mathematical model simulates groundwater flow and/or solute fate and transport indirectly by means of a set of governing equations, such as Darcy's law and law of mass conservation, thought to represent the physical processes that occur in the system (Anderson and Woessner 1991). The first step in the modeling process is to develop a conceptual model that is simpler than reality. Simplification can be achieved, for example, by combining strata with similar hydrogeologic properties into a single layer or aquifer. The next step requires translating the conceptual model into a mathematical model, which can then be solved in a computer simulation. A numerical mathematical model solves the underlying governing partial differential equations (PDEs) within a set of suitable boundary conditions, and if the transport problem is of transient nature, initial conditions. This step usually requires that additional simplifying assumptions have to be made to reduce the complexity of the mathematical model. For example, a coarser grid can be defined in parts of the flow domain where less accuracy is required, or fixed value boundaries (e.g., no-flux or constant head boundaries) can be defined, or the length of the simulation time steps can be manipulated to reduce the number of computations. These adjustments make the model amenable to either exact or numerical solution, but the modeler must weigh the risk of oversimplifying the flow domain against the problem of no longer reproducing the system adequately. A parsimonious model therefore is a model that accomplishes a desired level of explanation or prediction with the fewest predictor variables possible.

The flow and transport equations underlying the model are solved at discrete points within the flow domain. The two classical choices for the numerical solution of PDEs are the finite difference method (FDM) and the finite element method (FEM).

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Other methods exists, such as the finite volume method (FVM) or the analytic element method (AEM), but models build around these numerical solution schemes are currently not used widely. A detailed discussion of numerical methods is beyond the scope of this textbook and the reader is referred to Peiro and Sherwin (2005).

The current standard FDM program is MODFLOW, which was developed by the U.S. Geological Survey (USGS) for three-dimensional flow modeling (McDonald and Harbaugh 1988). Over the years, many modules have been added to the MODFLOW program, including modules to simulate coupled groundwater/surface-water systems, solute transport, variable-density flow (including saltwater), aquifer-system compaction and land subsidence, parameter estimation, and groundwater management (USGS 2014). MODFLOW can be used in conjunction with MT3DMS, which is a 3D multi-species transport model (Zheng et al. 2010). MT3DMS solves the advection-dispersion-reaction equation based on the methods of characteristics, MOC (Konikow et al. 1994). The FDM model domain is subdivided or discretized into a grid of rectangular blocks or cells within which the physical properties of the domain are assumed to be homogeneous. The block structure of the FDM models often make them difficult to adopt to more complex modeling domains. Under those circumstances, FEM models provide greater flexibility in design because the modeling domain is discretized by triangular elements. Common FDM programs include SUTRA, a variable-density, variably-saturated flow, solute or energy transport model by the U.S. Geological Survey (2015a) or FEFLOW, a commercial modelling environment for subsurface flow, solute and heat transport processes. Another versatile commercial FVM model is HYDRUS 2D/3D, which also offers unsaturated flow modeling capabilities (Simunek et al. 1999; Simunek et al. 2006) and modeling of agricultural pollutants especially those from nonpoint source pollution stemming from plant and animal production (Simunek et al. 2013). There are many more noteworthy models available and many are in public domain. The U.S. Geological Survey maintains a website from which public domain software packages for the simulation of groundwater flow and transport can be downloaded (USGS 2015b).

A model study by Davis (1986) demonstrates that deterministic models can be developed that incorporate heterogeneities. He modeled two aquifers with identical boundary conditions (Figure 2.29). One was uniform (Figure 2.30(a)) and one had variable transmissivity in the form of more permeable channels (Figure 2.30b). The deterministic model, based on the two-dimensional solute-transport equation, was used with small values of α_L and a α_T, 0.0003 m (0.01 in), and 0.00009 m (0.003 in), respectively. The resulting solute plume in the uniform media is very long and narrow. See Figure 2.31(b). If larger values of α_L and α_T are used—3 m (10 ft) and 1 m (3 ft), respectively—then a much broader plume results. See Figure 2.31(a). However, if the heterogeneous aquifer is used with the small values of dispersivity, the resulting plume, shown in Figure 2.31(c) has a size very similar to that created in the uniform media by using large values of dispersivity. This demonstrates that if deterministic models include the aquifer heterogeneities, then it may be possible to use dispersivity values that are more on the order of lab-scale values. Davis (1986) used the advective-dispersion equation in a model with varying transmissivities and with a value of α_L of only 0.01 m (0.4 in) was able to reproduce a solute plume that extended over a flow length of about 500 m (1,640 ft). He found that a fine mesh for the finite-difference model grid was necessary for accurate results. Figure 2.32 compares the results of his model results with the field data.

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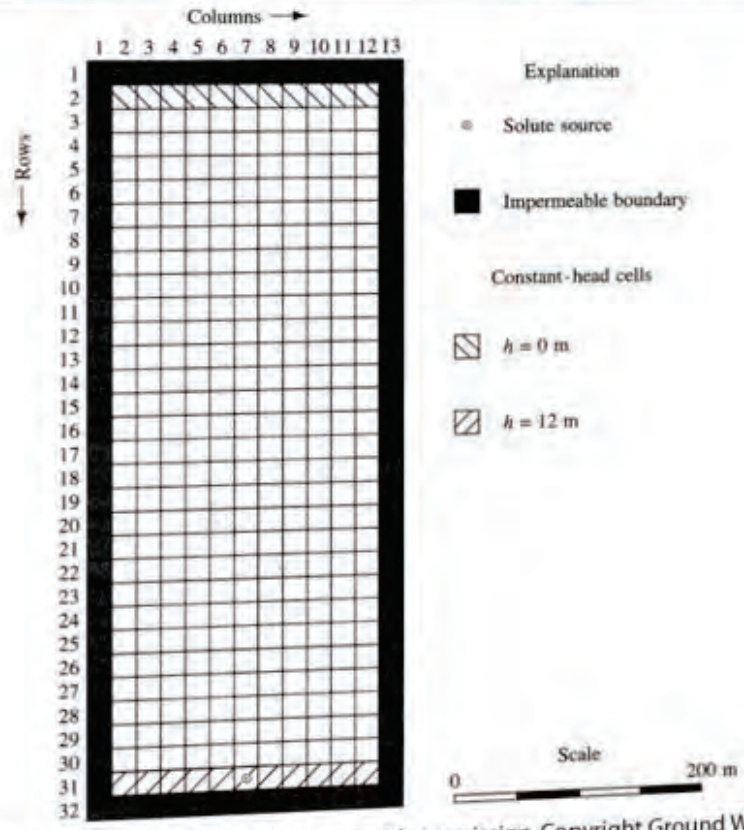
FIGURE 2.29 Finite-difference grid and boundary conditions for a deterministic model of solute transport.



Source: A. D. Davis. 1986. *Ground Water* 24:609–615. Used with permission. Copyright Ground Water Publishing Co.

FIGURE 2.30 Model areas for finite difference solute transport model with (a) uniform transmissivity and (b) with heterogeneous transmissivity.

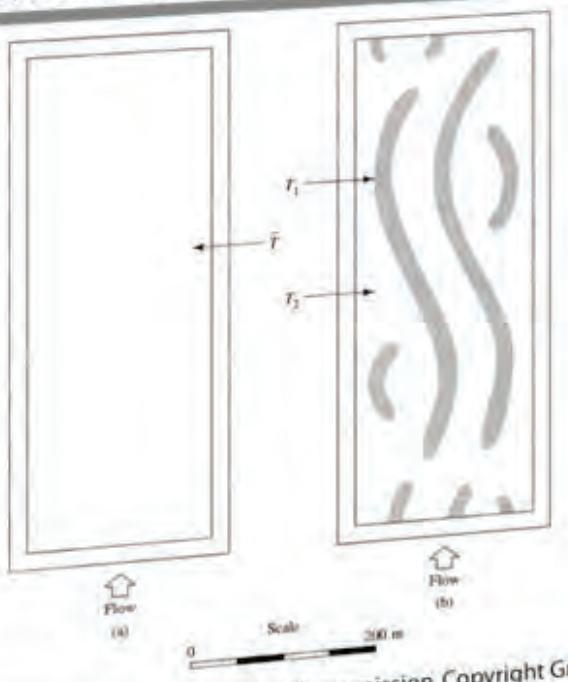


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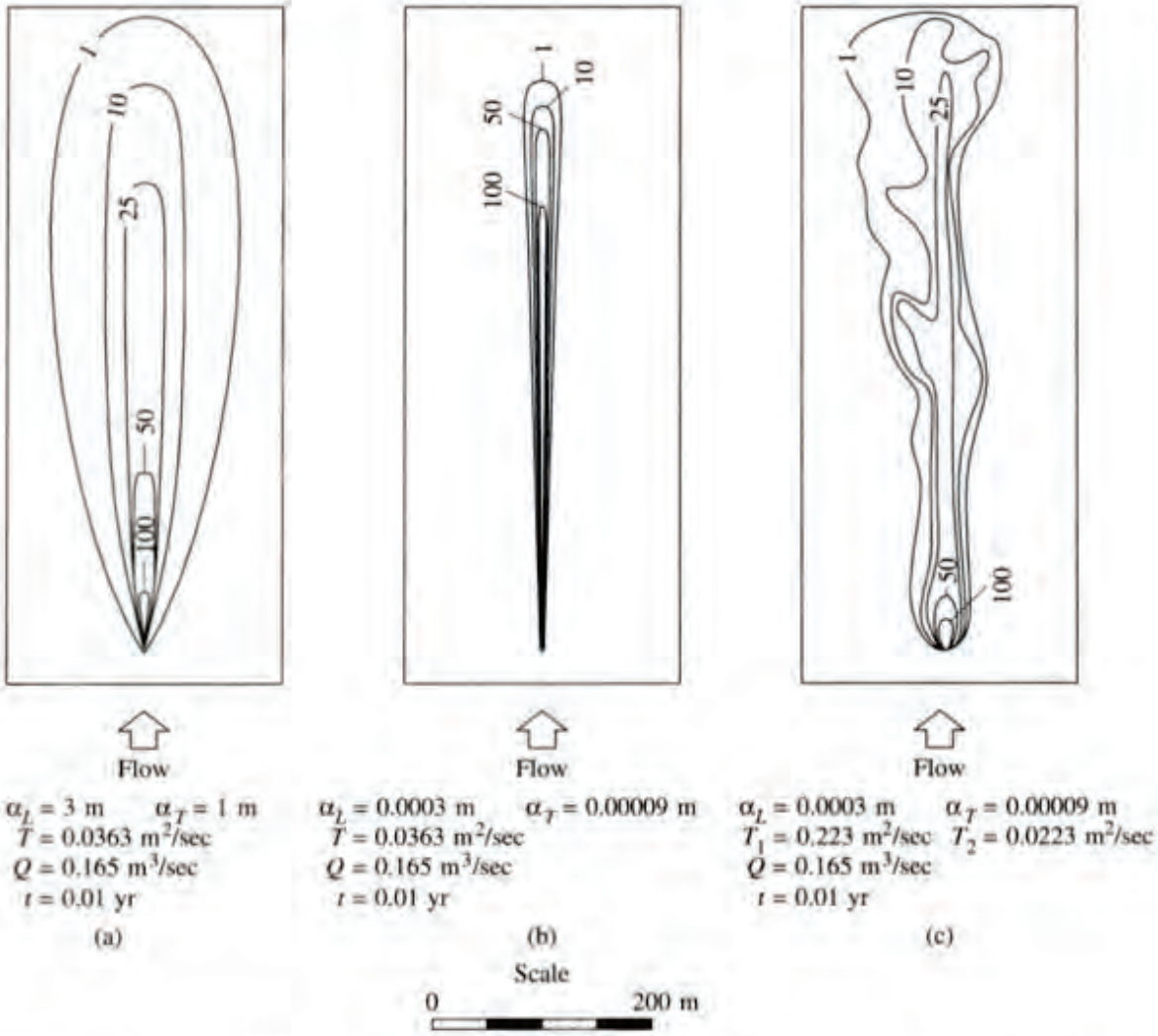
FIGURE 2.31 Model results for finite-difference solute-transport model. (a) Uniform media with large dispersivity values, (b) uniform media with small dispersivity values, and (c) heterogeneous media with small dispersivity values.



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Case Study: Borden Landfill Plume

Probably the best known subsurface contaminant transport field test site is located on the Canadian Forces Base in Borden, Ontario (Sudicky and Illman 2011). An abandoned landfill in a shallow sand aquifer at Borden has been extensively studied (Cherry 1983; Macfarlane et al. 1983) and Frind and Hokkanen (1987) made a very interesting study of the plume based on a deterministic model.

The landfill was active from 1940 to 1976 and covers about 5.4 ha to a depth of 5 to 10 m (16 to 32 ft). Figure 2.33 shows the location of water table wells and multilevel sampling devices. The multilevel sampling devices are concentrated along the long axis of the plume of groundwater contamination. The vertical location of the sampling points along cross section A-A′ are shown in Figure 2.34. The aquifer is about 20 m (65 ft) thick beneath the landfill and thins to about 9.5 m (31 ft) in the direction of groundwater flow. The aquifer consists of laminated fine to medium sand. An average hydraulic conductivity of 1.16×10^{-2} cm/sec

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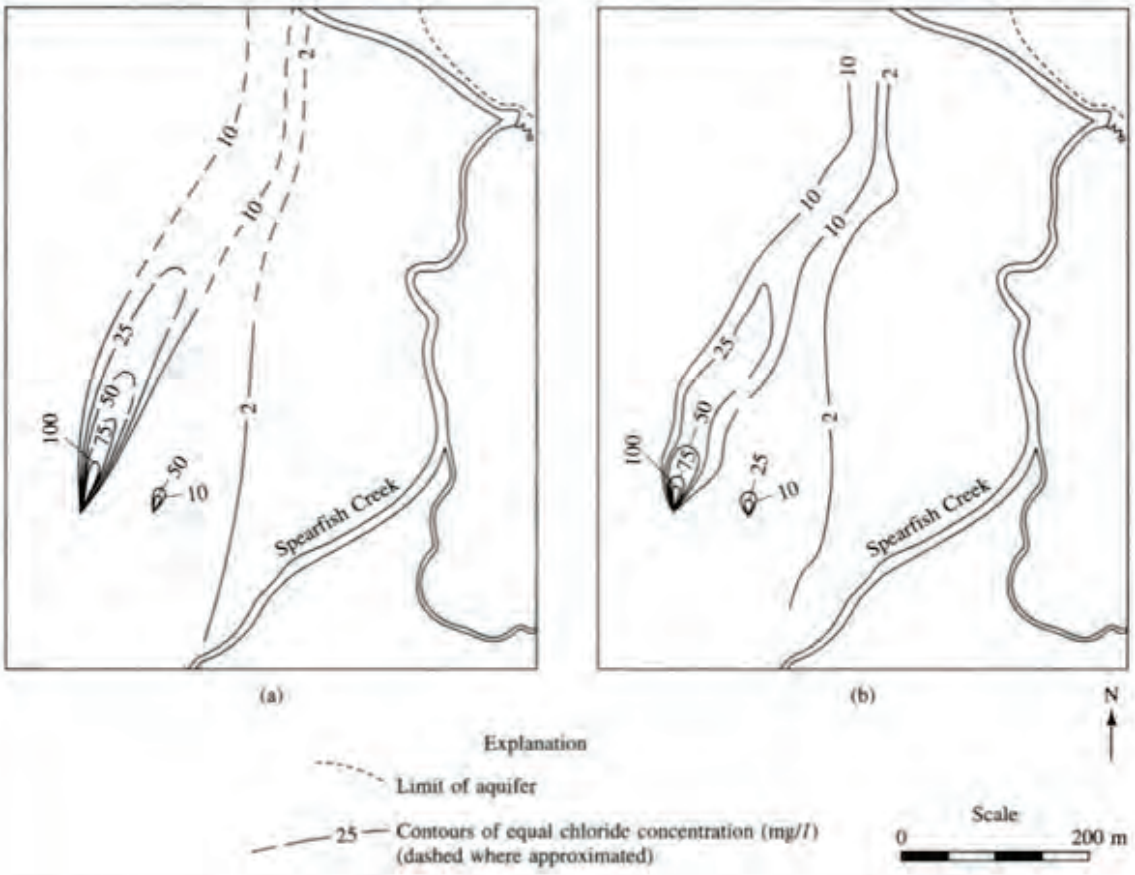
horizontally and 5.8×10^{-4} cm/sec vertically was used in the model with a porosity of 0.38. In 1979 a very extensive study of the water quality of the plume was conducted. Figure 2.35 shows the plume of chloride contamination along cross section A-A'. In 1979 the plume extended about 750 m (2,460 ft) from the landfill and had sunk to the bottom of the aquifer and then moved laterally with the flowing groundwater. The sinking of the plume is believed to be caused by recharge concentrated in a sand pit to the north of the landfill, which is in the direction of flow.

FIGURE 2.32 Comparison of (a) field observations at solute plume in an aquifer and (b) solute plume as computed by finite-difference solute-transport model for a heterogeneous aquifer.



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The finite-difference grid system for the cross-sectional model is shown in Figure 2.36. Equipotential lines for observed conditions were essentially vertical (Figure 2.37). The model was calibrated against the water-table contours for steady-state conditions.

Sensitivity analyses were performed to determine the impact of varying α_L and α_T. Field tests had indicated that the value of α_L at the site is on the order of 5 to 10 m (16 to 32 ft) (Sudicky et al. 1983). Figure 2.38 shows the sensitivity of the plume to the value of α_T. The value of α_L was kept at 10 m (32 ft) and α_T was varied from 0.005 m (0.02 in) to 1.0 m (3 ft). It can be seen that the shape of the plume is very sensitive to the value of α_T. With a high value of α_T, the plume spread through the entire vertical thickness of the aquifer, whereas with a low value it tended to sink toward the bottom. Figure 2.39 illustrates the fact that the

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plume was not very sensitive to changes in the value of α_L over the range tested. The value of α_T was kept constant at 0.01 m (0.4 in), whereas α_L varied from 2.5 to 20 m (8 to 65 ft). This figure is slightly misleading in that there is a 10:1 vertical exaggeration, so that the vertical spreading is more obvious than the horizontal. Also, the value of α_T was varied by a factor of 200, whereas α_L was varied only by a factor of 8.

FIGURE 2.33 Location of landfill at Canadian Forces Base, Borden, Ontario, showing location of cross section and monitoring network.

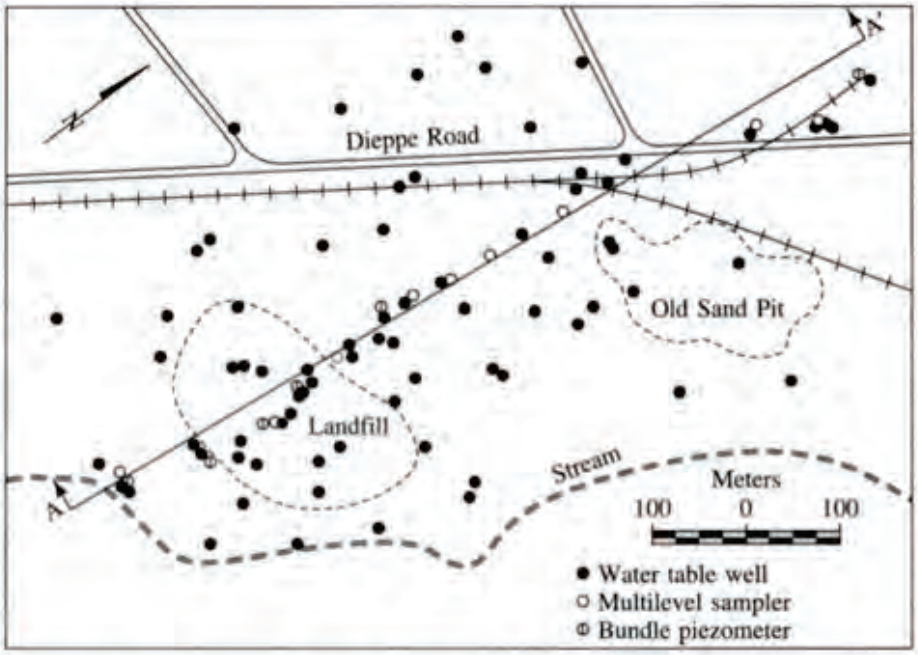

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FIGURE 2.34 Cross section of aquifer at the Border landfill showing the location of multilevel monitoring devices.

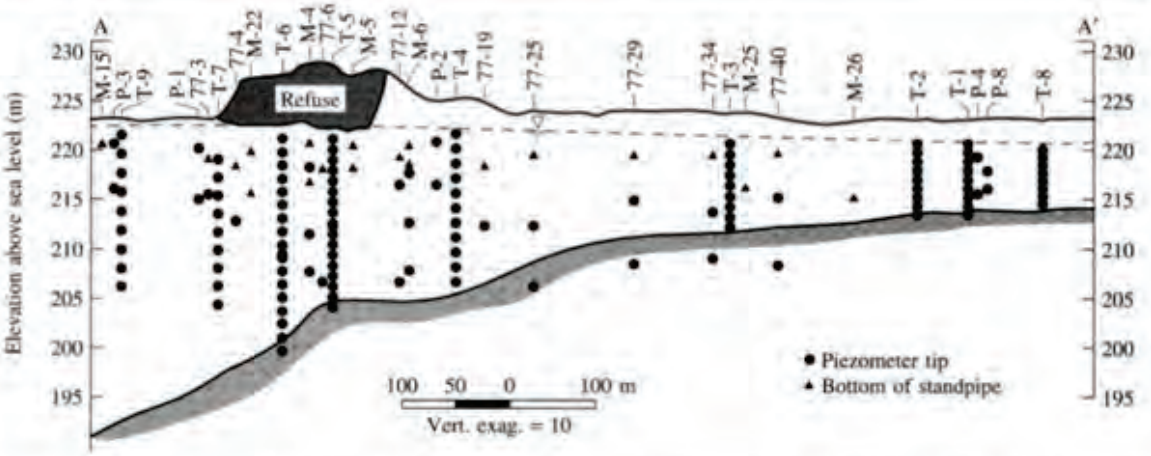

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FIGURE 2.35 Chloride plume along the Border landfill across section in 1979. Values are in milligrams per liter.

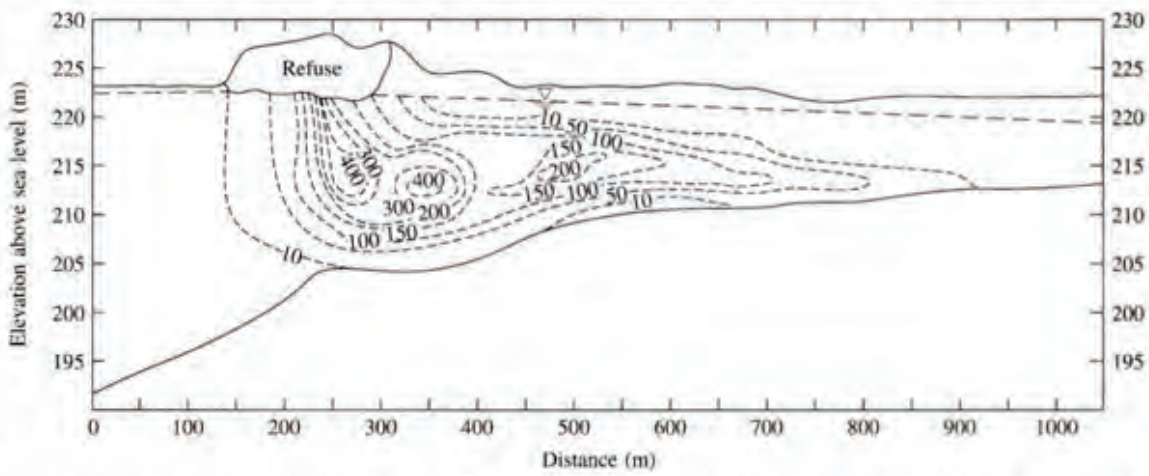

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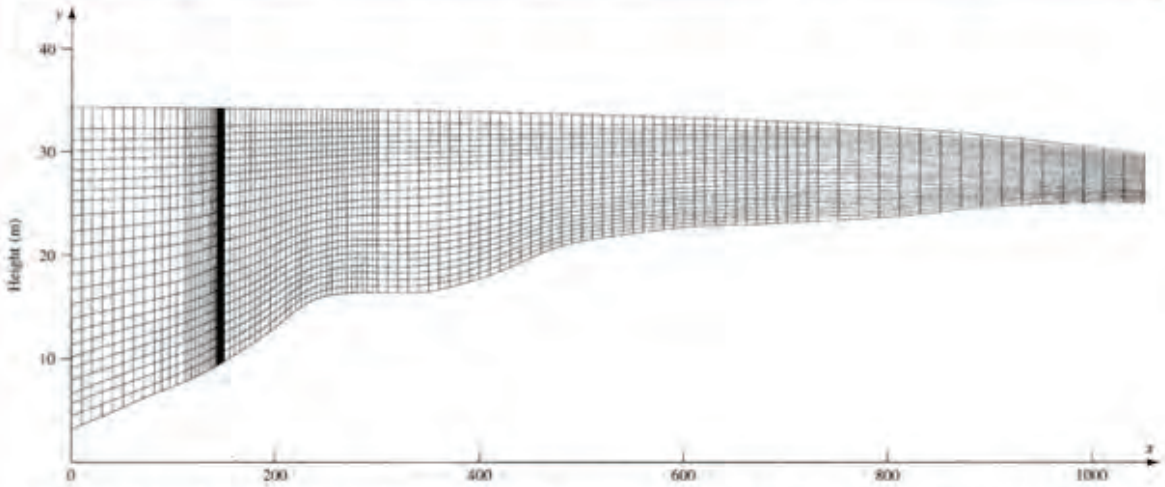
FIGURE 2.36 Finite-difference grid for Borden landfill solute transport model.



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Additional sensitivity analyses were conducted with respect to the water table boundary conditions and the concentration, size, and growth pattern of the source. The authors found that in order to reproduce the observed distribution, a source history that included multiple periods of high concentration was needed. Figure 2.40(a) shows the shape of the observed plume, Figure 2.40(b) illustrates the shape of a plume generated by a source with a history in which the concentration gradually increased (smooth source concentration), and Figure 2.40(c) contains the computed plume with the best match to the observed plume. It was generated by a run of the model in which the source concentration had two different periods of peak concentration. Although the solution was not unique—that is, several different combinations of model inputs might yield the same output—the shape of the plume could be reproduced with good accuracy. This was especially true at the leading edge of the plume, which is the most important part from the standpoint of predicting the movement of the plume into uncontaminated areas of the aquifer.

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FIGURE 2.37 Equipotential lines from the calibration of the Borden landfill solute-transport model; values in meters above datum.

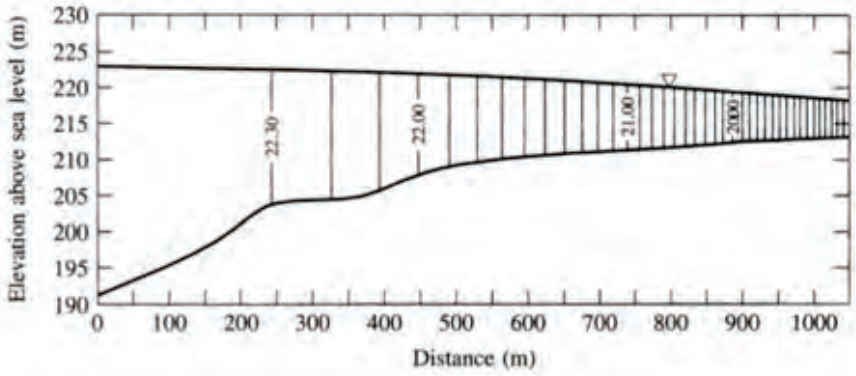

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FIGURE 2.38 Sensitivity analysis of the Borden landfill solute-transport model with respect to transverse dispersivity.

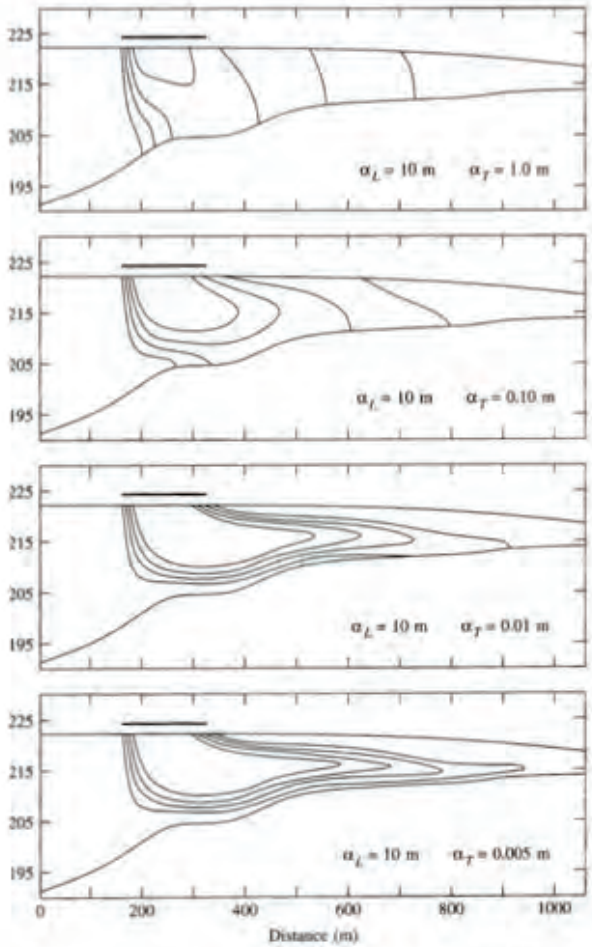

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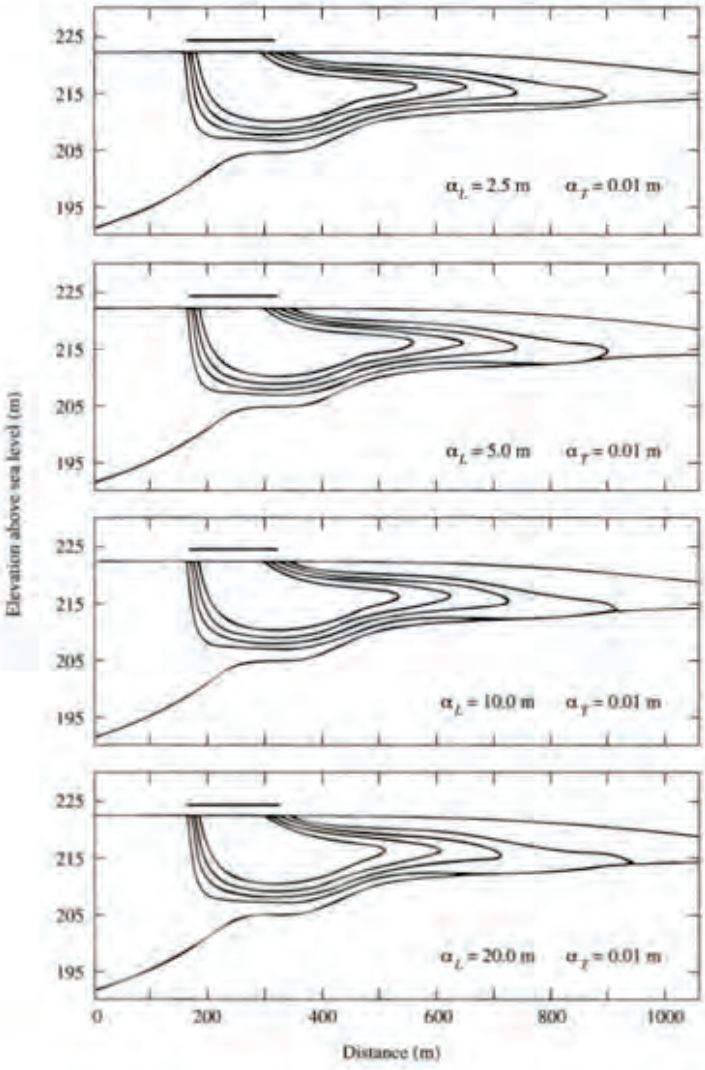
FIGURE 2.39 Sensitivity analysis of the Borden landfill solute-transport model with respect to longitudinal dispersivity.



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2.16 Transport in Fractured Media

Solute transport in fractured rock media is as important a process as transport in porous media. Understanding fluid flow and mass transport in fractured rocks is essential for assessing the groundwater resources of hard-rock aquifers and predicting the movement of hazardous chemicals if contamination occurs. Transport in fractured media is also important when assessing the suitability of underground sites for hazardous waste disposal, such as the heavily investigated former candidate site for a nuclear waste repository at Yucca Mountain in Nevada. However, less research has been done on this topic than on transport in porous media. One reason may is that existing theory of fluid flow through porous media is of limited usefulness when applied to fractured

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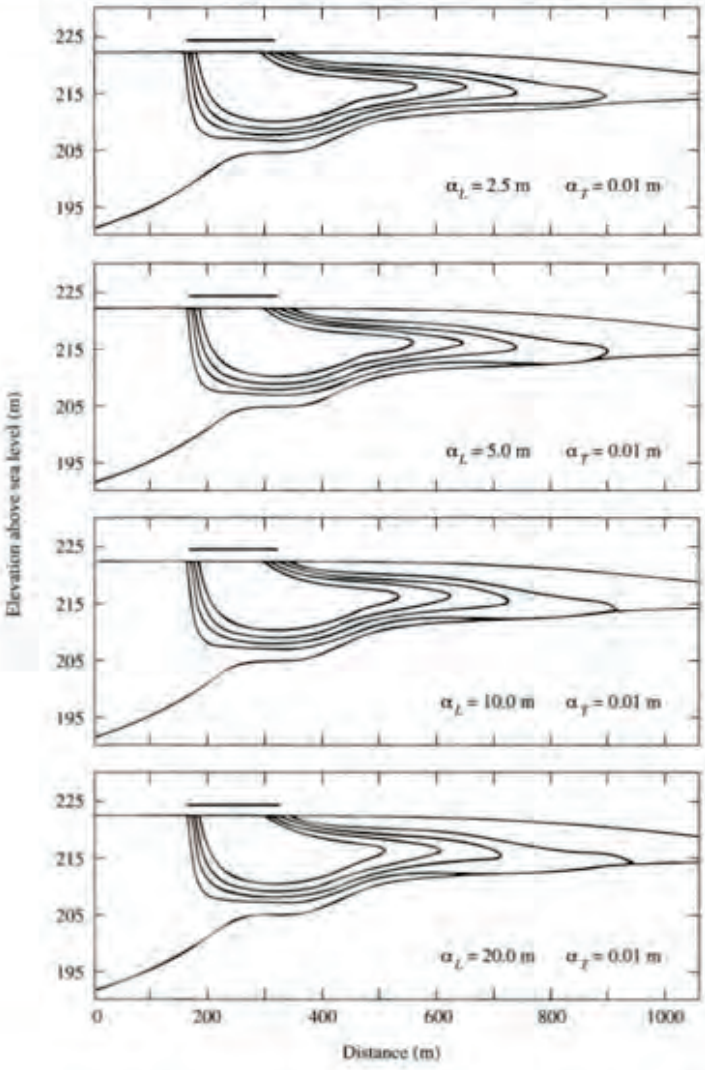
FIGURE 2.39 Sensitivity analysis of the Borden landfill solute-transport model with respect to longitudinal dispersivity.



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rocks (USGS 2015c). The rock in which fractures exist is porous. Hence, fluid moves in the fractures as well as in the rock matrix. Solutes in the fractures can diffuse into the fluid contained in the rock matrix and vice versa (Neretnieks 1980; National Research Council 2015). The fractures themselves are not smooth channels but contain dead-end passages that hold nonmoving water into which solutes can diffuse (Raven et al. 1988).

Berkowitz et al. (1988) suggested that solute transport in fractured media can be considered at a number of different scales. A very-near-field scale would be a single fracture near the source. A near-field scale would include a few fractures near the source. At a larger scale, the far field, the fracture network and the porous media matrix would have separate, discernible impacts on flow. At a very-far-field scale, which exists at considerable distance from the source, the entire flow domain can be considered as an equivalent porous medium in which the repeating fractures became large pores.

A number of different approaches to solute transport in fractured media have been attempted. These include analysis of transport in a single fracture in which effects of the transport in the fractures as well as interactions with a porous matrix are considered (e.g., Grisak and Pickens 1980; 1981; Tang et al. 1981; Rasmuson and Neretnieks 1981; Rasmussen 1984; Sudicky and Frind 1984). Sudicky and Frind (1982) and Barker (1982) examined transport in a media that consists of equally spaced fractures in a porous media. Endo and others (1984) made a deterministic study of flow in an irregular network of fractures contained in an impermeable host rock, whereas Schwartz et al. (1983) and Smith and Schwartz (1984) approached the same problem using a stochastic model. Berkowitz et al. (1988) and Schwartz and Smith (1988) examined the conditions under which the porous media matrix and the fractures can be considered to be a continuum that is representative of an equivalent porous media. Raven et al. (1988) made a field study of flow through a single fracture to test a model that incorporates the effects of nonflowing water in the fractures. Tsang et al. (1988) and Moreno et al. (1988) examine fracture flow on the basis of the assumption that most of the flow is concentrated in a few channels.

Dietrich et al. (2005) proposed a multi-continuum model in which separate, coupled hydraulic components in a heterogeneous aquifer are modeled. It is assumed that each component is distributed continuously in space and satisfies the condition of a porous medium (Bear and Bachmat 1990). For fracture matrix systems, this could be two fracture continua, such as a micro- and macro-fracture system, and a matrix continuum with appropriate equivalent parameters. The matrix and fractures are locally idealized as continua and the fractures are implemented discretely at their actual locations within the domain. It is obvious that the amount of data required to set up a discrete model of the actual domain is very large and to some extent not measureable. Consequently, the discrete model concept is preferentially used for relatively small domains and it is a suitable tool for principle studies of flow and transport processes (Dietrich et al. 2005).

One of the first considerations in dealing with fracture flow is deciding how to treat flow in a single fracture. Some authors (e.g., Tang et al. 1981; Schwartz and Smith 1988) assume that the fluid in a fracture is all moving at a constant velocity. Conversely, Endo et al. (1984) treated flow in a fracture to be two-dimensional, with a parabolic velocity profile across the width of the fracture, as shown in Figure 2.41. Transport within a single fracture is due to advection, which occurs at different rates, depending upon the position between the parallel walls of the fracture, and molecular diffusion, both normal and parallel to the flow direction.

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FIGURE 2.40 Comparison of (a) the observed chloride plume at the Borden landfill with (b) the chloride plume simulated by the solute transport model with a smooth source concentration and (c) the chloride plume simulated by the solute transport model with a doubly peaked source concentration.

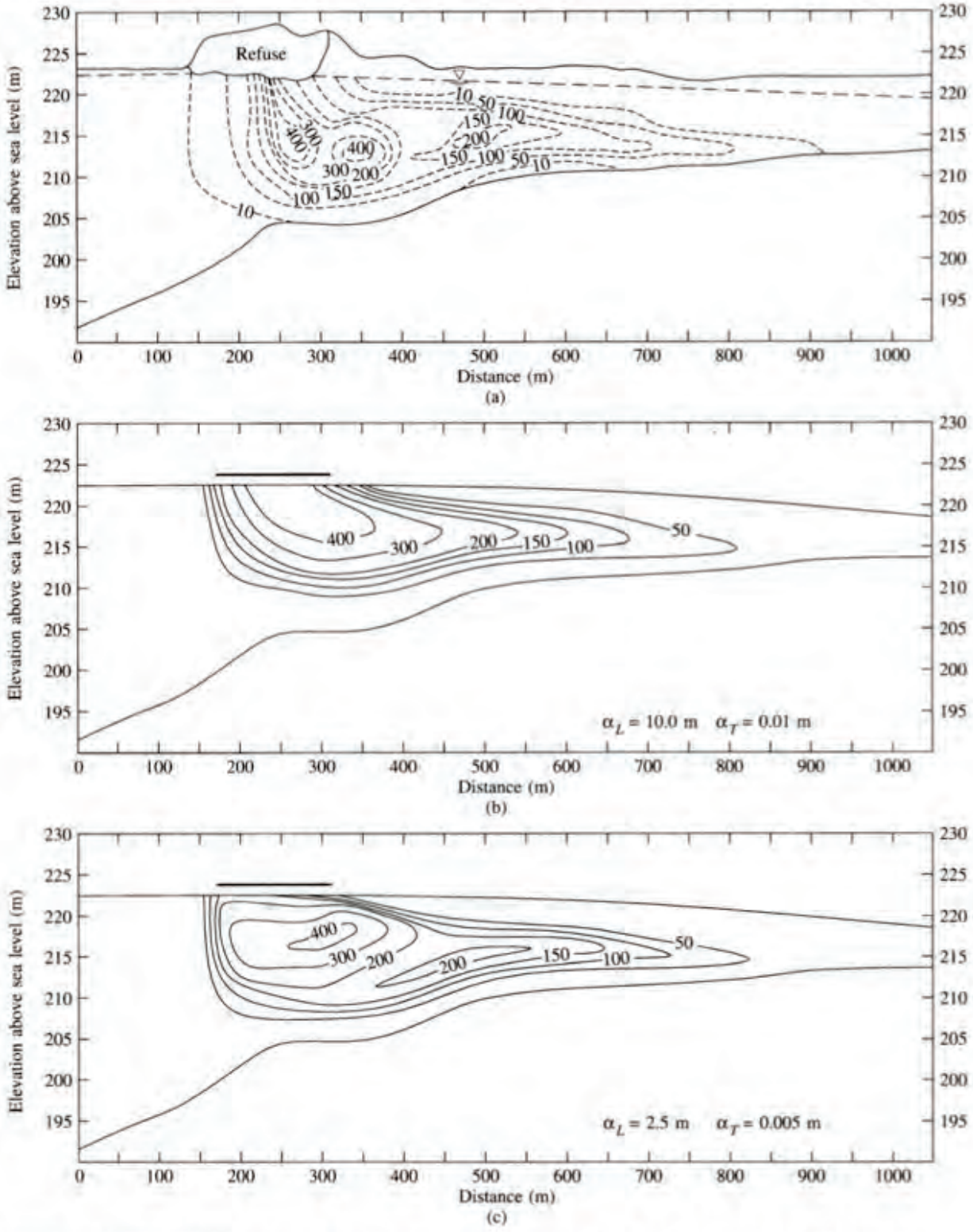

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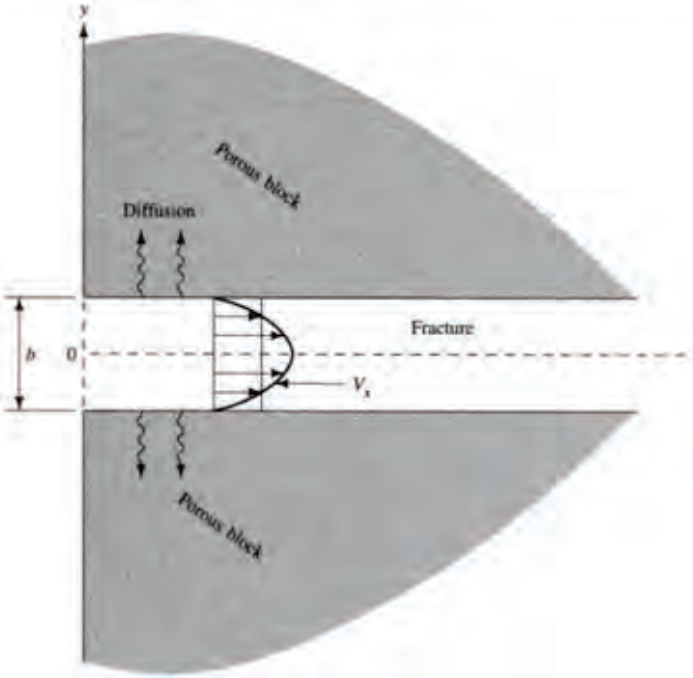
FIGURE 2.41 Horizontal distribution of flow in a vertical fracture and diffusion into the porous media matrix.



Hull et al. (1987) examined the conditions whereby diffusion within the fracture needs to be considered. In a fracture with parallel sides, the solute transport within the fracture is described by

$$\frac{\partial C}{\partial t} = D^*\left(\frac{\partial^2 C}{\partial x^2} + \frac{\partial^2 C}{\partial y^2}\right) - 6V\left[(\tau) - (\tau)^2\right]\frac{\partial C}{\partial x} \tag{2.49}$$

where

V = average fluid velocity in a fracture

τ = fractional transverse position in a fracture

At high flow rates, advection will dominate and the concentration will follow the velocity profile of Figure 2.41. At low velocities, diffusion will be important, since the concentration gradient at the solute front will be high and the distance will be short. Under these conditions, diffusion will homogenize the solute across the width of the fracture.

If L is the length of the fracture between cross fractures and β is the aperture of the fracture, the fracture residence time is L/V. This can be compared with $(\beta/2)^2/D$ to determine if diffusion needs to be considered (Crank 1956). If diffusion induces a change in the tracer concentration of less than 2% over a distance of 10% of the width of the fracture, the diffusion can be considered negligible, and the residence time in the fracture will be

$$\frac{L}{V} < 0.003\frac{(\beta/2)^2}{D} \tag{2.50}$$

If diffusion affects the tracer concentration to the extent that the tracer front is at 98% of the equilibrium value at all points across the fracture, the diffusion has homogenized the front, and the residence time in the fracture will be

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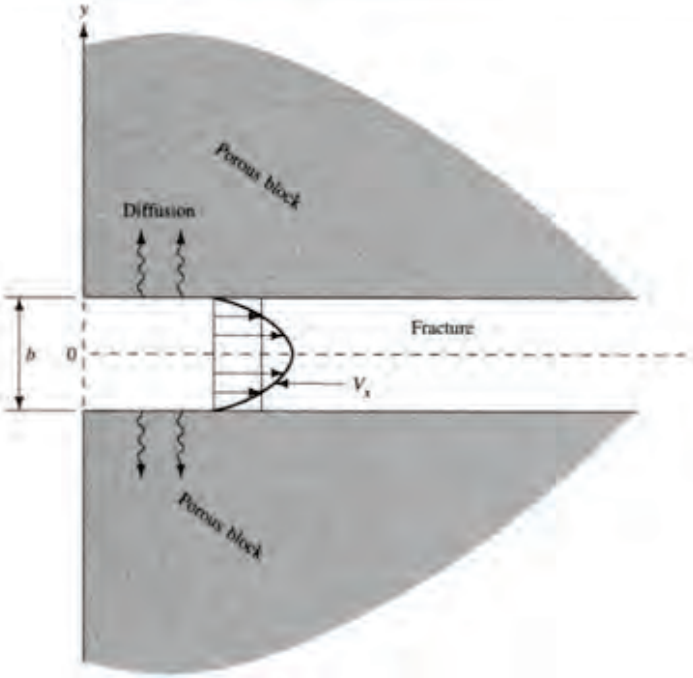
FIGURE 2.41 Horizontal distribution of flow in a vertical fracture and diffusion into the porous media matrix.



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$$\frac{\partial C}{\partial t} = D^*\left(\frac{\partial^2 C}{\partial x^2} + \frac{\partial^2 C}{\partial y^2}\right) - 6V\left[(\tau)-(\tau)^2\right]\frac{\partial C}{\partial x} \tag{2.49}$$

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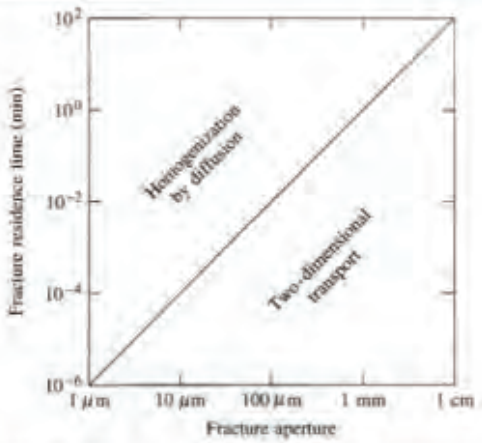
FIGURE 2.42 Fracture residence time necessary for homogenization of the tracer across the fracture width by molecular diffusion.



Source: Modified from L. C. Hull, J. D. Miller, and T. M. Clemo. 1987. *Water Resources Research* 23:1505–1513. Copyright by the American Geophysical Union. Reproduced with permission.

$$\frac{L}{V} < 0.05\frac{(\beta/2)^2}{D} \tag{2.51}$$

Figure 2.42 indicates the circumstances under which fracture flow can be considered to be one- or two-dimensional. Fracture residence time (L/V) is plotted against fracture aperture on this figure, which is based on a diffusion coefficient of 1.7×10^{-9} m^2/sec (1.93×10^{-8} ft^2/sec). The figure shows the conditions under which diffusion will homogenize the flow so that the transport within the fracture can be treated as one-dimensional (uniform conditions across the aperture). However, diffusion will still spread the tracer in advance of the advecting water. For even large fractures of 1mm aperture, this will occur with a residence time of 1min or more. This suggests that for most flow situations, one does not need to consider the velocity distribution across the fracture.

When the flow in a fracture is homogeneous, the mass transport can then be described by the one-dimensional advection-dispersion equation with the longitudinal dispersion coefficient equal to (Hull et al. 1987)

$$D_L = \frac{(V\beta)^2}{210D} \tag{2.52}$$

One approach to solute transport modeling is to determine the flux of water through the fractures and then use a numerical technique known as a random walk model to simulate diffusion of the solute (Hull et al. 1987). This ignores any diffusion into the porous media matrix. According to Witherspoon et al. (1980), flow through a fracture can be described by Darcy's law using an equivalent hydraulic conductivity for a fracture, K_f, given by

$$K_f = \frac{\rho g}{12\mu}\beta^2 \tag{2.53}$$

The quantity of flow, Q, can be found from the cubic law

$$Q = \frac{\rho g}{12\mu} Ia\beta^3 \tag{2.54}$$

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where

g = acceleration of gravity
I = hydraulic gradient along the fracture
a = width of the fracture-that is, the third dimension after length and aperture
μ = viscosity of fluid

If the velocity in the channel needs to be described in two dimensions, this can be done with three equations: one for the maximum velocity in the center of the fracture, one for the flow velocity profile across the aperture, and one for the vertical velocity profile in the fracture.

The maximum velocity can be found from (Hull et al. 1987):

$$V_x(\max) = \left[1.5 + 1.1664\left(\frac{a}{\beta}\right)^{-1.0557}\right] V \tag{2.55}$$

The velocity profile across the aperture is given by.

$$V_x(y) = 4\left(\tau - \tau^2\right) \tag{2.56}$$

where τ = fractional transverse position in a fracture, y/β.

The vertical velocity profile is given by

$$V_x(\zeta) = 15.56\zeta - 97.72\zeta^2 + 308\zeta^3 - 513\zeta^4 + 431\zeta^5 - 143.7\zeta^6 \tag{2.57}$$

where ζ = fractional vertical position in a fracture, z/a.

Raven et al. (1988) pointed out that the fractures through which flow occurs are not smooth, parallel plates but have irregular walls that promote the formation of zones along the edge of the fracture where the water is immobile (Figure 2.43). The fluid moves through the mobile zone, but the solutes can diffuse into the immobile fluid zones. The solute would be stored in the immobile fluid during the early part of solute transport and would be released from storage if the solute concentration in the mobile fluid would decrease—for example, as might happen during the latter part of a slug injection test. They derived an advection-dispersion equation for mass transport in the fracture with "transient solute storage in the immobile fluid zone (advection-dispersion transient storage model or ADTS). A field test was performed on the flow through a single fracture that had been isolated by packers in the borehole. Water was injected into one borehole and withdrawn from another. The water contained a tracer for the first few hours of the test, and then water without the tracer was again injected. Figure 2.44 contains circles representing the field data, in terms of relative concentration, plotted versus elapsed time. Also shown on this figure are the results of a conventional advection-dispersion (AD) model and an advection-dispersion transient storage (ADTS) model. Both models matched the observed data for the first few hours of the test. However, the ADTS model was far superior in matching the field data over the entire course of the test. The effect of transient storage was to reduce the peak concentration and to increase the concentrations above what would be produced by advection-dispersion alone during the later periods of the test.

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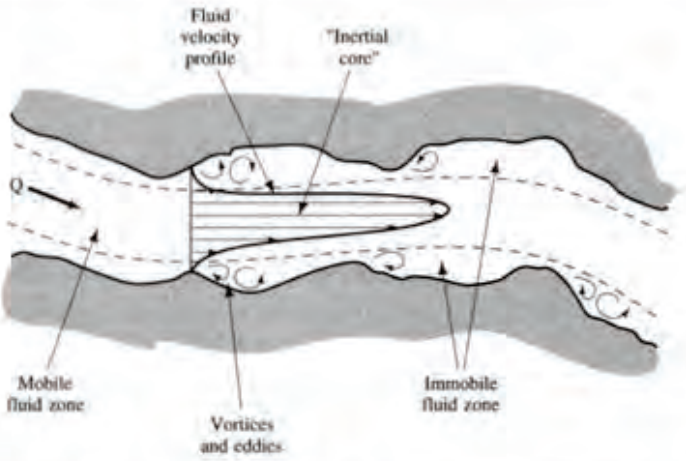
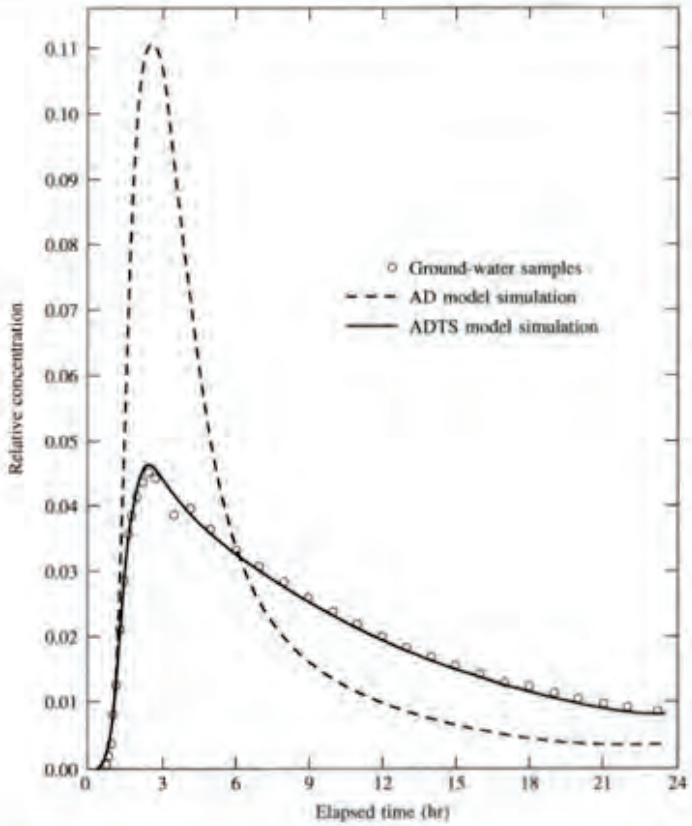
FIGURE 2.43 Zones of mobile and immobile water in a fracture.



Source: K. G. Raven, K. S. Novakowski, and P. A. Lapcevic. 1988. *Water Resources Research* 24:2019–2032. Copyright by the American Geophysical Union. Reproduced with permission.

FIGURE 2.44 Comparison of field data from a tracer test in fractured rock with results of model simulation using an advection-diffusion (AD) model and an advection-diffusion transient storage (ADTS) model.



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2.17 Summary

Solutes dissolved in groundwater are transported in two ways. Diffusion will cause solutes to move in the direction of the concentration gradient—that is, from areas of higher to lower concentration. This transport can occur even if the groundwater is not flowing and may be the major factor in mass transport in geologic materials of very low permeability.

Solutes are also transported by the process of advection. This occurs as the flowing groundwater carries the dissolved solutes with it. At the scale of a few pore diameters, groundwater will move parallel to the flow path at different rates due to differences in pore size. This causes the solute plume to spread along the direction of the flow path, a process called longitudinal dispersion. The solute plume will also spread laterally as flow paths diverge around mineral grains, a process known as transverse dispersion. At the laboratory column scale, the movement of a contaminant through a uniform porous media can be described by the advection-dispersion equation, which accounts for advection, diffusion, and porescale dispersion.

In field-scale studies it has been found that the coefficient of longitudinal dispersion obtained from the advection-dispersion equation increases with the length of the flow path. This is due to the heterogeneous nature of aquifer materials. As the length of the flow path increases, the range of permeability values that affect the rate of groundwater flow also increases. This causes the resulting solute plume to spread out more and more. This can be called macrodispersion. An apparent diffusion coefficient can be statistically correlated with the length of the flow path by the expression $\alpha_m = 0.83(\log L_p)^{2.414}$.

Stochastic methods of analysis have also been developed to analyze solute transport at the field scale. Stochastic methods are based on the variation in the hydraulic conductivity values because it is that variation that causes the solute plume to spread. The groundwater velocity depends upon the porosity as well as the hydraulic conductivity, but the hydraulic conductivity varies over a much greater range than porosity.

At the field scale the spreading due to hydraulic conductivity variation is much greater than that due to pore-scale dispersion. Both stochastic and advection-dispersion models demonstrate that the primary movement of the solute plume is due to advection. The stochastic model yields the movement of the center of mass of the solute plume from the average rate of movement of the groundwater. The variance of the solute concentration about the mean position, or the second spatial moment, is also obtained from stochastic models.

Chapter Notation

A	Cross-sectional area
a	Width of a fracture
b	Aquifer thickness
B	$[(v_x x)^2/(2D_L)^2 + (v_x y)^2/(4D_L D_T)]^{1/2}$
C	Solute concentration
C_i	Concentration at some point x and time t
C_0	Initial concentration, i.e. concentration at time 0
C_R	Dimensionless solute concentration (C/C_0)
$\langle C \rangle$	Ensemble mean concentration
c_0	Constant related to anisotropy
d	Characteristic flow length for Peclet number, P
dh/dl	Hydraulic gradient
D^*	Effective diffusion coefficient
D	Diffusion coefficient
D_d	Molecular diffusion coefficient
D_i	Coefficient of hydrodynamic dispersion in the i direction

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D_L	Coefficient of longitudinal hydrodynamic dispersion	S_Y^2	Variance of sampled values of Y
D_T	Coefficient of transverse hydrodynamic dispersion	t	Time
E	Euler number (0-577...)	t'	Dimensionless time (tU/ϵ_{ij})
E_i	Exponential integral	t_D	Dimensionless time $\left(\frac{V_x^2 t}{D_L}\right)$
f	Fractal dimension	t_R	Dimensionless time ($v_x t/L$)
F	Mass flux of solute per unit area per unit time	T	Tortuosity
g	Acceleration of gravity	T_f	Fractal tortuosity
G	Topological dimension	u	Average velocity of injection of water into a well
h	Hydraulic head	u	Fluctuation in the velocity vector
H	Separation of autocorrelation function	u_{ij}	Covariance
i	Decay constant	U	$\langle V \rangle$ ensemble mean of velocity vectors
I	Hydraulic gradient along a fracture	U_i	Total volume of water injected into a well
J	Constant length	U_p	Cumulative volume of water withdrawn from a well
k	Lag in autocorrelation function	v_f	Velocity along a fractal flowpath
K	Hydraulic conductivity	v_x	Average linear velocity in the x direction
K_f	Equivalent hydraulic conductivity of a fracture	V	Average fluid velocity in a fracture
K_G	Geometric mean of hydraulic conductivity	V	Velocity vector
K_0	Modified Bessel function of second kind and zero order	$\langle V \rangle$	Ensemble mean of the velocity vectors
L	Straight-line distance between ends of a flowpath	$W[t, B]$	Hantush leaky well function
L_c	Length of a tortuous flowpath	x	Coordinate vector
L_f	Length of a fractal flowpath	x_f	Length of fractal flowpath
L_s	Straight-line length between ends of a fractal flowpath	(x_o, y_o)	Origin of an xy field
M	Total mass of solute	x_s	Straight-line distance
N	Number of units	X'	Residual of the displacement of a particle
n	Porosity	$\langle X \rangle$	Ensemble mean of the center of mass
n_e	Effective porosity	$X_{ij}(t)$	Second spatial moment of the solute mass at time t and location i, j
P	Peclet number ($v_x L / D_L$)	X_t	Total particle displacement
PV	Pore volume	$\overline{Y}$	Mean of sample values of Y
Q	Rate at which a tracer is being injected into an aquifer	Y_i	log K_i
r	Radial distance to a well	Z_n	Constant related to a semivariogram
R	Length of well screen or open borehole	α	Dynamic dispersivity
R_f	Average frontal position of water injected into a well	α_L	Longitudinal dynamic dispersivity
r_Y	Autocorrelation of sampled values of Y	α_T	Transverse dynamic dispersivity
S_Y	Standard deviation of sampled values of Y	α_{ap}	Apparent dispersivity
		β	Aperture of a fracture
		ϵ_h	Correlation length for horizontal hydraulic conductivity

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$\in_v$	Correlation length for vertical hydraulic conductivity	ρ_Y	Autocorrelation of the population of Y
η	Fractal unit of measurement	σ_y	Standard deviation of population of Y
η_c	Fractal cutoff limit	σ_y^2	Variance of population of Y
γ_Y	Semivariogram of Y	τ	Fractional transverse position in a fracture
λ_Y	Correlation length of autocorrelation	τ_Y	Autocovariance
μ	Viscosity of a fluid	θ	Angle in polar coordinate system
$\bar{Y}$	Mean of population of Y	ξ	Fourier transform wave vector number
ν	Hurst coefficient for fractal dimensions	ζ	Fractional vertical position in a fracture
ω	Coefficient related to tortuosity		
Ω	Anisotropy ratio ($\in_v/\in_h$)		
ρ	Density of a fluid		

References

Anderson, M. P. 1979. Using models to simulate the movement of contaminants through groundwater flow systems. *Critical Reviews in Environmental Controls* 9:97–156.

Anderson, M. P. 1984. "Movement of contaminants in groundwater: Groundwater transport—advection and dispersion." In *Groundwater Contamination,* 37–45. Washington, DC: National Academy Press.

Anderson, M. P. 1990. Aquifer heterogeneity—a geological perspective. *Proceedings, Fifth Canadian/American Conference on Hydrogeology*. National Water Well Association, pp. 3–22.

Anderson, M. P., and W. W. Woessner. 1991. *Applied Groundwater Modeling: Simulation of Flow and Advective Transport*. San Diego, CA: Academic Press.

Aris, R. 1956. On the dispersion of a solute in a fluid flowing through a tube. *Proceedings of The Royal Society of London* 235:67–77.

Ayra, A. 1986. Dispersion and reservoir heterogeneity. Ph.D. Dissertation. University of Texas, Austin.

Bachmat, Y., and J. Bear. 1987. On the concept and size of a representative elementary volume (REV). *Advances in Transport Phenomena in Porous Media* 128:3–20.

Bakr, A. A. 1976. Effect of spatial variations of hydraulic conductivity on groundwater flow. Ph.D. Dissertation. New Mexico Institute of Mining and Technology, Socorro.

Barker, J. A. 1982. Laplace transform solutions for solute transport in fissured aquifers. *Advances in Water Resources* 5:98–104.

Bear, J. 1961. Some experiments on dispersion. *Journal of Geophysical Research* 66:2455–2467.

Bear, J. 1972. *Dynamics of fluids in porous media*. New York: American Elsevier Publishing Company, 764 pp.

Bear, J., and A. Verruijt. 1987. *Modeling Groundwater Flow and Pollution*. Dordrecht, Netherlands: D. Reidel Publishing Company, 414 pp.

Bear, J., and A. H.-D. Cheng. 1990. "Modeling Groundwater Flow and Contaminant Transport." In *Theory and Applications of Transport in Porous Media, Volume 23*. Reprint 2010. Springer, 396 pp.

Bedient, P. B., H. S. Rifai, and C. J. Newell. 1994. *Ground Water Contamination: Transport and Remediation*. Englewood Cliffs, NJ: Prentice Hall.

Berkowitz, B., J. Bear, and C. Braester. 1988. Continuum models for contaminant transport in fractured porous formations. *Water Resources Research* 24:1225–1236.

Bierkens, M., and F. van Geer. 2014. Stochastic Hydrology. Lecture notes. Accessed October 3, 2015 at http://www.earthsurfacehydrology.nl/wp-content/uploads/2012/01/Syllabus_Stochastic-Hydrology.pdf

Brigham, W. E. 1974. Mixing equations in short laboratory columns. *Society of Petroleum Engineers Journal* 14:91–99.

Boving, T. B., and P. Grathwohl. 2001. Tracer diffusion coefficients in sedimentary rocks: Correlation to porosity and hydraulic conductivity. *Journal of Contaminant Hydrology* 53:85–100.

Carman, P. C. 1997. Fluid flow through a granular bed. *Chemical Engineering Research and Design* 75: S32–S48.

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6

Inorganic Chemicals in Groundwater

6.1 Introduction

Groundwater is a solvent that is in contact with various earth materials. As a result, groundwater naturally contains dissolved cations and anions as well as some nonionic inorganic material, such as silica (SiO_2). Naturally occurring groundwater can contain dissolved solids that range in concentration from less than 100 mg/L to more than 500,000 mg/L (Hem 1985). The major ion constituents of natural water include calcium, magnesium, sodium, potassium, chloride, sulfate, and bicarbonate/carbonate. Dissolved gasses can include nitrogen, carbon dioxide, methane, oxygen, and hydrogen sulfide. There are a number of ions that can be naturally present in small amounts that can affect the water quality. In addition, inorganic ions that impact upon water quality can be released to the subsurface via human activity. For example, at least 18 inorganic elements can be used in pesticides (chromium, chlorine, fluorine, tin, arsenic, selenium, barium, cadmium, sulfur, phosphorus, mercury, zinc, lead, copper, thallium, bismuth, boron, and antimony), and many metals can be joined with carbon to form organometalic pesticides (Clarkson 2001).

We have already seen in Chapter 3 that ions can be removed from solution by ion exchange and sorption. In this chapter we will examine other chemical processes that act to remove inorganic ions from solution. We will also examine the chemical properties of a number of inorganic materials frequently found in groundwater. The geochemical zonation that can occur near landfills that have received municipal waste will be used to illustrate some basic principles.

6.2 Units of Measurement and Concentration

Chemical analyses are usually reported on the basis of weight of solute per volume of solvent. Common units are **milligrams per liter** (mg/L) and **micrograms per liter** (μg/L). Equivalent weight units are frequently used when the chemical behavior of a solute is being considered. The **equivalent weight** of an ion is the formula weight divided by the electrical charge. If the concentration of the ion in milligrams per liter is divided by the formula weight, the resulting concentration is expressed in terms of **milliequivalents per liter**. One **mole** of a substance is its formula weight in grams. A 1-**molal** solution has 1 mole of solute in 1000 g of solvent. A 1-**molar** (1-*M*) solution has 1 mole of solute in a liter of solution.

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If a solution is dilute and there is no need to make density corrections, the molality can be determined from the concentration by the following equation:

$$\text{Molality} = \frac{\text{milligrams per liter} \times 10^{-3}}{\text{formula weight in grams}} \tag{6.1}$$

6.3 Chemical Equilibrium and the Law of Mass Action

The law of mass action states that the rate of a chemical reaction will be proportional to the active masses of the participating substances (Hem 1985). If there are two substances, A and B, reacting to form two other substances, C and D, and if the process is reversible, then the reaction can be written as

$$aA + bB \rightleftharpoons cC + dD \tag{6.2}$$

The rate of the forward reaction, R_1, is

$$R_1 = k_1'[A]^a[B]^b \tag{6.3}$$

whereas the rate of the reverse reaction, R_2, is

$$R_2 = k_2'[C]^c[D]^d \tag{6.4}$$

where:

[A] = active concentration of substance A
k'_1 = proportionality constant for the forward reaction
k'_2 = proportionality constant for the reverse

If the reaction progresses to a point where the forward reaction rate is equal to the reverse reaction rate, then

$$k_1'[A]a[B]b \rightleftharpoons k_2'[C]c[D]d \tag{6.5}$$

Equation 6.5 can be rearranged to yield the following expression:

$$\frac{[C]^c[D]^d}{[A]^a[B]^b} = \frac{k_1'}{k_2'} = K_{eq} \tag{6.6}$$

where K_{eq} is the equilibrium constant.

If two or more ions react to form a solid precipitate and the reaction is reversible, then it can be represented as

$$aA + bB \rightleftharpoons cAB \tag{6.7}$$

The equilibrium relationship of this reaction is:

$$K_{sp} = \frac{[A]^a[B]^b}{[AB]^c} \tag{6.8}$$

where K_{sp} is called a **solubility product**. The activity of the solid together with the water is defined as unity. Solubility products can be used to compute the concentration

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of a solute in equilibrium with a solid phase, either via dissolution of the solid into an undersaturated solution or following precipitation of the solid from a saturated solution.

If one is dealing with a very dilute aqueous solution, then molal concentrations can be used to determine chemical equilibrium. However, for the general case, one must use **chemical activities** to employ the law of mass action.

The chemical activity of ion X, $[X]$, is equal to the molal concentration of X, m_x, times a factor known as an **activity coefficient**, γ_x:

$$[X] = m_x \gamma_x \tag{6.9}$$

The activity coefficient varies with the total amount of cations and anions in solution. The concentration and charge of the various ions in a solution determine its **ionic strength**. Ionic strength can be computed from the following formula:

$$I = \frac{1}{2} \sum m_i z_i^2 \tag{6.10}$$

where

I = ionic strength
m_i = molality of the ith ion
z_i = charge of the ith ion

Once the ionic strength is determined, the activity coefficient can be calculated using the Debye-Hückel equation:

$$-\log \gamma_i = \frac{A z_i^2 \sqrt{I}}{1 + a_i B \sqrt{I}} \tag{6.11}$$

where

γ_i = the activity coefficient for ionic species i
z_i = the charge on ionic species i
I = ionic strength of the solution
A = constant equal to 0.5085 at 25°C
B = constant equal to 0.3281 at 25°C
a_i = the effective diameter of the ion from Table 6.1

The Debye-Hückel equation can be used with solutions that have an ionic strength of 0.1 or less (approximately 5000 mg/L). Figure 6.1 is a graph showing the relationship of activity coefficient to ionic strength for specific ions; it was calculated using the Debye-Hückel equation. Specific curves are for ions with the same effective diameter and charge as listed in Table 6.1. Not all the ions to which a curve applies are listed on the figure. For example, the curve labeled Ca^{2+} and Fe^{2+} can also be used for Cu^{2+}, Zn^{2+}, Sn^{2+}, Mn^{2+}, Ni^{2+}, and Co^{2+}, because all these ions have the same effective diameter and charge.

Chemical equilibrium is a useful concept in studies of contaminant hydrogeology. Ionic contaminants discharged into groundwater may react with naturally occurring

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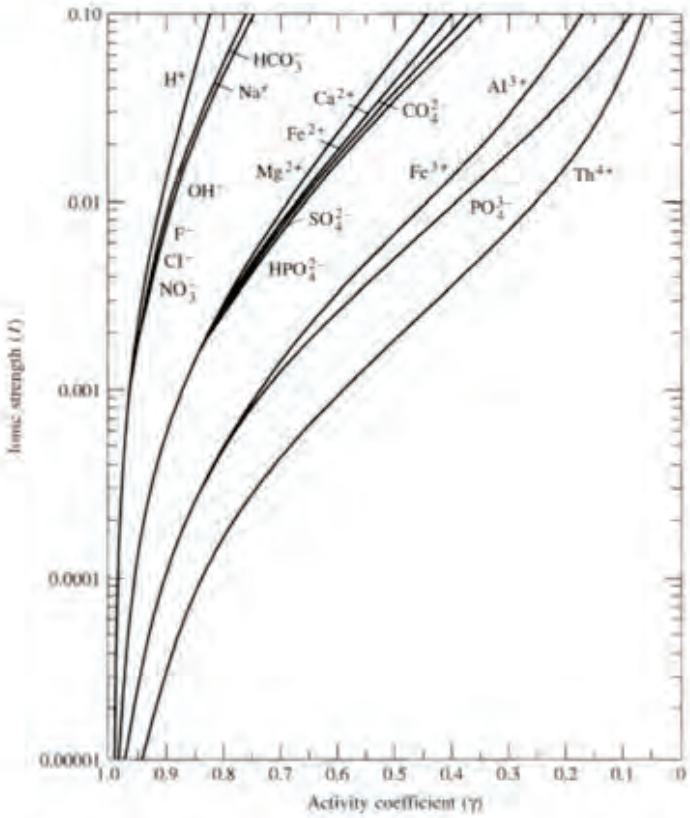
TABLE 6.1 Values of the parameter a_i in the Debye-Hückel equation.

a_i	Ion
11	Th^{4+}, Sn^{4+}
9	Al^{3+}, Fe^{3+}, Cr^{3+}, H^+
8	Mg^{2+}, Be^{2+}
6	Ca^{2+}, Cu^{2+}, Zn^{2+}, Sn^{2+}, Mn^{2+}, Fe^{2+}, Ni^{2+}, Co^{2+}, Li^+
5	$Fe(CN)_6^{4-}$, Sr^{2+}, Ba^{2+}, Cd^{2+}, Hg^{2+}, S^{2-}, Pb^{2+}, CO_3^{2-}, SO_3^{2-}, MoO_4^{2-}
4	PO_4^{3-}, $Fe(CN)_6^{3-}$, Hg_2^{2-}, SO_4^{2-}, SeO_4^{2-}, CrO_4^{3-}, HPO_4^{2-}, Na^-, HCO_3^-, $H_2PO_4^-$
3	OH^-, F^-, CNS^-, CNO^-, HS^-, ClO_4^-, K^+, Cl^-, Br^-, I^-, CN^-, NO_2^-, NO_3^-, Rb^+, Cs^+, NH_4^+, Ag^+

Source: J. Kielland. 1937. Individual activity coefficients of ions in aqueous solutions. *American Chemical Society Journal* 59:1676–1678. Published by the American Chemical Society. Used with permission.

FIGURE 6.1 Relationship of activity coefficients of dissolved ions as a function of the ionic strength of a solution at 25°C.



Source: J. D. Hem. 1985. *Study and interpretation of the chemical characteristics of natural waters.* Water Supply Paper 2254, U.S. Geological Survey.

ions in the groundwater to form a precipitate or they may mobilize ions sorbed on solid surfaces. They may also undergo oxidation or reduction. Both these processes are reversible and can be described by chemical equilibrium. Many geochemical processes in groundwater are not readily reversible, such as weathering of silicate minerals. These reactions must be treated using kinetics. However, as this type of reaction is

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not of significant interest in contaminant hydrogeology, we do not typically consider kinetic models.

Table 6.2 contains the solubility products for a large number of minerals, including many that can be formed from trace metals that can be ground-water contaminants.

6.4 Oxidation-Reduction Reactions

In some chemical reactions the participating elements change their valence state through the gain or loss of electron(s). If an electron is gained, there is a loss of positive valence called a reduction. A loss of negative valence is called an oxidation. Together, these are referred to as **oxidation-reduction**, or **redox**, reactions. In environmental systems they may be controlled by microorganisms that do not participate in the reaction but act as catalysts. The microbes occur as a biofilm on the surfaces of the aquifer materials. They obtain energy by oxidation of organic compounds or hydrogen or reduced inorganic forms of iron, nitrogen, and sulfur. Electron acceptors are necessary for these biologically mediated redox reactions to occur. Under aerobic conditions oxygen is the electron acceptor, whereas under anaerobic conditions nitrate, sulfate, and carbon dioxide are the electron acceptors (McCarty et al. 1984).

An example of a reduction is

$$Fe^{2+} + 2e^- \rightleftharpoons Fe^0 \qquad (6.12)$$

In this example, ferrous iron is reduced to metallic iron by the addition of two electrons. This is a half-reaction, since the electrons must be supplied either by an electrical current or by a simultaneous reaction in which another element is oxidized and releases the requisite number of electrons. The standard electrical potential of a half-reaction is the voltage represented by the flow of electrons when the reaction is at equilibrium. Under standard conditions (25°C and 1 atm pressure) the standard potential is represented by the symbol E^0. The potential is in volts, with a negative value representing reducing conditions and a positive value representing oxidizing conditions (Hem 1985). By convention, the standard potential for the reduction of H^+ to hydrogen gas is 0:

$$2H^+ + 2e^- \rightleftharpoons H_2 \quad \text{(gas)} \qquad (6.13)$$

An example of oxidation occurs where ferrous iron loses an electron to form ferric iron:

$$Fe^{2+} \rightleftharpoons Fe^{3+} + e^- \qquad (6.14)$$

Oxidation-reduction reactions involve elements that can occur in more than one valence state. In Equations 6.12 and 6.14, iron occurred in the metallic (0) as well as the +2 and +3 states. Metals can usually occur in the metallic state with a zero valence and at least one other valence state. Some elements that are environmentally important can occur in several different valence states. Table 6.3 lists several elements that occur in different valence states and examples of compounds and ions formed from those elements.

In order for oxidation or reduction to occur in a chemical reaction, one element must be reduced while a second element is being oxidized. For example, the complete equation for the oxidation of ferrous iron to ferric iron is

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TABLE 6.2 Solubility products for selected minerals and compounds.

Compound	Solubility Product	Mineral Name
Chlorides		
CuCl	$10^{-6.7}$	
$PbCl_2$	$10^{-4.8}$	
Hg_2Cl_2	$10^{-17.9}$	
AgCl	$10^{-9.7}$	
Fluorides		
BaF_2	$10^{-5.8}$	
CaF_2	$10^{-10.4}$	Fluorite
MgF_2	$10^{-8.2}$	Sellaite
PbF_2	$10^{-7.5}$	
SrF_2	$10^{-8.5}$	
Sulfates		
$BaSO_4$	$10^{-10.0}$	Barite
$CaSO_4$	$10^{-4.5}$	Anhydrite
$CaSO_4 \cdot 2\ H_2O$	$10^{-4.8}$	Gypsum
$PbSO_4$	$10^{-7.8}$	Anglesite
Ag_2SO_4	$10^{-4.8}$	
$SrSO_4$	$10^{-6.5}$	Celestite
Sulfides		
Cu_2S	$10^{-48.5}$	
CuS	$10^{-36.1}$	
FeS	$10^{-18.1}$	
PbS	$10^{-27.5}$	Galena
HgS	$10^{-53.3}$	Cinnebar
ZnS	$10^{-22.5}$	Wurtzite
ZnS	$10^{-24.7}$	Sphalerite
Carbonates		
$BaCO_3$	$10^{-8.3}$	Witherite
$CdCO_3$	$10^{-13.7}$	
$CaCO_3$	$10^{-8.35}$	Calcite
$CaCO_3$	$10^{-8.22}$	Aragonite
$CoCO_3$	$10^{-10.0}$	
$FeCO_3$	$10^{-10.7}$	Siderite
$PbCO_3$	$10^{-13.1}$	
$MgCO_3$	$10^{-7.5}$	Magnesite
$MnCO_3$	$10^{-9.3}$	Rhodochrosite
Phosphates		
$AlPO_4 \cdot 2\ H_2O$	$10^{-22.1}$	Variscite
$CaHPO_4 \cdot 2\ H_2O$	$10^{-6.6}$	
$Ca_3(PO_4)_2$	$10^{-28.7}$	
$Cu_3(PO_4)_2$	$10^{-36.9}$	
$FePO_4$	$10^{-21.8}$	
$FePO_4 \cdot 2\ H_2O$	$10^{-26.4}$	

Source: K. B. Krauskopf, *Introduction to Geochemistry*, 2d ed. (New York: McGraw-Hill, 1979).

Source: K. B. Krauskopf. 1979. *Introduction to Geochemistry, Second Edition*. New York: McGraw-Hill.

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TABLE 6.3 Selected elements that can exist in more than one oxidation state.

Element	Valence State	Examples
Carbon	+4	HCO_3^-, CO_3^{2-}
	0	C
	−4	CH_4
Chromium	+6	CrO_4^{2-}, $Cr_2O_7^{2-}$
	+3	Cr^{3+}, $Cr(OH)_3$
Copper	+1	CuCl
	+2	CuS
Mercury	+1	Hg_2Cl_2
	+2	HgS
Iron	+2	Fe^{2+}, FeS
	+3	Fe^{3+}, $Fe(OH)_3$
Nitrogen	+ 5	NO_3^-
	+3	NO_2^-
	0	N
	−3	NH_4^+, NH_3
Oxygen	0	O
	−1	H_2O_2
	−2	H_2O, O^{2-}
Sulfur	−2	H_2S, S^{2-}, PbS
	+2	$S_2O_3^{2-}$
	+5	$S_2O_6^{2-}$
	+6	SO_4^{2-}

$$4\,Fe^{2+} + O_2 + 4\,H^+ \rightleftharpoons 2\,H_2O + 4\,Fe^{3+} \qquad (6.15)$$

This complete reaction is composed of two half-reactions:

$$4\,Fe^{2+} \rightleftharpoons 4\,Fe^{3+} + 4\,e^- \qquad (6.16)$$

$$O_2 + 4\,H^+ + 4\,e^- \rightleftharpoons 2\,H_2O \qquad (6.17)$$

An aqueous solution has an oxidation potential indicated by the symbol Eh. This can be calculated from the **Nernst equation**:

$$Eh = E^0 - \frac{RT}{nF} \ln \frac{[\text{products}]}{[\text{reactants}]} \qquad (6.18)$$

where:

Eh = oxidation potential of the aqueous solution in volts
E^0 = standard potential of redox reaction in volts
R = gas constant, 0.00199 Kcal/(mole-K)
T = temperature in Kelvins
F = Faraday constant, 23.06 Kcal/V
n = number of electrons in half-reaction
[ ] = activity of products and reactants

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The standard potential for a reaction can be determined from the relationship

$$E^0 = \frac{-\Delta G_R^0}{nF} \tag{6.19}$$

where ΔG_R^0 in volts is the **free energy**, or **Gibbs free energy**, of the reaction.

The free energy of a reaction is the sum of the free energies of the products minus the sum of the free energies of the reactants. For the reaction

$$aA + bB \rightleftharpoons cC + dD$$

the free energy can be found from:

$$\Delta G_R^0 = c\Delta G_c^0 + d\Delta G_d^0 - a\Delta G_a^0 - b\Delta G_b^0 \tag{6.20}$$

Values of free energy for many elements, ions, and compounds are found in standard reference works. Table 6.4 contains values for a number of species.

The equilibrium constant for a reaction is related to the free energy of the reaction by

$$\Delta G_R^0 = -RT \ln K_{eq} \tag{6.21}$$

At standard temperature and pressure and with ΔG_R^0 in kilocalories, Equation 6.21 can be rewritten as

$$\log K_{eq} = \frac{-\Delta G_R^0}{1.364} \tag{6.22}$$

The oxidation potential of an aqueous solution can be measured using a redox or ORP electrode. If the value is positive, the solution is oxidizing, and if it is negative, the solution is reducing. Oxidation potential is measured in volts relative to the hydrogen electrode, which is at zero. Commercially available Eh meters are available that can be attached to a groundwater sampling pump. The groundwater sample is pumped under positive pressure into the flowthrough cell where the electrode is located. The water sample is never subjected to a vacuum, which could cause degassing. Moreover, it is not exposed to the atmosphere, where it can come into contact with atmospheric oxygen. This has simplified the accurate and precise measurement of Eh in groundwater. Eh is directly proportional to pE, which is defined as the logarithm of the electron concentration in a solution, and is an analogous measure of the **oxidation/reduction potential**, ORP.

■ 6.5 Relationship between pH and Eh

6.5.1 pH

Water undergoes a dissociation into two ionic species:

$$H_2O \rightleftharpoons H^+ + OH^- \tag{6.23}$$

The equilibrium constant for this reaction is

$$K_{eq} = \frac{[H^+][OH^-]}{[H_2O]} \tag{6.24}$$

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TABLE 6.4 Standard Gibbs free energy of formation for selected species.

Species	ΔG° kcal/mole	Species	ΔG° kcal/mole	Species	ΔG° kcal/mole
Arsenic		**Manganese**		UO_2(c) (uranite)	−246.61[a]
As_2O_3(c)	−187.0[a]	MnO_2(c) (pyrolusite)	−111.18[b]	UO_2^+(aq)	−229.69[a]
As_4O_6(c)	−275.46[a]	Mn_2O_3 (bixbyite)	−210.6[b]	UO_2^{2+} (aq)	−227.68[a]
As_2S_3(c)	−40.3[a]	Mn_3O_4 (hausmannite)	−306.7[b]	$(UO_2)_2(OH)_2^{2+}$(aq)	−560.99[a]
$FeAsO_4$(c)	−185.13[a]	$Mn(OH)_2$ (c) amorphous	−147.0[b]	$(UO_2)_3(OH)_5^+$ (aq)	−945.16[a]
H_3AsO_4(aq)	−183.1[a]	$MnCO_3$(c) (rhodochrosite)	−195.2[b]	$(UO_2)_3(OH)_7^-$	−1037.5[a]
$H_2AsO_4^-$(aq)	−180.04[a]	Mn^{2+}(aq)	−54.5[b]	$UO_2CO_3^0$(c)	−367.07[a]
$HAsO_4^{2-}$ (aq)	170.82[a]	$MnOH^+$(aq)	−96.8[b]	$UO_2(CO_3)_2^{2-}$(aq)	−503.2[a]
AsO_4^{3-}(aq)	−155.0[a]	**Molybdenum**		$UO_2(CO_3)_3^{4-}$(aq)	−635.69[a]
$HAsO_2$(aq)	−96.25[a]	MoO_3(c)	−159.66[b]	**Miscellaneous species**	
AsO_2^-(aq)	−83.66[a]	MoO_2(c)	−127.40[b]	$ZnFe_2O_4$(c)	−254.2[a]
Chromium		$FeMoO_4$(c)	−233[b]	$CuFeO_2$(c)	−114.7[b]
Cr_2O_3(c)	−252.9[f]	MoO_4^{2-}(aq)	−199.9[b]	$CuFe_2O_4$(c)	−205.26[b]
$HCrO_4^-$	−182.8[f]	**Silver**		$NiFe_2O_4$(c)	−232.6[b]
$Cr_2O_7^{2-}$(aq)	−311.0[f]	Ag_2O(c)	−2.68[b]	H_2O(l)	−56.687[a]
CrO_4^{2-} (aq)	−173.96[f]	AgCl(c)	−26.24[b]	OH^-(aq)	−37.594[a]
Copper		Ag_2S(c)	−9.72[b]	O_2(aq)	−3.9[a]
CuO(c)	−31.0[b]	Ag_2CO_3(c)	−104.4[b]	HSO_4^-(aq)	−180.69[a]
$CuSO_4 \cdot 3Cu(OH)_2$(c) (brochantite)	−434.5[b]	Ag^+(aq)	18.43[b]	SO_4^{2-} (aq)	−177.97[a]
Cu_2O(c)	−34.9[b]	AgOH(aq)	−22.0[b]	H_2S(aq)	−6.66[a]
Cu_2S(c)	−20.6[b]	$Ag(OH)_2^-$(aq)	−62.2[b]	HS^-(aq)	2.88[a]
Cu^{2+}(aq)	15.67[b]	AgCl(aq)	−17.4[b]	S^{2-}(aq)	20.5[a]
$CuSO_4$(aq)	−165.45[b]	$AgCl_2^-$(aq)	−51.5[b]	CO_2(g)	−94.254[a]
$HCuO_2^-$(aq)	−61.8[b]	**Vanadium**		CO_2(aq)	−92.26[a]
CuO_2^{2-}(aq)	−43.9[b]	$H_4VO_4^+$	−253.67[k]	H_2CO_3(aq)	−148.94[a]
Cu^+(aq)	11.95[b]	$H_3VO_4^0$	−249.2[k]	HCO_3^- (aq)	−140.26[a]
Iron		$H_2VO_4^-$	−244[k]	CO_3^{2-} (aq)	−126.17[a]
$Fe(OH)_3$(c) ppt.	−166.0[b]	HVO_4^{2-}(aq)	−233.0[f]	Cl^-(aq)	−31.37[a]
$Fe(OH)_2$(c) ppt.	−116.3[f]	VO_4^{3-}(aq)	−214.9[k]	CH_4(g)	−12.13[a]
$FeCO_3$(c) (siderite)	−159.35[b]	VO^{2+}(aq)	−106.7[f]	CH_4(aq)	−8.22[a]
FeS_2(c) (pyrite)	−39.9[b]	$V(OH)_3^0$(aq)	−212.9[k]	H^+(aq)	0.00
Fe_2O_3 (hematite)	−177.4[b]	VOH^{2+}(aq)	−111.41[k]	Cl^-(aq)	−31.38[c]
Fe^{3+}(aq)	−1.1[b]	$V(OH)_2^+$	−163.2[k]	PO_4^{3-} (aq)	−243.5[a]
$FeOH^{2+}$(aq)	−54.83[b]	$VOOH^+$	−155.65[k]	HPO_4^{2-} (aq)	−260.34[a]
$Fe(OH)_2^+$(aq)	−106.7[f]	V^{3+}	−57.8[k]	$H_2PO_4^-$ (aq)	−270.14[k]
Fe^{2+}(aq)	−18.85[b]	**Uranium**		$H_3PO_4^0$(c)	−273.10[a]
$FeOH^+$(aq)	−62.58[f]	U^{4+}(aq)	−126.44[a]	Na^+(aq)	−62.59[c]
$Fe(OH)_3^-$(aq)	−147.0[b]	UOH^{3+}(aq)	−182.24[a]	K^+(aq)	−67.51[c]
$Fe(OH)_4^-$(aq)	−198.4	$U(OH)_4^0$(c)	−347.18[a]	NH_4^+(aq)	−18.99[c]
FeO(c)	−60.03[a]			Pb^{2+}(aq)	−5.83[a]
Fe_2S(c) (pyrite)	−38.3[a]			O_2(g)	0.00
FeS(c)	−24.22[a]				

c = solid
aq = aqueous solutions
g = gas

[a] Wageman, D. D., W. H. Evans, V. B. Parker, 1. Halow, S. M. Baily, and R. H. Schumm. 1968. *Selected values of chemical thermodynamic properties.* National Bureau of Standards Technical Note 270–3; 264 pp.
[b] Wageman, D. D., W. H. Evans, V. B. Parker, 1. Halow, S. M. Baily, and R. H. Schumm. 1969. *Selected values of chemical thermodynamic properties.* National Bureau of Standards Technical Note 270–4; 141 pp.

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TABLE 6.4 *Cont't*

[c] CODATA Task Group on Key Values for Thermodynamics. 1976. Recommended key values for thermodynamics 1975. *Journal of Chemical Thermodynamics* 8:603–5.
[d] CODATA Task Group on Key Values for Themodynamics. 1977. Recommended key values for thermodynamics 1976. *Journal of Chemical Thermodynamics* 9:705–6.
[e] Giridhar J., and Donald Langmuir. 1991. Determination of E^0 for the UO_2^{2+}/U^{4+} couple from measurement of the equilibrium: $UO_2^{2+} + Cu(s) + 4\,H^+ = U^{4+} + Cu\,2^+ + 2\,H_2O$ at 25°C and some geochemical implications. *Rodiochemica Acta* 54: 133–38.
[f] *Handbook of Chemistry and Physics.* Selected Values of Chemical Thermodynamic Properties. Boca Raton, Fla.: CRC Press.
[g] Robie, R. A., B. S. Hemingway, and J. R. Fisher. 1978. *Thermodynamic properties of minerals and related substances* at 298.15 K *and* 1 bar (105 *pascals) pressure and higher temperatures.* U. S. Geological Survey Bulletin 1452; 456 pp.
[h] Feitknecht, Walter, and P.W. Schindler. 1963. Solubility constants of metal oxides, metal hydroxides and metal salts in aqueous solution. *Pure and applied Chemistry* 6: 130–57.
[i] Baes, C. F., Jr., and R. E. Messmer. 1976. *The Hydrolysis of Cations.* New York: Wiley, 489 pp.
[j] Wageman, D. D., W. H. Evans, V. B. Parker, I. Halow, S. M. Baily, and R. H. Schumm. 1968. *Selected values of chemical thermodynamic properties.* National Bureau of Standards Technical Note 270–5.
[k] Langmuir, Donald. 1977. Uranium solution mineral equilibria at low temperatures. *Geochimica et Cosmochimica Acta* 42:547–69.

The value of this equilibrium constant depends upon the temperature, but at 25°C it is 1×10^{-14}. Water that is neutral has the same number of H^+ and OH^- ions. If there are more H^+ ions, water is acidic, and if there are more OH^- ions, it is basic.

The pH of an aqueous solution is a measure of the number of hydrogen ions or protons present. The definition of pH is the negative logarithm of the hydrogenion activity. It ranges from 0 (most acidic) to 14 (most basic), and at 25°C a pH of 7 means that the solution is neutral. Because $[H_2O]$ is unity, from Equation 6.24 we have the relationship $[H^+][OH^-] = K_{eq} = 10^{-14}$. The pH of a solution is measured with a pH meter and an electrode. It should be measured in the field, preferably in a flowthrough cell so that dissolved gas isn't exchanged with the atmosphere prior to the measurement. The pH of a solution is especially sensitive to the amount of dissolved CO_2.

6.5.2 Relationship of Eh and pH

We thus have two ways to characterize a solution. The pH describes the number of protons present and the Eh is related to the number of electrons. Eh and pH can be related through the Nernst equation for a reaction that contains water and H^+ ions. Such a reaction can be written (Robertson 1975)

$$bB + mH^+ + ne^- \rightleftharpoons aA + wH_2O \qquad \textbf{(6.25)}$$

where

A = reactant
B = product
n = number of electrons released
a = moles of reactant
w = moles of water
b = moles of product
m = moles of hydrogen ions

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The Nernst equation for Reaction 6.25 is

$$\mathrm{Eh} = E^{\circ} - \frac{RT}{nF} \ln \frac{[\mathrm{A}]^{a}[\mathrm{H_2O}]^{w}}{[\mathrm{B}]^{b}[\mathrm{H}^{+}]^{m}} \tag{6.26}$$

The activity of water is unity. For a particular reaction, E° is given and R, T, and F are constants. The significant variables are the Eh and the activities of the reactant, the product, and the hydrogen-ion activity, which can be expressed as a pH. Equation 6.26 can be rearranged and expressed in base 10 logs as either

$$\mathrm{Eh} = E^{\circ} - 2.303 \frac{RT}{nF} \log \frac{[\mathrm{A}]^{a}}{[\mathrm{B}]^{b}[\mathrm{H}^{+}]^{m}} \tag{6.27}$$

or

$$\mathrm{Eh} = E^{\circ} - 2.303 \frac{RT}{nF} \log \frac{[\mathrm{A}]^{a}}{[\mathrm{B}]^{b}} + 2.303 \frac{RTm}{nF} \log[\mathrm{H}^{+}] \tag{6.28}$$

At 25°C and 1 atm of pressure, Equation 6.28 can be expressed as

$$\mathrm{Eh} = E^{\circ} - \frac{0.0592}{n} \log \frac{[\mathrm{A}]^{a}}{[\mathrm{B}]^{b}} - 0.0592 \frac{m}{n} \mathrm{pH} \tag{6.29}$$

6.5.3 Eh-pH Diagrams

The Eh-pH relationship is particularly useful when applied in the form of an Eh-pH diagram, with Eh the ordinate and pH the abscissa. If a solution has several ions present that can react to form different products or occur in different valence states, the stable product or valence state at a given concentration of reactants will be a function of the pH and Eh of the solution.

Figure 6.2 is a basic Eh-pH diagram. The range of pH is 0 to 14. For Eh, it is convenient to specify a range of about +1.4 to −1.0 V. In certain regions of the Eh-pH field, water will be oxidized to O_2, and in other regions water will be reduced to H_2. We will calculate these regions as an example problem.

EXAMPLE PROBLEM

Calculate the stability field for water at standard conditions.

The oxidation of water is given by

$$O_2(g) + 4H^{+} + 4e^{-} \rightleftharpoons 2H_2O(l)$$

From Table 6.4,

$$\Delta G^{0}_{H_2O(l)} = -56.69 \text{ kcal}$$

$$\Delta G^{0}_{O_2(g)} = 0$$

$$\Delta G^{0}_{H^{+}} = 0$$

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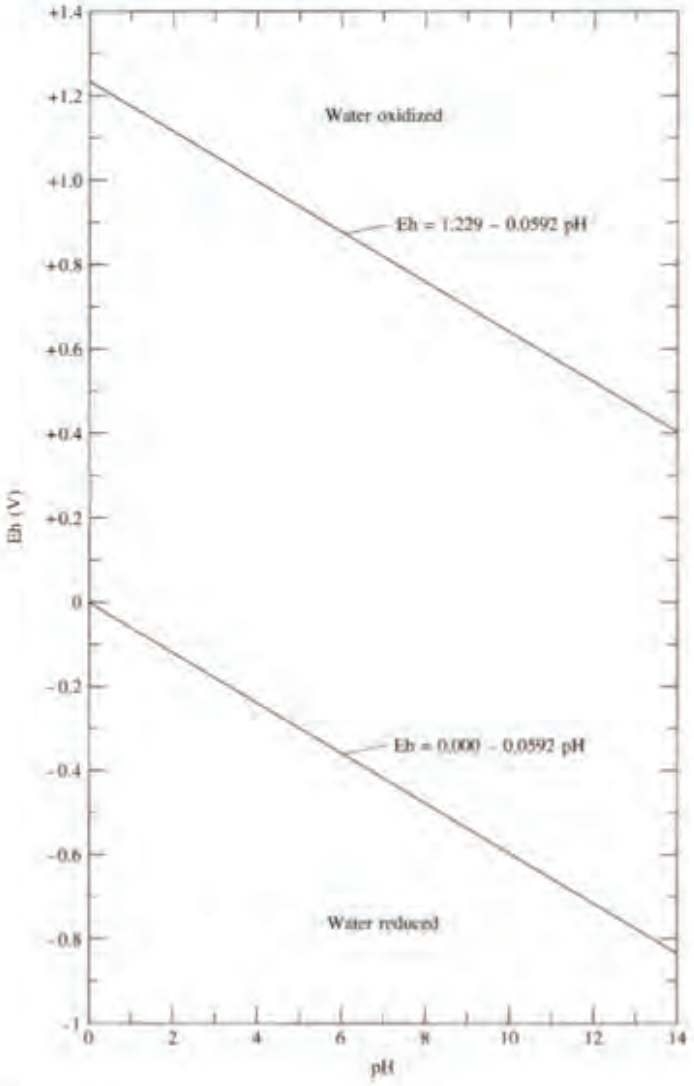
FIGURE 6.2 Eh-pH diagram showing the stability field for water.



From Equation 6.20,

$$\Delta G_R^0 = 2\Delta G_{H_2O(l)}^0 - \Delta G_{O_2(g)}^0 - 4\Delta G_{H^+}^0$$

$$\Delta G_R^0 = 2(-56.69) - 0 - 4(0) = -113.38\ kcal$$

The value of ΔG_R^0 in kilocalories is converted to a standard potential by use of Equation 6.19:

$$E^0 = \frac{-\Delta G_R^0}{nF} = \frac{-(-113.38)}{4 \cdot 23.06} = 1.229\ \text{V}$$

The Nernst equation (Equation 6.24) can be expressed as:

$$\text{Eh} = E^0 - \frac{RT}{nF} 2.303 \log \frac{[H_2O]}{[O_2][H^+]^4}$$

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The activity of dissolved gaseous oxygen is expressed as a partial pressure, P_{o2}. At standard conditions it has a value of 1atm. The activity of water is unity. The Nernst equation thus reduces to

$$Eh = 1.229 - \frac{0.00199 \cdot 298}{4 \cdot 23.06} 2.303 \log \left[H^+\right]^{-4}$$

This expression can be reduced to

$$Eh_{(Volts)} = 1.229 - 0.0592pH$$

This equation defines the upper boundary of stability for water, above which oxidation would break apart the water molecule.

The reduction of hydrogen ions to form gaseous hydrogen is

$$2H^+ + 2e^- \rightleftharpoons H_{2(gas)}$$

From Table 6.4,

$$\Delta G^0_{H^+} = 0$$

$$\Delta G^0_{H_2(gas)} = 0$$

The value of ΔG^0_R for the formation of hydrogen gas is obviously zero. Therefore, the value of E^0 is also zero.

From the Nernst equation,

$$Eh = E^0 - \frac{0.00199 \cdot 298}{2 \cdot 23.06} 2.303 \log \frac{P_{H_2}}{\left[H^+\right]^2}$$

The value of P_{H2} is 1 atm and the calculated value of E^0 is 0, hence the preceding expression can be reduced to

$$Eh_{(volts)} = 0.000 - 0.0592pH$$

This equation forms the lower boundary of the stability field for water. These boundaries are plotted in Figure 6.2.

6.5.4 Calculating Eh-pH Stability Fields

The stability fields within the Eh-pH diagram for various forms of an element can be computed using chemical thermodynamics. Basic sources of thermodynamic data include Bagman et al. (1968; 1969; 1971) and Robie et al. (1978).

Boundaries for an element between dissolved species that have different valence states are computed using the Nernst equation (Equation 6.27, 6.28, or 6.29). If both ions are at the same valence state, then the equation for chemical equilibrium is used. If one is calculating the boundary between a solid species and a dissolved form, the chemical activity of the solid species is 1. For some of the boundaries of solid species, it will be necessary to assume an activity for the dissolved species.

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EXAMPLE PROBLEM

Calculate an Eh-pH diagram for iron in which the solid species are $Fe(OH)_3$ and FeO and the activity of dissolved iron is 56 µg/L(10^{-6} M).

Soluble forms of the ferrous ion and the ferric ion include $Fe2^+$, $Fe3^+$, $FeOH2^+$, and $Fe(OH)_2^+$. Transformations between these ions are determined by redox equations:

$$FeOH^{2+} + H^+ + e^- \rightleftharpoons Fe^{2+} + H_2O \quad (6.30)$$

$$Fe(OH)_2^+ + H^+ + e^- \rightleftharpoons Fe^{2+} + 2H_2O \quad (6.31)$$

$$Fe^{3+} + e^- \rightleftharpoons Fe^{2+} \quad (6.32)$$

The free energy and the standard potential for these reactions can be determined from Equations 6.20 and 6.19, respectively.

From Table 6.4 free energies are as follows.

$FeOH^{2+} = -54.83$ kcal/mol

$FeO = -60.03$ kcal/mol

$Fe(OH)_2^+ = -106.7$ kcal/mol

$Fe(OH)_3 = -166$ kcal/mol

$Fe^{2+} = -18.85$ kcal/mol

$Fe(OH)_4^- = -198.4$ kcal/mol

$Fe^{3+} = -1.1$ kcal/mol

$H^+ = 0$

$H_2O = -56.69$ kcal/mol

For Reaction 6.30 ($FeOH^{2+} + H^+ + e^- \rightleftharpoons Fe2^+ + H_2O$):

$$\Delta G_R^0 = \left[\Delta G_{H_2O}^0 + \Delta G_{Fe^{2+}}^0\right] - \left[\Delta G_{FeOH^{2+}} + \Delta G_{H^+}^0\right]$$

$$\Delta G_R^0 = -56.69 + (-18.85) - (-54.83) - 0$$

$$\Delta G_R^0 = -20.71 \text{kcal/mol}$$

$$E^0 = \frac{-\Delta G^0{}_R}{nF} = \frac{-(-20.71)}{1 \cdot 23.06} V$$

$$E^0 = +0.898\,V$$

For Reaction 6.31 ($Fe(OH)_2^+ + 2H^+ + e^- \rightleftharpoons Fe^{2+} + 2H_2O$):

$$\Delta G_R^0 = 2\Delta G_{H_2O}^0 + \Delta G_{Fe^{2+}}^0 - \Delta G_{Fe(OH)_2^+}^0 - 2\Delta G_{H^+}^0$$

$$\Delta G_R^0 = 2(-56.69) + (-18.85) - (-106.7) - 2(0)$$

$$\Delta G_R^0 = -25.53 \text{kcal/mol}$$

$$E^0 \frac{-\Delta G_R^0}{nF} = \frac{-(-25.53)}{1 \cdot 23.06} V$$

$$E^0 = +1.107V$$

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For Reaction 6.32 ($Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$):

$$\Delta G_R^0 = \Delta G_{Fe^{2+}}^0 - \Delta G_{Fe^{3+}}^0$$

$$\Delta G_R^0 = -18.85 - (-1.1)$$

$$\Delta G_R^0 = -17.75$$

$$E^0 = \frac{-\Delta G_R^0}{nF} = \frac{-(-17.75)}{1 \cdot 23.06} V$$

$$E^0 = +0.770V$$

The boundaries between the stability fields are determined from the Nernst equation. At the boundary between two fields, the activities of the iron species on the left of the reaction is equal to the activity of the iron species on the right of the equation—i.e., the two species are at equilibrium.

For Reaction 6.30 ($FeOH^{2+} + H^+ + e^- \rightleftharpoons Fe^{2+} + H_2O$):

$$Eh = E^0 - \frac{0.0592}{n} \log \frac{[Fe^{2+}]}{[FeOH^{2+}]} - 0.0592 \frac{m}{n} pH$$

Since $[FeOH^{2+}] = [Fe^{2+}]$, m (the number of hydrogen ions) = 1, n(the number of electrons) = 1, $E^0 = +0.898$ V, and log 1 = 0:

$$Eh_{(volts)} = 0.898 - 0.0592\ pH \quad \textbf{(6.33)}$$

For Reaction 6.31 ($Fe(OH)_2^+ + 2H^+ + e^- \rightleftharpoons Fe^{2+} + 2H_2O$):

$$Eh = E^0 - \frac{0.0592}{n} \log \frac{[Fe^{2+}]}{[Fe(OH)_2^+]} - 0.0592 \frac{m}{n} pH$$

Since $[Fe(OH)_2^+] = [Fe^{2+}]$, $m = 2$, $n = 1$, and $E^0 = +1.107$ V:

$$Eh_{(volts)} = 1.107 - 0.1184\ pH \quad \textbf{(6.34)}$$

For Reaction 6.32 ($Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$):

$$Eh = E^0 - \frac{0.0592}{n} \log \frac{[Fe^{2+}]}{[Fe^{3+}]} - 0.0592 \frac{m}{n} pH$$

This reaction is independent of pH because neither $[H^+]$ nor $[OH^-]$ appears in the reaction. Hence the value of m is 0. Because as $[Fe^{3+}] = [Fe^{2+}]$ and log 1= 0, Eh is a constant equal to E^0, which is 0.770 V:

$$Eh = 0.770\ V \quad \textbf{(6.35)}$$

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The boundary between two dissolved species that are at the same valence state can be determined from chemical equilibrium.

For iron there are two boundaries between dissolved ions of ferric iron. These boundaries are represented by these reactions:

$$Fe^{3+} + H_2O \rightleftharpoons FeOH^{2+} + H^+ \quad \textbf{(6.36)}$$

$$FeOH^{2+} + H_2O \rightleftharpoons Fe(OH)_2^{+} + H^+ \quad \textbf{(6.37)}$$

For Reaction 6.36 $\left(Fe^{3+} + H_2O \rightleftharpoons FeOH^{2+} + H^+\right)$, the equilibrium constant can be obtained from the free energy of the reaction. The first step is to find the free energy of the reaction using Equation 6.20.

$$\Delta G_R^0 = \Delta G^0_{FeOH^{2+}} + \Delta G^0_{H+} - \Delta G^0_{Fe^{3+}} - \Delta G^0_{H_2O}$$

$$\Delta G_R^0 = -54.83 + 0 - (-1.1) - (-56.69)$$

$$\Delta G_R^0 = +2.96 \text{ kcal/mol}$$

The next step is to determine the equilibrium constant using Equation 6.22.

$$\log k_{eq} = -\frac{\Delta G_R^0}{1.364} = -\frac{2.96}{1.364} = -2.17$$

$$K_{eq} = 10^{-2.17}$$

From Equation 6.6,

$$K_{eq} = \frac{\left[FeOH^{2+}\right]\left[H^+\right]}{\left[Fe^{3+}\right]\left[H_2O\right]} = 10^{-2.17}$$

Since $[H_2O] = 1$ and at the boundary $[FeOH^{2+}] = [Fe^{3+}]$,

$$[H^+] = 10^{-2.17} \quad \textbf{(6.38)}$$

This means that a vertical line at a pH of 2.17 separates these two stability fields.

For Reaction 6.37 $\left(FeOH^{2+} + H_2O \rightleftharpoons Fe(OH)_2^{+} + H^+\right)$, find the free energy of the reaction:

$$\Delta G_R^0 = \Delta G^0_{Fe(OH)_2^+} + \Delta G^0_{H+} - \Delta G^0_{FeOH^{2+}} - \Delta G^0_{H_2O}$$

$$\Delta G_R^0 = -106.7 + 0 - (-54.83) - (-56.69)$$

$$\Delta G_R^0 = +4.82 \text{ kcal/mol}$$

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Next find the value of K_{eq}:

$$\log K_{eq} = \frac{-\Delta G_R^0}{1.364} = \frac{-4.82}{1.364} = -3.53$$

$$K_{eq} = 10^{-3.53}$$

Finally, from Equation 6.6,

$$K_{eq} = \frac{\left[Fe(OH)^{2+}\right]\left[H^+\right]}{\left[FeOH^{2+}\right]\left[H_2O\right]} = 10^{-3.53}$$

Since $[H_2O] = 1$ and $[Fe(OH)^{2+}] = [FeOH^{2+}]$,

$$[H^+] = 10^{-3.53} \quad \textbf{(6.39)}$$

Lines that delineate the stability field for solids can be obtained by similar reasoning. Remember that the activity of a solid in equilibrium with dissolved species is 1. The location of the boundaries of solid species is a function of the amount of dissolved iron present.

In this situation there are two stable iron precipitates, Fe(OH)3 and FeO. The reactions at the boundaries include

$$Fe(OH)_3 + H^+ \rightleftharpoons Fe(OH)_2^+ + H_2O \quad \textbf{(6.40)}$$

$$Fe(OH)_3 + 3H^+ + e^- \rightleftharpoons Fe^{2+} + 3H_2O \quad \textbf{(6.41)}$$

$$Fe(OH)_4^- + H^+ \rightleftharpoons Fe(OH)_3 + H_2O \quad \textbf{(6.42)}$$

$$Fe(OH)_3 + e^- \rightleftharpoons FeO + H_2O + OH^- \quad \textbf{(6.43)}$$

$$Fe(OH)_4^- + 2H^+ + e^- \rightleftharpoons FeO + 3H_2O \quad \textbf{(6.44)}$$

$$FeO + 2H^+ \rightleftharpoons Fe^{2+} + H_2O \quad \textbf{(6.45)}$$

Reaction 6.40 $Fe(OH)_3 + H^+ \rightleftharpoons Fe(OH)_2^+ + H_2O$ is solved using an equilibrium approach:

$$\Delta G_R^0 = \Delta G^0_{Fe(OH)_2^+} + \Delta G^0_{H_2O} - \Delta G^0_{Fe(OH)_3} - \Delta G^0_{H^+}$$

$$\Delta G_R^0 = -106.7 + (-56.69) - (-166) - 0 = 2.61$$

$$\log K_{eq} = -\frac{\Delta G_R^0}{1.364} = -\frac{2.61}{1.364} = -1.91$$

$$K_{eq} = 10^{-1.91}$$

$$K_{eq} = \frac{\left[Fe(OH)_2^+\right]\left[H_2O\right]}{\left[Fe(OH)_3\right]\left[H^+\right]} = 10^{-1.91}$$

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Since [Fe(OH)3] = 1and [H2O] = 1,

$$\left[H^+\right]=\frac{\left[Fe(OH)_2{}^+\right]}{10^{-1.91}}$$

Reaction 6.41 $Fe(OH)_3 + 3H^+ + e^- \rightleftharpoons Fe^{2+} + 3H_2O$ is solved using the Nernst equation:

$$\Delta G_R^0 = \Delta G_{Fe^{2+}}^0 + 3\Delta G_{H_2O}^0 - \Delta G_{Fe(OH)_3}^0 - 3\Delta G_{H^+}^0$$

$$\Delta G_R^0 = -18.85 + 3(-56.69) - (-166) - 0$$

$$\Delta G_R^0 = -22.95 \text{ kcal/mol}$$

$$E^0 = \frac{-\Delta G_R^0}{nF} = -\frac{(-22.95)}{1{\cdot}23.06} = +0.994\text{V}$$

$$Eh = E^0 - \frac{0.0592}{n}\log\frac{\left[Fe^{2+}\right]}{\left[Fe(OH)_3\right]} - 0.0592\frac{m}{n}\text{pH}$$

Since there are three hydrogen ions ($m = 3$) and one electron ($n = 1$) and $[Fe(OH)_3] = 1$, then

$$Eh_{(\text{Volts})} = 0.994 - 0.0592\ \log\left[Fe^{2+}\right] - 0.178\text{pH} \qquad \textbf{(6.47)}$$

Reaction 6.42 $\left(Fe(OH)_4{}^- + H^+ \rightleftharpoons Fe(OH)_3 + H_2O\right)$ is solved by using an equilibrium approach:

$$\Delta G^0{}_R = \Delta G^0{}_{Fe(OH)_3} + \Delta G^0{}_{H_2O} - \Delta G^0{}_{Fe(OH)_4{}^-} - \Delta G^0{}_{H^+}$$

$$\Delta G^0{}_R = -166 - 56.69 - (-198.4) - 0$$

$$\Delta G^0{}_R = -24.29$$

$$\log K_{eq} = -\frac{\Delta G^0{}_R}{1.364} = \frac{24.29}{1.364} = 17.8$$

$$K_{eq} = 10^{17.8}$$

$$K_{eq} = \frac{\left[Fe(OH)_3\right]\left[H_2O\right]}{\left[Fe(OH)_4{}^-\right]\left[H^+\right]} = 10^{17.8}$$

Since $[Fe(OH)_3] = 1$ and $[H_2O] = 1$,

$$\left[H^+\right] = \frac{10^{-17.8}}{\left[Fe(OH)_4{}^-\right]} \qquad \textbf{(6.48)}$$

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Equation 6.43 $\left(Fe(OH)_3 + e^- \rightleftharpoons FeO + H_2O + OH^-\right)$ is solved using the Nernst equation:

$$\Delta G^0{}_R = \Delta G^0{}_{FeO} + \Delta G^0{}_{H_2O} + \Delta G^0{}_{OH^-} - \Delta G^0{}_{Fe(OH)_3}$$

$$\Delta G^0{}_R = -60.03 + (-56.69) + (-37.59) - (-166)$$

$$\Delta G^0{}_R = +11.69$$

$$E^0 = \frac{-\Delta G^0{}_R}{nF} = \frac{-11.69}{1 \cdot 23.06} = -0.507\,V$$

$$Eh = E^0 - \frac{0.0592}{n} \log \frac{[FeO][H_2O][OH^-]}{[Fe(OH)_3]}$$

Since $[Fe(OH)_3] = 1$, $[FeO] = 1$, $[H_2O] = 1$, and $n = 1$,

$$Eh = -0.507 - 0.0592 \log[OH^-]$$

Because the diagram uses pH as a variable, $[OH^-]$ must be expressed in terms of pH. By definition, $[OH^-] = 10^{-14}/[H^+]$; therefore, $\log [OH^-] = \log 10^{-14} - \log [H^+]$, so that

$$Eh = -0.5.7 - 0.0592(pH - 14)$$

$$Eh_{(volts)} = 0.322 - 0.0592\ pH \qquad \textbf{(6.49)}$$

Reaction 6.44 $\left(Fe(OH)_4{}^- + 2H^+ + e^- \rightleftharpoons FeO + 3H_2O\right)$ is solved using the Nernst equation:

$$\Delta G^0{}_R = \Delta G^0{}_{FeO} + 3\Delta G^0{}_{H_2O} - \Delta G^0{}_{Fe(OH)_4{}^-} - 2\Delta G^0{}_{H+}$$

$$\Delta G^0{}_R = -60.03 + 3(-56.69) - (-198.4) - 0$$

$$\Delta G^0{}_R = -31.7\ kcal/mol$$

$$E^0 = \frac{-\Delta G^0{}_R}{nF} = \frac{-(-31.7)}{1 \cdot 23.06} = +1.375$$

$$Eh = E^0 - \frac{0.0592}{n} \log \frac{[FeO][H_2O]^3}{[Fe(OH)_4{}^-][H^+]^2}$$

Since $[FeO]$ and $[H_2O]$ are 1and $n = 1$,

$$Eh = +1.375 - 0.0592 \log \frac{1}{[Fe(OH)_4{}^-][H^+]^2}$$

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This can be expressed in terms of pH as

$$Eh = 1.375 + 0.0592 \log\left[Fe(OH)_4^-\right] + 2(0.0592) \log\left[H^+\right]$$

$$Eh_{(volts)} = 1.375 + 0.0592 \log\left[Fe(OH)_4^-\right] - 0.118pH \qquad \textbf{(6.50)}$$

Reaction 6.45 ($FeO + 2H^+ \rightleftharpoons Fe^{2+} + H_2O$) is solved as an equilibrium reaction:

$$\Delta G^0{}_R = \Delta G^0{}_{Fe^{2+}} + \Delta G^0{}_{H_2O} - \Delta G^0{}_{FeO} - 2\Delta G^0{}_{H^+}$$

$$\Delta G^0{}_R = -18.85 + (-56.69) - (-60.03) - 2(0)$$

$$\Delta G^0{}_R = -15.51 \text{ kcal/mol}$$

$$\log k_{eq} = \frac{-\Delta G^0{}_R}{1.364} = 11.36$$

$$k_{eq} = 10^{11.36}$$

$$k_{eq} = \frac{[Fe^{2+}][H_2O]}{[FeO][H^+]^2}$$

Since $[H_2O]$ and $[FeO] = 1$,

$$[H^+]^2 = \frac{[Fe^{2+}]}{10^{11.36}}$$

$$[H^+] = \sqrt{\frac{[Fe^{2+}]}{10^{11.36}}} \qquad \textbf{(6.51)}$$

Several of the equations, including Equations 6.46, 6.47, 6.48, 6.50, and 6.51, depend upon the activity of the dissolved iron.

The following equations, which are independent of dissolved iron activity, have been derived.

Boundary	Equation Number	Equation
$FeOH^{2+} - Fe^{2+}$	6.31	$Eh_{(volts)} = 0.898 - 0.0592pH$
$Fe(OH)_2^+ - Fe^{2+}$	6.32	$Eh_{(volts)} = 1.107 - 0.118pH$
$Fe^{3+} - Fe^{2+}$	6.33	$Eh_{(volts)} = 0.770$
$Fe^{3+} - FeOH^{2+}$	6.38	$pH = 2.17$
$Fe(OH)^{2+} - Fe(OH)_2^+$	6.39	$pH = 3.53$
$Fe(OH)_3 - FeO$	6.49	$Eh_{(volts)} = 0.322 - 0.0592pH$

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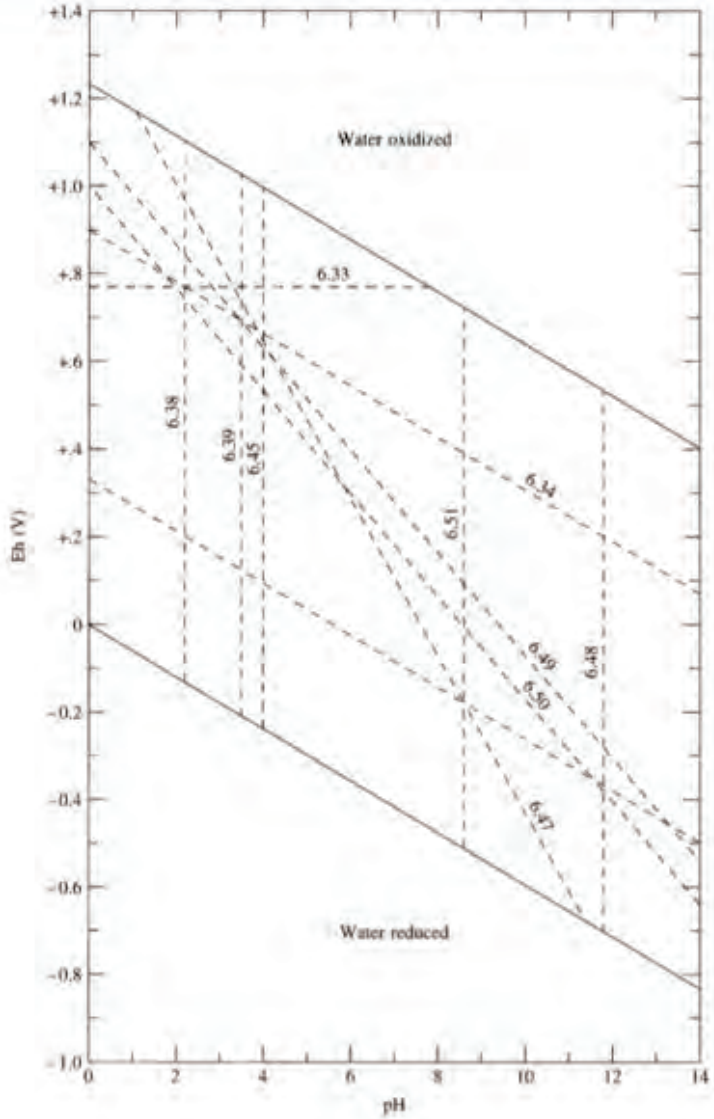
FIGURE 6.3 Equations for an Eh-pH diagram for dissolved iron with dissolved iron activity of 10^{-6} Mol under standard conditions. (Numbers adjacent to dotted lines refer to equations discussed in the text.)



The iron Eh-pH diagram of Figure 6.4 is for a system that contains only dissolved iron. If other elements are present, such as sulfur, then additional iron compounds are possible. Figure 6.5 shows an Eh-pH diagram for a system with an iron activity of 56 µg/L (10^{-6} mol), sulfur of 96 mg/L as SO_4^{2-}, and carbon dioxide of 61 mg/L as HCO_3^-. Solids in the shaded area are thermodynamically stable. Under the conditions specified in this diagram, iron carbonate ($FeCO_3$) saturation was not reached and none is recorded as a solid phase.

The area of the region in which iron is precipitated rather than dissolved is a function of the concentration of dissolved iron. The more dissolved iron that is present, the greater the size of the stability field for the precipitates. This is illustrated in Figure 6.6. In this diagram the sulfur is 96 mg/L as SO_4^{2-}– and the carbonate is 61 mg/L as HCO_3^-. Dissolved iron ranges from 5.6 µg/L to 56 mg/L.

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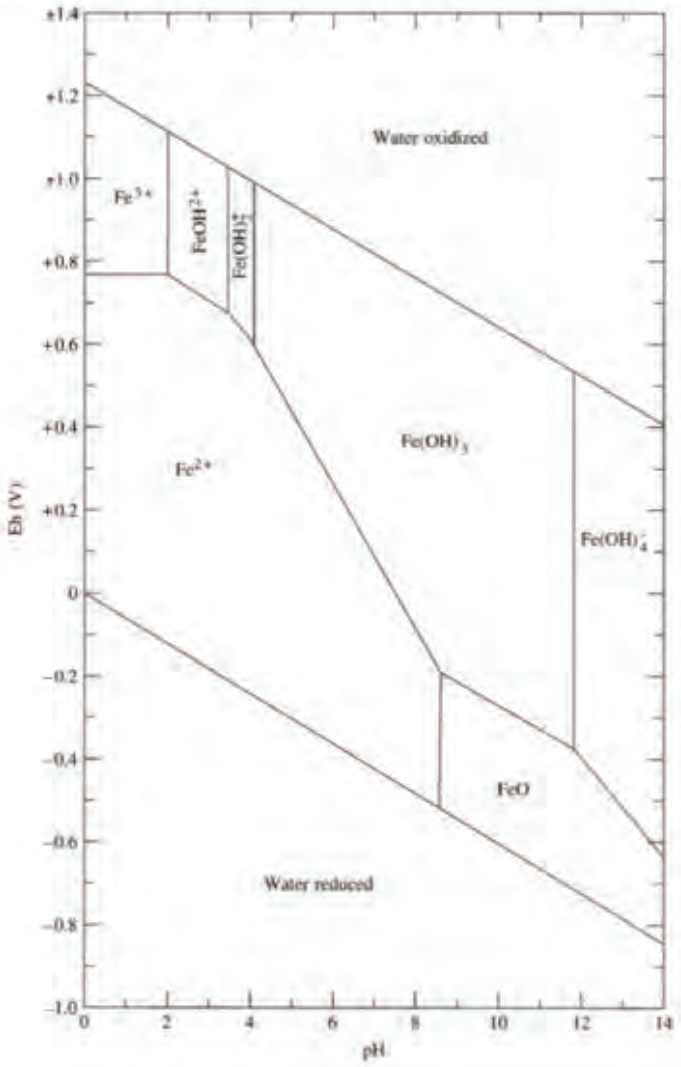
FIGURE 6.4 Final Eh-pH diagram for a dissolved iron system with dissolved iron at 10^{-6} moles under standard conditions.



Eh-pH diagrams have been used in the ground-water literature to explain such phenomena as the solubility of ferric oxyhydroxides (Whittemore and Langmuir 1975), hexavalent chromium (Robertson 1975), manganese (Hem 1985), iron, copper, silver, chromium, manganese, vanadium, molybdenum, and arsenic (Hem 1977), uranium (Langmuir 1978), thorium (Langmuir and Herman 1980), and arsenic (Matisoff et al. 1982).

6.6 Metal Complexes and Facilitated Particle Transport

6.6.1 Hydration of Cations

Although we consider that metallic ions exist in solution as an isolated ion, such as Cu^{2+}, in fact that is not the case. The Cu^{2+} ion is surrounded by polar water atoms that are chemically bound to the ion. Metallic ions, in general, have six water molecules

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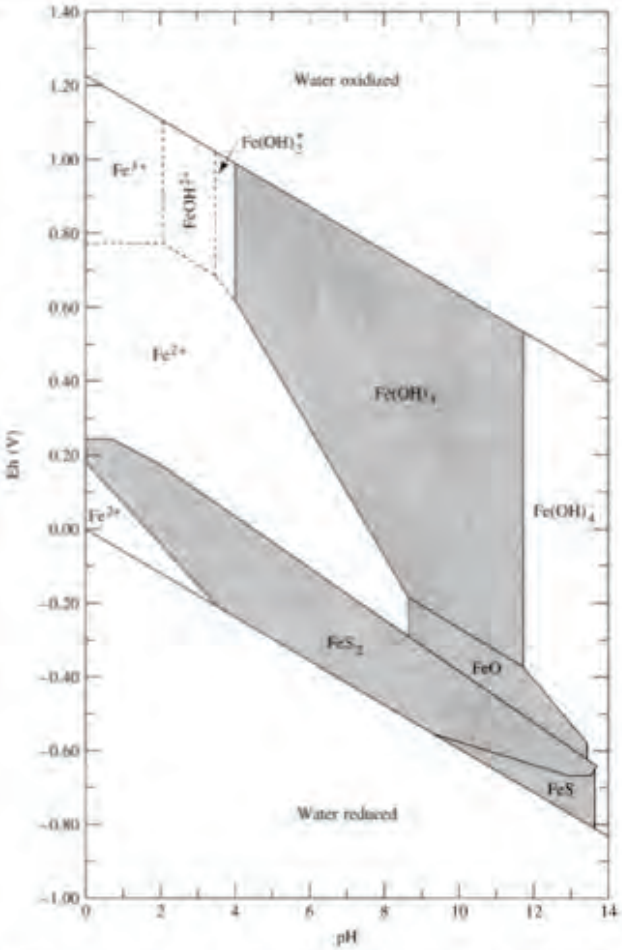
FIGURE 6.5 Eh-pH diagram showing fields of stability for dissolved iron under standard conditions. Activity of dissolved iron is 10^{-6} mol (56 µg/L), of sulfur species is 96 mg/L as SO_4^{2-}, and of carbon dioxide species is 61 mg/L as HCO_3^-.



Source: J. D. Hem. 1985. *Study and interpretation of the chemical characteristics of natural waters*. Water Supply Paper 2254, U.S. Geological Survey.

surrounding them. The hydrated cupric ion is $Cu(H_2O)_6^{2+}$. Even outside the shell of chemically bound water molecules, there is a region where the polar water molecules are ordered by the electrostatic charge of the metallic ion. Anions in close association with a metal cation are called **ligands**; together they form a coordination compound. Water is considered to be a **ligand** that is bound to the metal ion. If other ligands bind to the metal, they must replace some of the water molecules acting as ligands. The stability of a complex relative to cation or ligand exchange can be described by equilibrium constants for the reaction.

6.6.2 Complexation

The following inorganic anions act as simple ligands in natural waters: OH^-, CO_3^{2-}, SO_4^{2-}, Cl^-, Br^-, F^-, NO_3^-, SiO_3^{2-}, S^{2-}, $S_2O_3^-$, PO_4^{3-}, $P_2O_7^{4-}$, $P_3O_{10}^{5-}$, and CN^-. Ammonia (NH_3) is a polar molecule that can also act as a ligand. Ligands can bond either covalently or electrostatically with a metal to form a complex ion or compound. We have already

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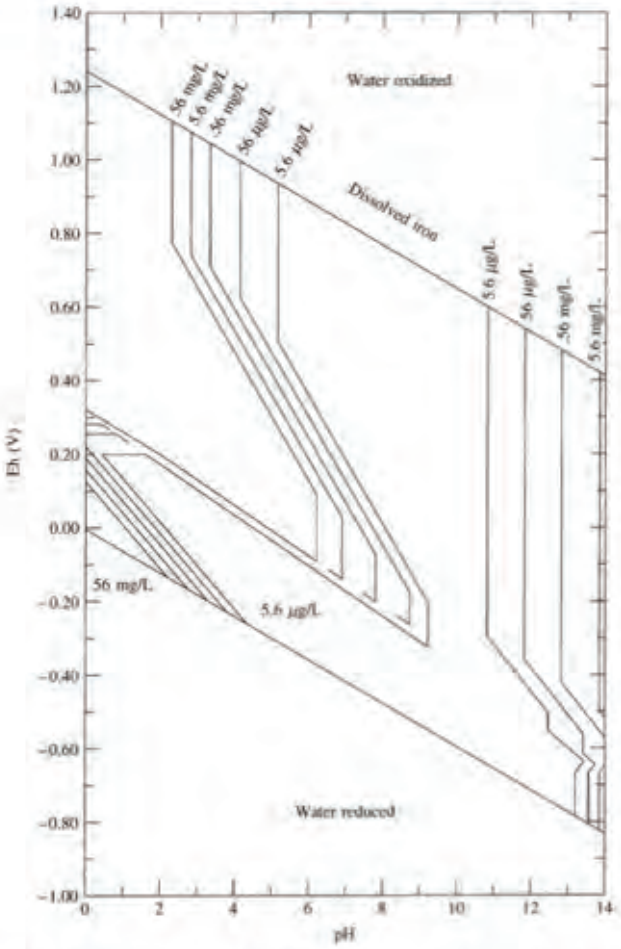
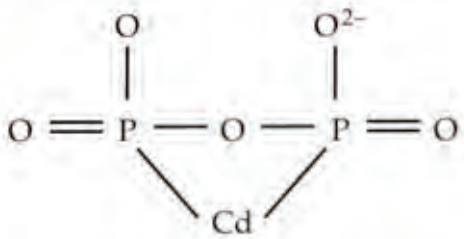
FIGURE 6.6 Equilibrium activity of dissolved iron as a function of Eh and pH under standard conditions, sulfur activity of 96 mg/L as SO_4^{2-} and activity of carbon dioxide of 61 mg/L as HCO_3^-.



Source: J. D. Hem. 1985. *Study and interpretation of the chemical characteristics of natural waters*. Water Supply Paper 2254, U.S. Geological Survey.

looked at the complex forms of the ferric ion and the hydroxyl ion. They form a series of complex ions: $FeOH^{2+}$, $Fe(OH)_2^+$, $Fe(OH)_3$ and $Fe(OH)_4^-$. Complex formation is involved with chemical equilibrium of ionic compounds and oxidation-reduction reactions.

In the case of monovalent ions, there is only one site where the ligand bonds to the metal ion and the ligand is called monodentate (literally, "one tooth"). If the ligand has more than one site that can bond (polydentate), then it forms what is known as a **chelating agent**. For example, the pyrophosphate ion, $P_2O_7^{4-}$, can bond to a metal ion, such as cadmium, at two locations:



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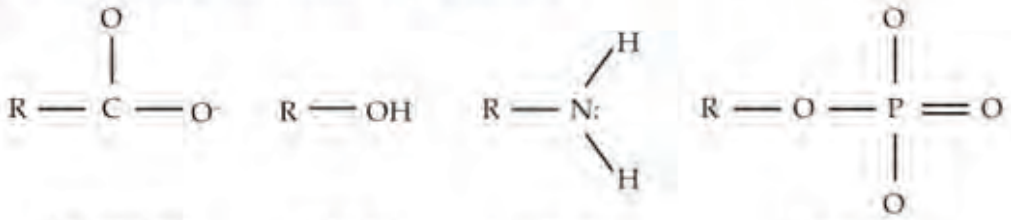
6.6.3 Organic Complexing Agents

Both natural waters and wastewaters contain a number of organic compounds that can act as chelating agents. In general, these organic compounds have a functional group that contains oxygen, nitrogen, phosphorous, or sulfur. If R symbolizes one or more carbon atoms with the appropriate number of hydrogens, then organic complexes can include functional groups such as



Carboxylate Alcohol Amine Phosphate

There are a number of organic complexing agents that occur in nature. They are associated with **humic substances** that form from the decomposition of vegetation. These are complex organic molecules with molecular weights ranging upward into the tens of thousands. If a humic substance is extracted with a strong base and then acidified, there are three products. The nonextractable organic material is called **humin**. Substances called **fulvic acids** remain in the acidic solution, and other substances called **humic acids** precipitate from the acidified extract. These represent classes of compounds that contain many different individual organic molecules. Humic and fulvic acids contain many functional groups that can chelate to metals. Metals may be kept in solution by chelation with soluble fulvic acids or they may bind to the insoluble humic substances by cation exchange (Manahan 1984).

Synthetic organic complexing agents are used in a number of industrial processes. They can be used as cleaning compounds, as constituents of detergent, in metal plating baths, and in water conditioning. These compounds include sodium tripolyphosphate, sodium ethylenediaminetetraacetate (EDTA), citric acid, and sodium nitrilotriacetate (NTA). The structures of some of these compounds are given in Figure 6.7. Synthetic chelating agents may keep metals in solution under conditions where the unchelated metal would precipitate or undergo cation exchange.

EDTA in wastewater can vastly increase the mobility of associated metals in the subsurface. Monitoring wells near radioactive waste disposal trenches at the Oak Ridge (Tennessee) National Laboratory contained significant levels of sodium EDTA, which was used as a cleaning agent. The same wells also contained radioactive ^{60}Co, a metal that is normally not expected to migrate very far due to cation exchange. The ^{60}Co had been chelated by the EDTA and hence had greatly increased mobility in the subsurface (Means et al. 1978).

6.6.4 Facilitated Particle Transport

Many metals and other inorganic compounds have a great sorptive capacity and an affinity for particles suspended in water. Normally in subsurface environments this limits contaminant mobility in that most mobile particles and colloids are filtered out of flowing groundwater in porous media. However, particles suspended in groundwater

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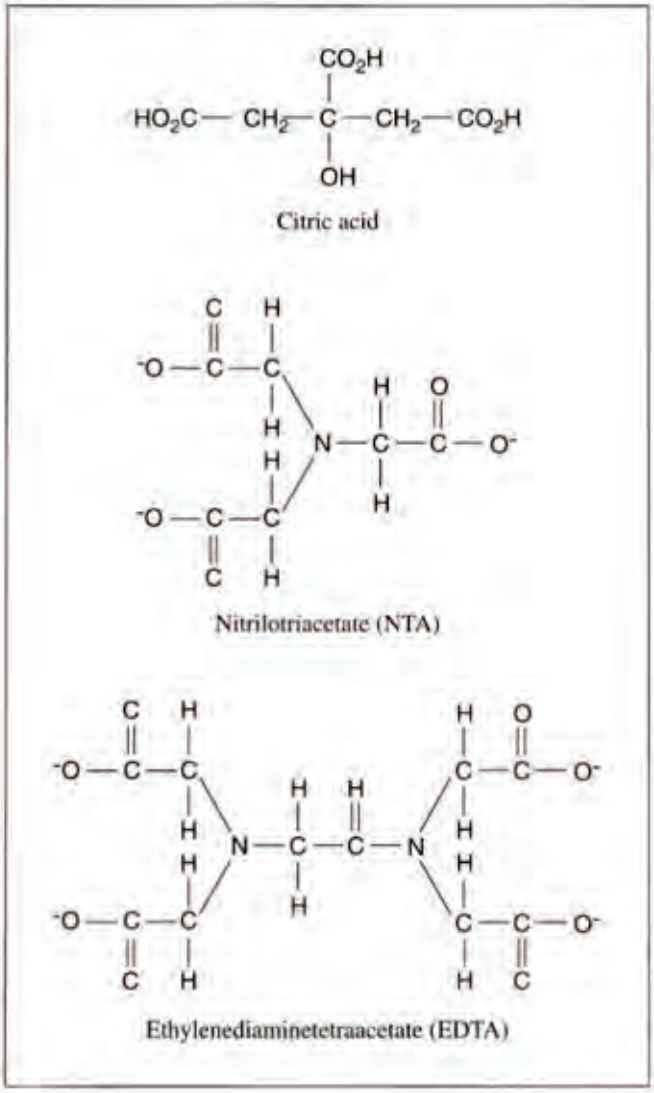
FIGURE 6.7 Structure of chelating agents including (a) citric acid, (b) nitrilotriacetate (NTA), and (c) ethylenediaminetetraacetate (EDTA).



can be mobilized in flow through fractured rock or karst rocks where groundwater moves through larger conduits and suspended particles are not filtered by the geologic medium. Contaminants sorbing on these particles, including many metals, essentially can "hitch a ride" on moving grains and colloids and this can increase the effective speed of contaminant movement through aquifers by orders of magnitude. This enhanced mobility is called **facilitated particle transport**.

Facilitated particle transport can pose problems in modeling contaminant movement and dispersion because of accelerated movement, and also impact the representativeness of groundwater sampling protocols. Many standard techniques for measuring metal concentrations in groundwater require samples to be filtered and acidified in the field. In conditions where groundwater contains contaminants sorbed on suspended particles and colloids, some practitioners collect both filtered and unfiltered samples for comparative chemical analysis.

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6.7 Chemistry of Nonmetallic Inorganic Contaminants

6.7.1 Fluoride

Fluoride occurs in water as the F^- ion. In natural waters the amount of fluoride present is generally less than 1.0 mg/L, although concentrations as great as 67 mg/L have been reported (Hem 1985). Fluoride is present in minerals such as fluorite (CaF_2) and apatite ($Ca_5(Cl,F,OH)(PO_4)_3$). Weathering of these minerals may release fluoride. It may be released as a contaminant from industrial processes utilizing hydrofluoric acid. Cryolite (Na_3AlF_6) is used as a flux in the electrolytic production of aluminum. The manufacture of phosphate fertilizer from phosphate-rich rock may also release fluoride. Effluent from a Florida fertilizer plant had fluoride ranging from 2810 to 5150 mg/L (Cross and Ross 1970).

Fluoride can form complexes in water with a number of cations, including aluminum, beryllium, and ferric iron (Hem 1985). Dissolved fluoride can react with calcium to form fluorite. The solubility product for fluorite is $10^{-10.4}$. Precipitation of fluorite can act as a control on the amount of dissolved fluoride in solution if dissolved calcium is present. Table 6.5 shows the equilibrium amount of dissolved fluoride calculated for various activities of calcium. Actual activities of fluoride are likely to be somewhat higher due to the effect of the ionic strength of the solution as well as the effect of any complexes that might form with the fluoride ion.

Fluoride can dissolve into groundwater from anthropogenic sources, but also from volcanic activity and other natural geologic sources through subsurface rock-water interaction. Magmatic fluorine is often in the form of hydrogen fluoride (HF) which is one of the most soluble gases in magmas, exsolving from molten rock only partially, and leaving large amounts of fluoride in cooled volcanic and plutonic rocks. High subsurface temperatures and acidic conditions enhance the dissolution of fluoride from these rocks into groundwater. Portions of the earth's large magmatic provinces, such as the Deccan flood basalts of India, the Siberian traps of central Asia, and the East African Rift Valley are endemic for fluorosis from consumption of high fluoride concentration in groundwater, as are smaller more isolated locales at the base of volcanoes (Brindha and Elango 2011; D'Alessandro 2006).

Corbett and Manner (1984) have reported on the distribution of fluoride in water from both unconsolidated and bedrock aquifers of northeastern Ohio. They found that 239 out of 255 wells had fluoride concentrations less than 1mg/L. However, 14 of

TABLE 6.5 Equilibrium fluoride concentrations as a function of calcium activity.

Calcium		Fluoride	
Activity (mol)	Concentration (mg/L)	Activity (mol)	Concentration (mg/L)
2×10^{-2}	800	4.48×10^{-5}	0.85
10^{-2}	400	6.31×10^{-5}	1.20
5×10^{-3}	200	8.92×10^{-5}	1.70
10^{-3}	40	2.00×10^{-4}	3.79
5×10^{-4}	20	2.82×10^{-4}	5.36
10^{-4}	4	6.31×10^{-4}	11.99

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the wells had fluoride ranging from 1 to 5.9 mg/L. All these high-fluoride wells were associated with a specific bedrock formation. Such information is useful from a public health standpoint because there is a 2.0-mg/L drinking-water criteria for fluoride. Some fluoride is needed to build strong teeth in growing children; however, fluoride in excess of 2.0 mg/L will cause teeth to discolor. Chronic ingestion of high fluoride in drinking water can also produce a serious condition known as skeletal fluorosis, which can damage bones and joints.

6.7.2 Chlorine and Bromine

The halides chlorine and bromine have similar chemistry, although chlorine is far more abundant in nature than bromine. Even though the elements can exist in a number of oxidation states, the chloride and bromide ions (Cl^-, Br^-) are the only ones of significance in natural waters. These halides are widely distributed in rocks and soil, and can be naturally leached into groundwaters. The chloride ion occurs in natural waters in fairly low concentrations, usually less than 100 mg/L, unless the water is brackish or saline. Chloride is used by humans in many applications and can be added to the subsurface via industrial discharges, sewage, animal wastes, and road salting. Chlorine gas is used as a disinfectant for purification of water and is a strong oxidizing agent when dissolved in water. Commercial fertilizers can contain chloride as KCl. Chlorine and bromine are components of halogenated organic compounds used for industrial solvents and pesticides. These compounds have been released to the environment both intentionally through the use of pesticides and accidentally through spills and leaks. Recent increases in shale hydrocarbon development have produced large quantities of post-fracking brine waters (which flow back upwards to the surface after well development), as has brine production from dewatering associated with coal bed methane extraction (also called coal seam gas). These large quantities of brine have increasingly been disposed of through underground injection. Fracking flowback water with Cl^- concentrations as high as 151,000 mg/L have been reported (Haluszczak et al. 2013).

Chloride and bromide ions are not reactive. They don't participate in redox reactions, aren't sorbed onto mineral or organic surfaces, and don't form insoluble precipitates. Chloride is sometimes used as a tracer in groundwater studies because it is conservative. Distinctive ratios of Cl^- and Br^- and other elements in groundwater have been valuable in reconstruction groundwater's movement and origin, including determining mixing ratios of different source waters. These ions are highly mobile in the subsurface and are often eventually transported to closed basins or oceans. Additionally, concentrations of chlorine isotopes in groundwater have effectively been used for groundwater dating techniques, including bomb-pulse chlorine-36 put into atmosphere with nuclear weapons testing and falling with rainfall, infiltrating and percolating into groundwater (Challan 2016). These forensic groundwater analytical techniques aid in the tracking of groundwater pollution (see Chapter 8).

6.7.3 Sulfur

Sulfur is naturally released to the environment by the weathering of minerals containing the element. Rock containing pyrite can be oxidized to release sulfur, with microorganisms acting as a catalyst and mediating the oxidation. This is the source

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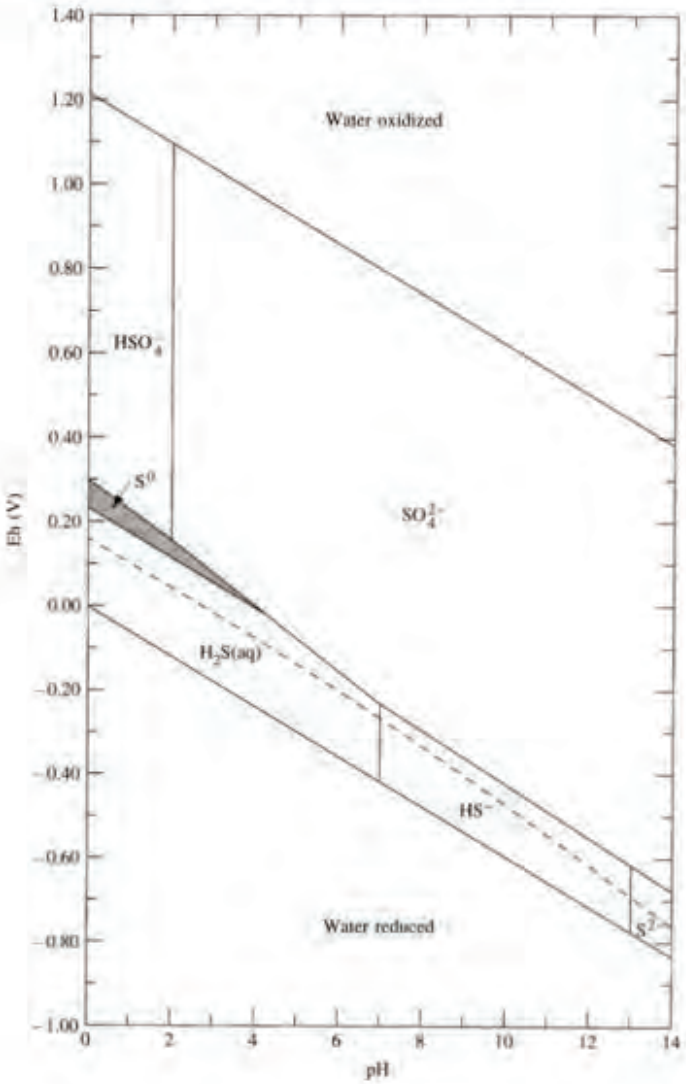
of the acidic water that drains from many areas that have been mined. Sulfuric acid is widely used in industrial processes. Sulfur can be released to the environment by the processing of sulfide ores and by the burning of fossil fuels, all of which contain sulfur to some degree. Sulfur is also a component of many fertilizers and can leach into groundwater systems from agricultural sources.

Sulfur can exist in valence states ranging from S^{-2} to S^{+6}. Figure 6.8 is an Eh-pH diagram showing the stability of the two oxidized forms of sulfur, $HSO4^-$ and SO_4^{2-}, and the three reduced forms, S^{2-}, HS^-, and H_2S (aqueous). The field of stability for elemental sulfur is also shown. The total sulfur activity used in computing the diagram is 10^{-3} mol/L or 96 mg/L as. SO_4^{2-}. If a greater total sulfur activity were used, the stability field for elemental sulfur would be larger. Although this is a very useful diagram

FIGURE 6.8 Eh-pH diagram for sulfur species at standard conditions with total dissolved sulfur activity of 96 mg/L.



Source: J. D. Hem. 1985. *Study and interpretation of the chemical characteristics of natural waters.* Water Supply Paper 2254, U.S. Geological Survey.

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for understanding the equilibrium conditions for dissolved sulfur, the redox reactions can be slow if microbes are not mediating the reactions. Hence, it may take a long time for the system to reach equilibrium.

Gypsum (calcium sulfate) is quite soluble in water ($K_{eq} = 10^{-4.6}$) and, except for waters with extremely high sulfate, would not be a sink for sulfate. Strontium sulfate is sparingly soluble ($K_{eq} = 10^{-6.5}$), whereas barium sulfate is nearly insoluble ($K_{eq} = 10^{-10.0}$). However, strontium and barium are not found in much abundance in natural waters. Sulfate could act as a sink for strontium and barium. Sulfur isotopes can be used to distinguish pollutant sources in some cases.

6.7.4 Nitrogen

Nitrogen is another element that can occur in both oxidized and reduced forms as well as the elemental state. The common forms of inorganic nitrogen include nitrate, NO_3^-, nitrite, NO_2^-, nitrogen gas, N_2, ammonium, NH_4^+, and cyanide, CN^-. Nitrogen is also a major constituent of organic matter in the form of amino acids. The majority (78%) of the Earth's atmosphere is nitrogen gas. Atmospheric nitrogen can be "fixed", or converted to nitrate, by cyanobacteria in lakes and the ocean and by bacteria living on the roots of plants such as legumes and lichens. Atmospheric nitrogen can also be converted to oxidized and reduced forms via fertilizer production and by heating it to high temperatures in internal combustion engines, power plants, lightning discharges and forest fires. Rainwater contains dissolved nitrate and ammonia. Nitrogen is released to the subsurface from sewage, animal wastes, and fertilizers.

In soil and groundwater, oxidation and reduction of nitrogen species is accomplished by microorganisms. Under oxidizing conditions ammonia is converted to nitrite, which is converted to nitrate. Nitrite is a very reactive ion and is almost immediately converted to nitrate, so that little nitrite is normally found in the environment. Under reducing conditions nitrate is converted primarily to nitrogen gas, a process known as **denitrification**. Organic matter will decay to ammonia under reducing conditions. Septic tank effluent, for example, normally has high ammonia and very little nitrate. If the receiving groundwater is reducing, the nitrogen will stay in the ammonia form. If it is oxidizing, bacteria will convert the ammonia to nitrate (Feth 1966). Nitrate is chemically conservative, can be mobile in the subsurface environment, and understandably, high nitrate concentrations in drinking water are most often associated with privately owned wells. Since the 1940s, health concerns and regulatory standards for nitrogen in groundwater center on infant methemoglobinemia (commonly called the "blue baby" disease). The high gastric pH of infants and their great fluid intake relative to body weight contribute to their internal bacterial reduction of ingested nitrate to nitrite, and the generated nitrite inhibits the function of blood hemoglobin in the transfer of oxygen.

Nitrate contamination of groundwater has been documented in a number of areas (e.g., Hill 1982; Flipse et al. 1984; and Silver and Fielden 1980). Hill studied the distribution of nitrate in groundwater from a shallow unconsolidated sand aquifer. It was found that the groundwater beneath areas of forest or permanent pasture has less than 1.0 mg/L of nitrate as nitrogen. The groundwater beneath heavily fertilized potato fields typically contained in excess of 10 mg/L nitrate as nitrogen. Gray and Morgan-Jones (1980) found that the nitrate content of groundwater in a study area

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increased over the past 40 years and that the use of fertilizers in this catchment area also increased over the same time period.

Nitrogen occurs as two isotopes, ^{14}N and ^{15}N. Of the two, ^{14}N is by far the most abundant in the atmosphere. The relative abundance of ^{15}N—that is, the $^{15}N/^{14}N$ ratio—in nitrate may be used to distinguish nitrate that comes from animal and human waste from nitrate that comes from mineral fertilizers (Flipse et al. 1984).

The $^{15}N/^{14}N$ ratio is usually expressed as a $\delta^{15}N$ value, which is defined as

$$\delta^{15}\mathrm{N}(‰) = \frac{\left(^{15}\mathrm{N}/^{14}\mathrm{N}\right)\text{sample} - \left(^{15}\mathrm{N}/^{14}\mathrm{N}\right)\text{standard}}{\left(^{15}\mathrm{N}/^{14}\mathrm{N}\right)\text{standard}} \times 1000$$

where ‰ stands for parts per thousand.

If the $\delta^{15}N$ is positive, then the nitrate of the sample has been enriched in ^{15}N with respect to the standard. For nitrogen, the standard is the atmospheric composition. Nitrate from animal and human waste typically has a $\delta^{15}N$ in excess of +10‰.

Flipse and Bonner (1985) found that mineral fertilizers used on Long Island had $\delta^{15}N$ values that averaged 0.2‰ at one site and –5.9‰ at another. However, the $\delta^{15}N$ of the groundwater beneath the sites that had been fertilized was about +6‰. This increase in $\delta^{15}N$ from the mineral fertilizer was attributed to fractionation that occurred during infiltration of the nitrogen. However, the resulting $\delta^{15}N$ was still clearly lower than that expected from animal and human waste.

6.7.5 Arsenic

Arsenic can occur in valence states of +5, +3, +1, 0 and –3. However, the important states of dissolved arsenic in water are the arsenate $H_nAsO_4^{3-n}$, with a valence state of +5, and the arsenite $H_nAsO_3^{2-n}$, with a valence state of +3. An Eh-pH diagram for arsenic that shows the fields of stability for the arsenates and arsenites is given in Figure 6.9. Dissolved arsenic species can be absorbed by ferric hydroxides. Arsenic (+5) is more strongly sorbed than arsenic (+3). Ferric hydroxides are stable over a wide Eh-pH range, so this fact limits the mobility of arsenic. However, conditions that reduce Fe^{3+} to Fe^{2+} and As^{5+} to As^{3+} increase the mobility of arsenic in the environment, because the precipitated ferric hydroxides become soluble ferrous hydroxides (Matisoff et al. 1982). In an oxidizing environment with a pH above 4.09, we will find colloidal ferric iron hydroxides, which will sorb arsenic and would thus expect to have little arsenic in solution. Under strongly reducing conditions, if both iron and hydrogen sulfide are present, arsenic sulfide coprecipitates with iron sulfide. Mildly reducing conditions that lack hydrogen sulfide present conditions under which one would expect to find the most mobile arsenic, as iron would be in the soluble ferrous state and arsenic would be in the arsenite form (Hounslow 1980).

Arsenic has been released to the environment through the burning of coal and the smelting of ores. In the past it was used in the formulation of insecticides and embalming corpses. Starting at the time of the Civil War in the United States (1860–1865), arsenic was an ingredient in a popular embalming fluid. As much as 3 lb of arsenic could have been used per corpse. The use of arsenic in embalming fluids was

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banned by the federal government in 1910 because its use interfered with the investigation of suspected arsenic poisonings. However, graveyards from the Civil War and the late nineteenth century may be a source of arsenic contamination (Konefes 1990). It has some modern industrial uses. Groundwater has been found to have high (up to 96 μg/L) concentrations from natural sources in northeastern Ohio (Matisoff et al. 1982). Elevated arsenic (up to 5 mg/L) in groundwater in Nova Scotia, Canada, was reportedly due to the weathering of piles of mining waste that contained arsenopyrite (Grantham and Jones 1977). In the western United States high (>50 μg/L) concentrations of arsenic are common in groundwater. These are associated with areas of sedimentary rocks derived from volcanic areas, geothermal systems and gold and uranium mining districts. Irrigation in some areas has liberated arsenic to the extent that concentrations of up to 1 mg/L are found in shallow groundwater beneath irrigated fields (Welch, Lico, and Hughes 1988).

Naturally occurring arsenic in groundwater can also be a huge problem. In what one writer called "one of the largest mass poisonings in history," thousands of tube wells were drilled in shallow aquifers contaminated with naturally-occurring arsenic in Bangladesh and India in the 1980s and 1990s before the problem was recognized (Brahic 2004). As a result, arsenic has posed risk to an estimated 57 million people in Bangladesh (Hossain 2006), and 100,000 are estimated to have been affected by high concentrations in shallow well water in the region (Brahic 2004). Annually, another 270,000 have been estimated to have had cancer related deaths, as long-term exposure to arsenic has been related to cancer of the kidneys, lungs, bladder and skin (Brahic 2004). The problem was unrecognized for many years, in part because a study by the British Geological Survey (BGS) and Britain's National Environment Research Council (NERC) did not adequately test for arsenic in reconnaissance groundwater quality surveys which subsequently served as the basis for drawing up national water policies and the drilling of thousands of wells.

6.7.6 Selenium

Selenium occurs in oxidizing solutions as selenite, SeO_3^{2-}, with a +4 valence and as selenate, SeO_4^{2-}, with a +6 valence. It can be reduced to the insoluble elemental form, Se^0. It may also form a precipitate ferroselenite, $FeSe_2$, under reducing conditions. Selenite may be sorbed onto amorphous ferric hydroxides. Selenium has a number of industrial uses, such as the manufacture of pigments, stainless steel, and rubber compounds. It is contained in phosphate fertilizers. Selenium has been known to concentrate in irrigation return water draining from land that has soil high in selenium, and can be present in waste liquids from metal smelting. It is naturally present in coal, particularly bituminous coal, and can be concentrated approximately 1,250 times in the burning process at coal-fired power plants (coal versus precipitator ash), and can be present in elevated concentrations in waste scrubber water, ash ponds or other liquid wastes which could leach and percolate into the subsurface.

In small concentrations selenium is an essential nutrient, but in large amounts it is harmful to humans, fish, and wildlife (Coefield 2009). High selenium in groundwater-dependent ecosystems can wipe out entire species and cause massive

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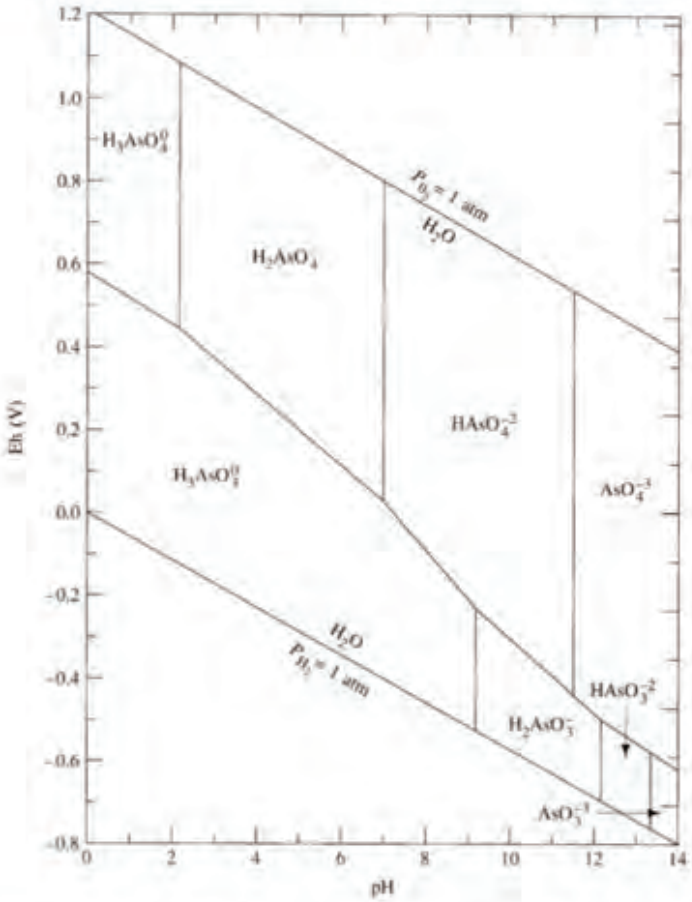
wildlife and fish kills. High selenium has been problematic at many sites and from activities worldwide, including (Lemly 2002):

1. Nickel and silver mining in Torun, Poland.
2. Municipal landfill leachates in Stockholm, Sweden; Minnesota, U.S.A.; and in London, U.K.
3. Irrigation runoff in Chihuahua, Mexico; Utah, U.S.A.; and in Kesterson National Wildlife Refuge, California, U.S.A.
4. Coal combustion waste in Texas, Pennsylvania, Kentucky, North Carolina, U.S.A. and Alberta Canada.
5. Phosphate mining waste in Idaho, U.S.A.
6. Gold mining waste in Buenos Aires, Argentina; Quito, Ecuador; and Yukon, Canada.
7. Metal smelting waste in Ontario, Canada.
8. Oil-refinery waste in Louisiana, U.S.A.

FIGURE 6.9 Eh-pH diagram for arsenic species under standard conditions.



Source: A. H. Welch, M. S. Lico, and J. L. Hughes. 1988. Arsenic in ground water of the western United States. *Groundwater* 26:333–347. Used with permission.

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6.7.7 Phosphorus

Phosphorus can occur in a number of valence states, but in natural water it is really significant only in the +5 state. Dissolved phosphorus in water occurs as phosphoric acid (H_3PO_4) and its dissociation products, the orthophosphate ions: $H_2PO_4^-$, HPO_4^{2-} and PO_4^{3-}. The proportion of each present in an aqueous solution is a function of pH. Dissolved phosphorus is readily sorbed onto soil and has a very low mobility in groundwater. in alkaline soils it can react with calcium carbonate to form a mineral precipitate, hydroxyapatite.

$$3HPO_4^{2-} + 5CaCO_3 + 2H_2O \rightarrow Ca_5(PO_4)_3(OH) + 5HCO_3^- + OH^-$$

Phosphate is released to the environment from mineral fertilizers, animal wastes, sewage, and detergents.

■ 6.8 Chemistry of Metals

Metals are cations, and most have fairly limited mobility in soil and groundwater because of cation exchange or sorption on the surface of mineral grains. They can also form precipitates of varying solubility under specific Eh-pH conditions. Geologically, metal ores are typically in the form of sulfides, oxides, silicates, or "native" metals. Metals are mobile in groundwater if the Eh-pH range is such that soluble ions exist and the soil has a low cation-exchange capacity (Dowdy and Volk 1983). They can also be mobile if they are chelated or if they are attached to a mobile colloid. Conditions that promote mobility include an acidic, sandy soil with low organic and clay content. Discharge of a metal in an acidic solution would keep the metal soluble and promote mobility.

6.8.1 Beryllium

Beryllium occurs only in the +2 valence state. In natural waters we can have Be^{2+}, $Be(OH)^+$, $Be(OH)_2$ and $Be(OH)_3^-$. Beryllium oxide and hydroxide have low solubilities and can act as a control on beryllium concentration. At equilibrium with $Be(OH)_2$, the dissolved form would have an activity of about 100 μg/L at a pH of 6 (Hem 1985). Nonetheless, beryllium can find its way into groundwater from industrial wastewater discharges or from natural weathering and dissolution of rocks, particularly igneous rock containing granites and pegmatites. Beryllium is used for making metal alloys for the aerospace industry, nuclear reactors, and is used in electrical equipment and microwave ovens.

6.8.2 Strontium

Strontium also occurs in the +2 valence state and has a chemistry similar to that of calcium. The solubility product for strontium sulfate, $SrSO_4$, is $10^{-6.4}$. This suggests that there might be an equilibrium control on strontium concentration if sulfate is present in the water. Strontium carbonate, $SrCO_3$, has a solubility product of 10^{-10}. In general, strontium is present in groundwaters in concentrations of less than 1mg/L.

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However, in tracing groundwater pathways and subsurface movement of potential contaminants, the isotopic ratio of $^{87}Sr/^{86}Sr$ can be a "powerful tool in distinguishing among solute sources," as the ratio can reflect mineral interaction with groundwater, differences in initial water quality, recharge waters of varying evaporative concentrations or pCO_2 concentration, and differences in relative mobilities of different groundwaters (USGS 2015).

6.8.3 Barium

This alkaline earth element also has a valence of +2. Its distribution is controlled by the solubility of barite, $BaSO_4$. Barite has a solubility product of 10^{-10}. If the activity of sulfate is 96 mg/L (10^{-3} *M*), then the activity of barium is 10^{-7} *M*, or 0.014 mg/L. Barium is also found as witherite ($BaCO_3$), and other compounds, but is not found in the environment as a free element because of its high reactivity. Barium sulfate can be an additive to oil-well drilling fluid, medical waste, and because in its ionic form barium is soluble and toxic, it is a component of some rodenticides.

6.8.4 Vanadium

This transition metal has oxidation states of + 3, +4, and +5. In aqueous solutions it forms 10 different oxides and hydroxides. Dissolved iron can react with vanadium to form an insoluble ferrous vanadate, which can act as a control on vanadium in natural water (Hem 1977).

$$FeOH^+ + 2H_2VO_4^- + H^+ \rightleftharpoons Fe(VO_3)_2 + 3H_2O$$

6.8.5 Chromium

Chromium in natural waters occurs in a +3 and a +6 valence state. Stable ionic forms in aqueous systems include Cr^{3+}, $CrOH^{2+}$, $Cr(OH)_2^+$, $Cr_2O_7^{2-}$ and CrO_4^{2-}. Chromous hydroxide, $Cr(OH)_3$ is a possible precipitate under reducing conditions. Figure 6.10 is an Eh-pH diagram for the stability field for chromous hydroxide. Under some conditions chromate might react with ferrous iron to produce a chromous hydroxide precipitate (Robertson 1975).

$$CrO_4^{2-} + 3Fe^{2+} + 8H_2O \rightleftharpoons 3Fe(OH)_3 + Cr(OH)_3 + 4H^+$$

In general the hexavalent chromium in groundwater is soluble and mobile and trivalent chromium will be insoluble and immobile. Industrial discharges of hexavalent chromium are common from metal-plating industries. This material may be quite mobile in groundwater. A hexavalent chromium spill on Long Island, New York, U.S.A., traveled more than 900 m (≈3000 ft) from a waste-discharge pond to a stream (Perlmutter, Lieber, and Frauenthal 1963). Hexavalent chromium from a natural source has been found in groundwater in Paradise Valley, Arizona, U.S.A. (Robertson 1975), and the Blacksmith Institute reports that groundwater containing 6.2 mg/L Cr (VI) was found in Kanpur, India (the Indian government limit is 0.05 mg/L) from

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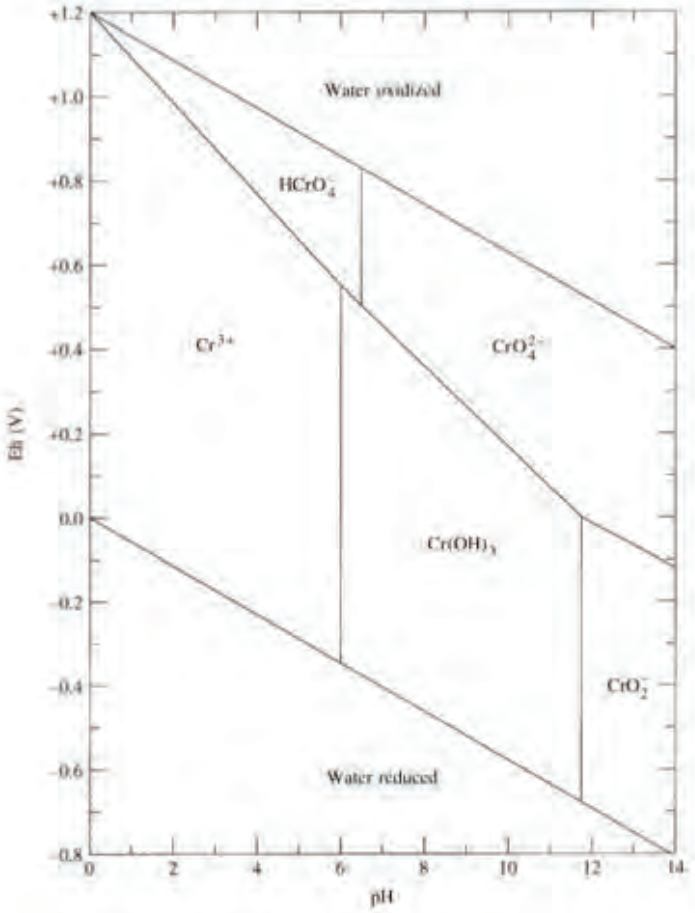
tannery operations, potentially affecting 30,000 people. Popular attention was focused on groundwater pollution from hexavalent chromium in Hinkley, California, U.S.A., after it was dramatized in the 2000 film *Erin Brockovich*.

Chromium in groundwater is much more mobile in the aqueous Cr^{6+} phase than as Cr^{3+}. In a study of a three dimensional chromium plume in a glaciofluvial aquifer in Connecticut, Nikolaos et al. (1994) tested the sorbed chromium in the soil and the dissolved chromium in the groundwater. The mean soil concentration was 0.675 g/kg while 25 mg/L was dissolved in the groundwater. A mass balance calculation reveled that more than 99% of the mass of chromium was immobilized in the soil. This has important implications for groundwater remediation. The mobile chromium in the groundwater could be removed by pump and treat methods. However, if the geochemical equilibrium is upset and chromium is desorbed from the soil, then it would be very difficult to ever remove all of the chromium by pump and treat. As a part of a remedial investigation at a chromium spill site, one must determine how strongly the chromium is bound to the soil. Methods of extracting the dissolved portion without upsetting the equilibrium that binds the majority of the chromium to the soil must be developed.

FIGURE 6.10 Eh-pH diagram for chromium under standard conditions.



Source: Modified from F. N. Robertson. 1975. Hexavalent chromium in the ground water in Paradise Valley, Arizona. *Groundwater* 13:516–527. Used with permission.

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Case History

Henderson (1994) investigated a chromium spill in the Trinity Sand aquifer near Odessa, Texas. He found that the mobile Cr^{6+} was being reduced to Cr^{3+} by ferrous iron (Fe^{2+}) and organic carbon. The trivalent chromium is then sorbed onto the soil surfaces which are coated with solid iron oxyhydroxides. The soil contained up to 5 g/kg and 95 to 99 percent was in the trivalent state. Prior to the initiation of the study, the chromium plating operation had ceased operations, so that the source of hexavalent chromium ended. Over the course of the study, the plume of groundwater contaminated with Cr^{6+} stopped growing, and even began to shrink (Figure 6.11). The cause of this degradation is the reduction of the Cr^{6+} to Cr^{3+} which forms chromium hydroxide ($CrOH_3$) and its subsequent sorption onto the soil.

The calculated half life of the chromium was 2.5 years. The reduction in dissolved hexavalent chromium mass in the aquifer is illustrated in Figure 6.12. The shaded area represents observed conditions at four different sampling events. The curved line is a first order reduction with the 2.5 year half life.

With the transformation of dissolved to solid chromium as a function of time, the groundwater in the aquifer is undergoing natural remediation. Computer modeling of the plume resulted in a diminution of the dissolved Cr^{6+} below a 100 µg/L drinking water standard by no later than the year 2006 (Figure 6.13). Operation and maintenance at the site were still ongoing in 2017.

6.8.6 Cobalt

Cobalt occurs with valence states of +2 and +3. In the Eh and pH range of natural waters, only the +2 valence state is stable. It is thought that cobalt can coprecipitate or be absorbed by manganese and iron oxides. Cobalt carbonate has a solubility product of 10^{-10}. At a pH of 8.0 with 100 mg/L of carbonate, the equilibrium solubility of cobalt is 6 µg/L (Hem, 1985). The solubility product of cobalt sulfide is very low, $10^{-21.3}$. Virtually no cobalt would be in solution in a reducing environment. Radioactive cobalt is a waste product of certain defense activities (Means, Crerar, and Duguid 1978). Cobalt occurs in nature as smaltite ($CoAs_2$), and cobaltite (CoAsS). In the United States, stable cobalt has been identified at 426 of the 1,636 current or former National Priorities List (NPL) sites, whereas radioactive cobalt has been found at 13 sites (ATSDR 2015).

6.8.7 Nickel

This metal occurs in aqueous solutions in the +2 valence state. Nickel ores include a variety of minerals, consisting of nickel, antimony, sulfur, and arsenic: NiSb, $NiAs_2$, NiAsS, and NiSbS. Nickel carbonate is more soluble than cobalt carbonate ($K_{sp} = 10^{-6.9}$), whereas the sulfide has a similar solubility ($K_{sp} = 10^{-19.4}$). Nickel is widely used in industry.

6.8.8 Molybdenum

Molybdenum occurs as the ore mineral molybdenite, MoS_2. The most common oxidation states are +4 and +6. Under oxidizing conditions the Mo^{6+} state dominates. Below pH 1.8 one finds H_2MoO_4 (aqueous). Between pH 1.8 and pH 5.3, $HMoO_4^-$ occurs, whereas above pH 5.3 the molybdate ion, MoO_4^{2-}, is stable. If ferrous iron is present, ferrous molybdate ($FeMoO_4$) presents a possible solubility control, since this has a solubility product of $10^{-10.45}$ at a pH range of 5.3 to 8.5 (Hem 1977). Molybdenum may also sorb

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onto amorphous ferric hydroxide (Kaback and Runnels 1980). The solubility product of calcium molybdate, $CaMoO_4$, is $10^{-8.7}$ (Hem 1985). Molybdenum is used as an alloy in steel and as an additive to lubricants. Waste sources include mining and smelting of ore.

6.8.9 Copper

Copper occurs in either a +1 or a +2 valence state. Dissolved copper species in water include Cu^{2+}, $HCuO_2^-$, CuO_2^{2-}, and Cu+. Cupric copper and ferrous iron can undergo an oxidation-reduction:

$$2Cu^{2+} + 2Fe^{2+} + 7H_2O \rightleftharpoons Cu_2O + 2Fe(OH)_3 + 8H^+$$

Both cupric and cuprous sulfide have very low solubility products. Copper concentrations can be very high in acid mine drainage from metal mines, up to several hundred milligrams per liter. Copper can be leached from copper water-supply pipes and fixtures, especially by waters that have a pH of less than 7 (Hem 1985).

6.8.10 Silver

Silver, a rare element, is widely used in industry. It occurs in the +1 valence state. Silver chloride, AgCl, has a solubility product of $10^{-9.7}$, which limits the solubility of silver in waters with chloride ion. Silver can also be naturally reduced to the metallic state by ferrous iron:

$$Ag^+ + Fe^{2+} + 3H_2O \rightleftharpoons Fe(OH)_3 + Ag + 3H^+$$

Silver sulfide has a low solubility. Thus, in water with chloride, iron, and sulfur present, stable solid forms of silver occur over the entire Eh-pH field (Hem 1977). As a result, there is very little soluble silver in natural waters.

6.8.11 Zinc

Zinc is a fairly common metal and is extensively used in metallurgy and as a pigment, zinc oxide, which is often worn on the noses of lifeguards and other people in the sun. It occurs in the +2 valence state. Zinc carbonate has a rather low equilibrium constant, 10^{-10}, which would limit the solubility at pH ranges where the carbonate ion predominates. In a pH range of 8 to 11 and with 610 mg/L of HCO_3^-, there should be less than 100 µg/L of dissolved zinc (Hem 1985).

6.8.12 Cadmium

Cadmium has a very low maximum contaminant level (MCL) in drinking water, 4 µg/L, due to its toxicity. It exists in aqueous solution in the +2 valence state. Cadmium carbonate has a very low solubility product, $10^{-13.7}$. Although this could serve as a control on solubility under some conditions, cadmium can be mobile in the environment. On Long Island, New York, a metal-plating waste containing cadmium and chromium traveled about 3000 ft in a shallow aquifer (Perlmutter, Lieber, and Frauenthal 1963). Cadmium has been implicated in an outbreak of a disease in Japan resulting in a softening of the bones of the victims that resulted in extreme bone pain.

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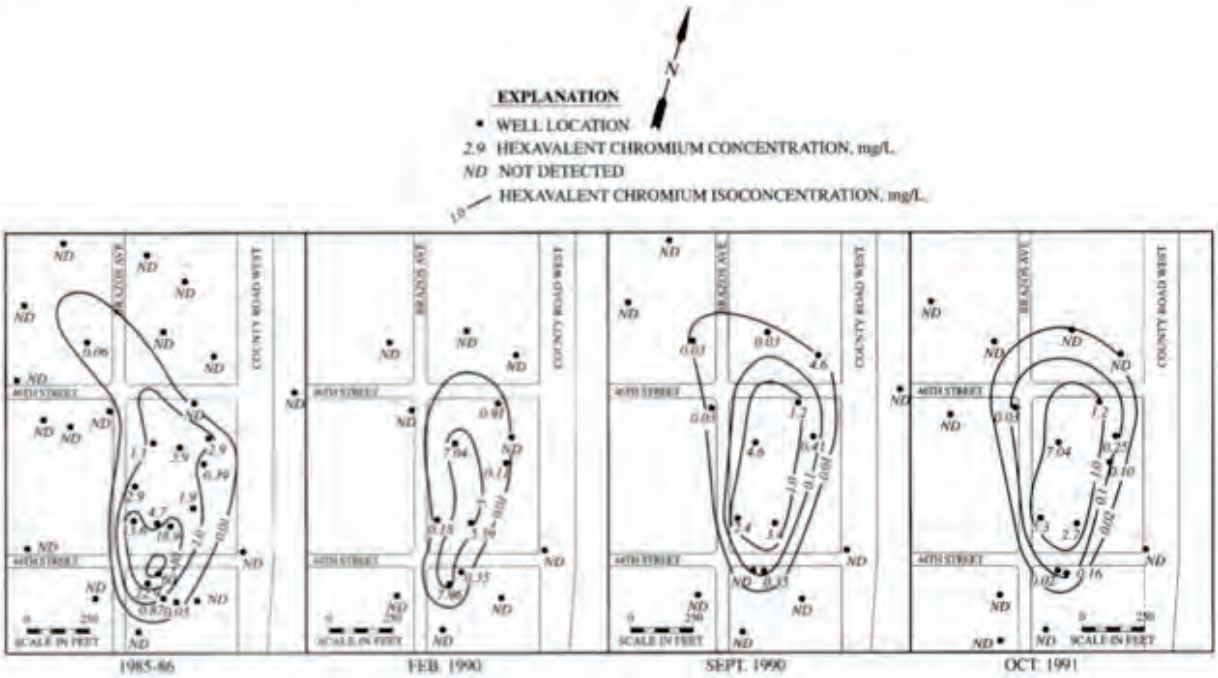
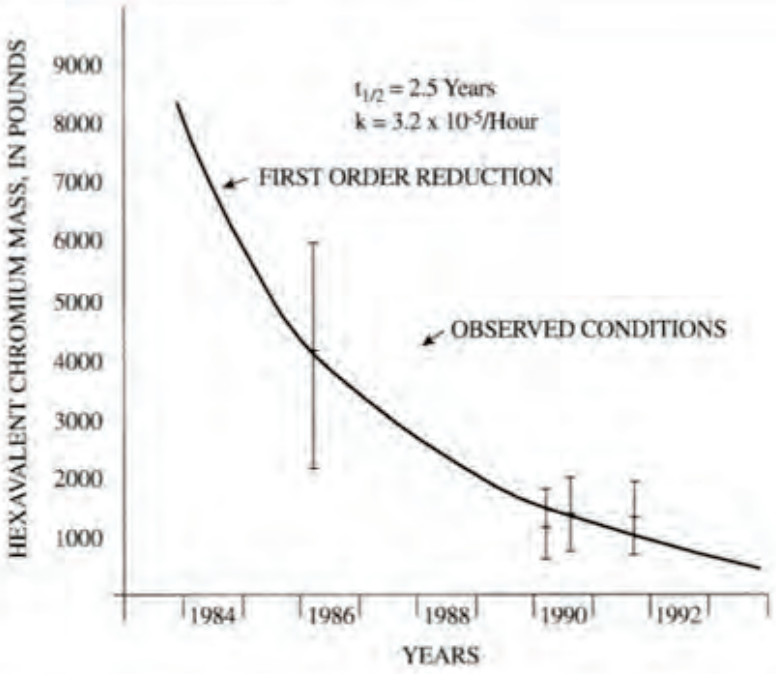
FIGURE 6.11 Shrinkage of the maximum extent of an observed plume of Cr^{6+} with time.



Source: T. Henderson. 1994. Geochemical reduction of hexavalent chromium in the Trinity Sand aquifer. *Groundwater* 32:477–486. Used with permission.

FIGURE 6.12 Reduction of the dissolved mass of Cr^{6+} with time.



Source: T. Henderson. 1994. Geochemical reduction of hexavalent chromium in the Trinity Sand aquifer. *Groundwater* 32:477–486. Used with permission.

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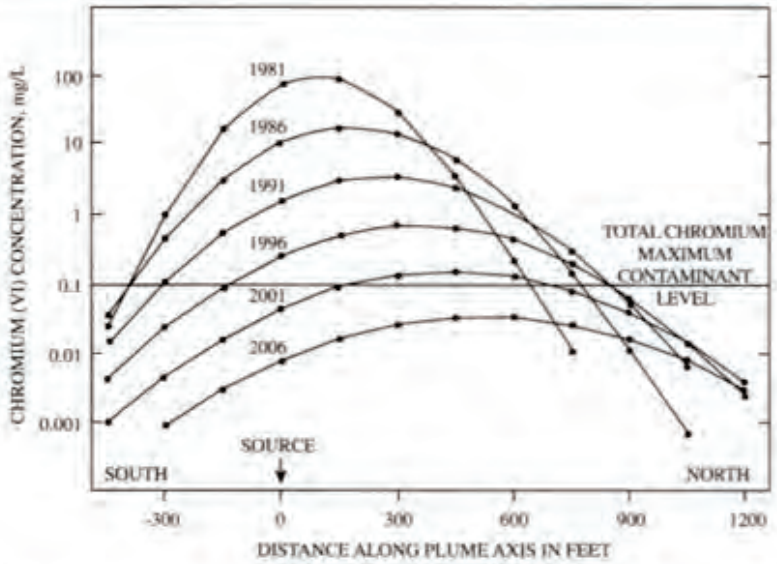
FIGURE 6.13 Result of fate and transport modeling of concentration of Cr^{6+} along the axis of the plume.



Source: T. Henderson. 1994. Geochemical reduction of hexavalent chromium in the Trinity Sand aquifer. *Groundwater* 32:477–486. Used with permission.

The cadmium was traced to rice and soybeans grown in soil contaminated by airborne cadmium that came from a nearby lead-and zinc-smelting operation (Emmerson 1970).

6.8.13 Mercury

Mercury has the lowest MCL for any inorganic chemical, 2 μg/L. It is considered to be very toxic. It has been known to concentrate in the food chain, especially in fish. Several outbreaks of mercury poisoning have been confirmed in Japan. Local discharges of mercury from industrial processes into surface-water bodies resulted in high mercury levels in fish. Inhabitants of fishing villages ate fish up to three times a day. Mortality of those affected was about 40%, and the poisoning was passed to unborn babies by apparently healthy mothers (Waldbott 1973). Mercury occurs as a metal and in the valence states +1 and +2. Most of the inorganic mercury compounds have a low solubility. The solubility product of Hg_2Cl_2 is $10^{-17.9}$, and for HgS it is about 10^{-50}. Under most natural conditions there is little soluble inorganic mercury. However, methane-generating bacteria can convert metallic mercury to organic forms such as methyl mercury, $HgCH_3^+$. The monomethyl mercury ion is soluble in water. Bacteria can also produce dimethyl mercury, $Hg(CH_3)_2$, which is volatile. Other organic forms of mercury, such as ethylmercuric chloride (C_2H_5HgCl), are manufactured and used as fungicides.

6.8.14 Lead

Lead occurs in aqueous solution as Pb^{2+} and in various hydroxides. Various lead compounds have solubility products that indicate that under the right Eh-pH conditions, lead solubility would be limited in natural waters: $PbCl_2$, $K_{sp} = 10^{-4.8}$; PbF_2, $K_{sp} = 10^{-7.5}$; $PbSO_4$, $K_{sp} = 10^{-7.8}$; $PbCO_3$, $K_{sp} = 10^{-13.1}$ and PbS, $K_{sp} = 10^{-27.5}$. Lead and the other metals are cations

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that can be expected to undergo cation and exchange with clays. Hence, the mobility of lead in groundwater is limited. Lead is present in nature as a trace element. In two different studies soils in uncontaminated areas were reported to contain 17 μg of lead per gram of soil (μg Pb/g) (Nriagu 1972) and 29 μg Pb/g (Ure and Berrow 1972). However, there are a number of anthropogenic sources of lead, including mining and smelting, paint, use of sewage sludge as a soil conditioner, lead arsenate pesticides, and leaded gasoline. Urban areas especially have much higher levels of lead in the soil due primarily to paint flaking from buildings and burning of leaded gasoline (Davis 1990). A study of lead in soils near highways in the Minneapolis-St. Paul, USA, area revealed concentrations ranging from 128 to 700 μg Pb/g (Singer and Hanson 1969). A study in California, U.S.A. found that lead in soil decreased with distance from a freeway which ran through a rural area, with 118 μg Pb/g found 15 meters from the expressway and 85 μg Pb/g as much as 362 meters away (Page et al. 1971). Lead additives were used as anti-knock compounds in gasoline, but are now restricted or banned in many parts of the world.

Elevated lead is also found in soil around lead smelters. Davies (1990) estimates that in the immediate area of a well established lead smelter (1 to 3 km away), lead in soil is likely to be on the order of 1500 μg Pb/g. In a study conducted in southeastern Missouri, USA, the investigators were able to distinguish lead from automobile exhaust from lead from smelter activities on the basis of the ratio of stable lead isotopes, $^{206}Pb/^{204}Pb$ (Rabinowitz and Wetherill 1972). In that study they found lead in soil near smelters averaging 2600 μg Pb/g and near highways averaging 270 μg Pb/g.

In general urban soils have higher lead content than rural soils. In a major study of metals in urban soils in Great Britain a total of 4,126 lawns were tested, with a geometric mean lead content of 266 μg Pb/g and a range of thirteen to 14,100 μg Pb/g (Culbard et al. 1988). In London a total of 578 samples had a geometric mean lead content of 654 μg Pb/g.

Soluble lead is absorbed by soils, and its mobility is limited. The two most important factors in determining the amount of lead that will be sorbed by soil are the pH and the cation exchange capacity (CEC) of the soil (Zimdahl and Skogerbe 1977). This relationship can be described by an equation, with the amount of lead sorbed per gram of soil represented by N^*:

$$N^*_{(mol/gm)} = 2.81\times10^{-6}CEC_{(meq/100g)} + 1.07\times10^{-5}pH - 4.93\times10^{-5}$$

The above equation shows that with a pH greater than 4.61 the amount of lead sorbed by the soil increases and that below a pH of 4.61, it decreases. The cation exchange capacity of a soil is dependent upon the amount and type of clay in the soil and the amount of soil organic matter. Lead absorption is due to precipitation of the carbonate, fixation on organic matter, or sorption by hydrous oxides of iron and magnesium. Griffin and Shimp (1976) demonstrated that the sorption capacity of a clay for lead at a pH of 5.0 was much greater than at a pH of 4.0.

Because of the high affinity of soil for lead, the metal tends to accumulate in the upper few centimeters of soil. In a study of heavy metal mobility in soils near a zinc smelter, lead was found to be concentrated in the upper 10 cm of the soil (Scokart et al. 1983). This was due to the extremely low mobility of lead in soil. The reason that urban soils have such high lead levels is twofold. First, there are more

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sources of lead. But more important is the fact that the lead in the soil is so immobile that it continues to accumulate. In a study of trace metals in virgin agricultural soil profiles in Canada, Wright and others (1955) found lead to be more concentrated in the upper part of the soil profile. The lead was assumed to come from the weathering process and was concentrated in the zone where leaching was the most prevalent. This is further evidence for the very low mobility of lead in the environment.

There is one potential pathway for lead migration. If lead is sorbed onto colloidal-sized metal hydroxides, and the hydroxide moves through an aquifer as a colloidal particle, then the lead would also move. This would show up as lead in total metals analysis, which is run on an unfiltered sample. The colloidal particles, which may impart turbidity to the sample, would be digested and any sorbed lead liberated in the analysis. Colloidal-sized lead particles could also migrate with groundwater and be detected with the total lead analysis.

6.8.15 Rare Earth Elements

Rare earth elements (REEs) are increasingly important materials for modern technologies and can be found in groundwater. Although REE concentrations in groundwater can be low, they are used in investigations as tracers to indicate water movement and source, and importantly have associated radioactive pollutants in REE mining waste. There are 17 REEs, but the name "rare" is misleading as some (e.g., cerium) can be relatively abundant in the earth's crust. REE mining activity is rapidly expanding as are the economic uses of REEs. For example, REEs are used in cellular phones, laptop computer hard drives, automobile airbags and ABS brakes, medical magnetic resonance imaging (MRI), hybrid car batteries, wind turbine generators, plasma color televisions, satellite components, and communications equipment, to name a few applications. REEs have been shown to be useful in tracking and tracing groundwater (Johannessonn et al. 1997; Kreamer et al. 1996; Johannessonn 2006), and radioactive elements of uranium and thorium are commonly found in slurry tailing from REE mining.

■ 6.9 Radioactive Isotopes

6.9.1 Introduction

Certain isotopes of elements undergo spontaneous decay, resulting in the release of energy and energetic particles and consequent formation of different isotopes. Some of these radioactive isotopes are naturally occurring and others are created by the bombardment of the Earth by cosmic radiation. Humans have created nuclear isotopes through the detonation of nuclear weapons and the construction of nuclear reactors. Table 6.6 lists the sources of environmentally important isotopes.

Radionuclides emit ionizing radiation–alpha particles, beta particles, and gamma rays–when they decay. An alpha particle is a helium nucleus with atomic mass 4 and atomic number 2. A beta particle is either a negative electron or a positron (positive electron). Gamma radiation consists of electromagnetic radiation similar to X-rays but more energetic (i.e., it has a shorter wave length). Gamma radiation is more destructive to tissue than X-rays. The primary effect of these particles is to produce ions, hence the name ionizing radiation. Alpha particles do not penetrate very far into matter due

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TABLE 6.6 Sources of environmentally important radioactive isotopes.

Source	Radionuclides
Naturally occurring	^{40}K, ^{222}Rn, ^{226}Ra, $^{230,232}Th$, $^{235,238}U$
Cosmic irradiation	^{3}H, ^{7}Be, ^{14}C, ^{22}Na
Nuclear weapons tests	^{3}H, ^{90}Sr, ^{137}Cs, $^{239,240}Pu$
Mining waste—uranium, phosphate, coal	^{222}Rn ^{226}Ra, $^{230,232}Th$, $^{235,238}U$
Industrial wastes—e.g., nuclear power plants, weapons manufacturing, research and medical waste	$^{59,63}Ni$, ^{60}Co, ^{90}Sr, $^{93,99}Zr$, ^{99}Tc, ^{107}Pd, ^{129}I, ^{137}Cs, ^{144}Ce, ^{151}Sm, $^{152,154}Eu$, ^{237}Np, $^{239,240,242}Pu$, $^{241,243}Am$

Source: G. W. Gee, D. Roi, and R. J. Serne. 1983. Mobility of radionuclides in soil. In D. W. Nelson et al. (ed.) *Chemical Mobility and Reactivity in Soil Systems*, 203. (Madison, WI: Soil Science Society of America Spec. Publ. 11, 1983).

to their large size, but they produce a lot of ions along their short path. Beta particles penetrate to a greater depth but produce fewer ions per unit path length.

Radionuclide concentrations can be reported in terms of their mass per volume concentration (e.g., milligrams per liter). However, they are more frequently reported in terms of a standard unit of radioactivity, the **curie** (Ci). A curie is 3.7×10^{10} disintegrations per second. In water we use the **picocurie** (pCi), which is 1×10^{-12} Ci, or 3.7×10^{-2} disintegrations per second. In the SI system the unit of radioactivity is the **becquerel** (Bq), which is 1disintegration per second.

Radiation doses are measured in terms of **rads**, which are a measure of the absorption by the body of ionizing radiation of any type. A rad is equivalent to 100 ergs of energy from ionizing radiation absorbed per gram of soft tissue. In the SI system the unit of dose is a **gray** (Gy), which is equal to 100 rads.

The effect of ionizing radiation depends upon the type of particle and the body tissue with which it interacts. Therefore, the absolute measurement of dose must be converted to a **dose equivalent**. The unit of dose equivalent is the **rem**. Rads are converted to rems by multiplying by a factor that depends upon the type of ionizing radiation and its biological effect. For example, with gamma radiation the factor is 1and a rad is equal to a rem. In the SI system the unit of dose equivalent is the **seivert** (Sv), and it is equal to a gray times the dose factor. A seivert is 100 rem.

6.9.2 Adsorption of Cationic Radionuclides

The cationic radionuclides may be subjected to ion exchange and other processes that sorb the radionuclide onto mineral or organic surfaces in the soil. The following transition metals and lanthanides have large distribution coefficients and hence low mobilities in waters that are in the neutral range: ^{60}Co, ^{59}Ni, ^{63}Ni, ^{65}Zn, ^{93}Zr, ^{107}Pd, ^{110}Ag, ^{114}Ce, ^{147}Pm, ^{151}Sm, ^{152}Eu, and ^{154}Eu. Many of them do not desorb significantly. The degree of sorption is strongly related to the pH of the solution. Insoluble metal hydroxides may also be formed. Technetium (Tc) solubility depends strongly upon the Eh of the solution, because under oxidizing conditions it forms the soluble pertechnetate ion (TcO_4^-) (Gee, Rai, and Serne 1983).

^{90}Sr, ^{137}CS, and ^{226}Ra undergo cation exchange in a fashion similar to other exchangeable cations, such as Ca^{2+} and Mg^{2+}. Thorium and lead also have high distribution coefficients and limited mobility in neutral to alkaline soil. Lead is sorbed on

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hydrous oxides of iron, aluminum, and most likely manganese. Thorium hydroxides are of very limited solubility (Gee, Rai, and Serne 1983).

6.9.3 Uranium

Uranium occurs primarily as ^{238}U, with ^{235}U being much more rare. One of the disintegration products of ^{238}U is ^{226}Ra. This decay series ends with ^{206}Pb, a stable isotope. ^{238}U can also degrade to ^{234}U. The $^{234}U/^{238}U$ ratio is useful in tracking and dating groundwater (see Chapter 8). ^{238}U has a very long half-life, 4.5×10^9 years, which indicates that it is not very radioactive. The ^{235}U isotope can decay to form ^{223}Ra.

The chemistry of dissolved uranium is somewhat complex (Giridher and Langmuir 1991; Langmuir 1978). It has three valence states, +4, +5, and +6. Uranium can undergo oxidation-reduction reactions such as oxidation from the +4 to the +6 state:

$$U^{4+} + 2H_2O \rightleftharpoons UO_2^{2+} + 4H^+ + 2e^-$$

In a system with just uranium and water, stable species include (1) +4 valence: U^{4+} UOH^{3+}, and (2) +6 valence: UO_2^{2+} UO_2H^+ $(UO2)_3(OH)_5^+$ and $(UO2)_3(OH)_7^-$. The stability fields for this ions and precipitates are shown in Figure 6.14 for an aqueous solution with a total uranium activity of 10^{-6} mol/L The U(6+) species has a tendency to from a complexes with a wide variety of inorganic anions, including carbonate, hydroxide, phosphate, fluoride, and sulfate. This can be illustrated with an Eh-pH diagram of the same 10^{-6} mol/L solution of U but in contact with carbon dioxide at a partial pressure of 10^{-2} atm. This is represented by Figure 6.15. In Figure 6.14 the UO_2^{2+} formed a series of complexes with OH^-, starting with UO_2OH^+, at a pH above about 5.2. With carbon present, as in Figure 6.15, UO_2^{2+} can form a series of carbonate complexes that replace the hydroxyl complexes.

The soluble complexes of oxidized uranium depend upon the pH of the water. Most natural water contains fluoride, phosphorus, carbon dioxide, and sulfur. Figure 6.16 shows the distribution of uranyl complexes for a groundwater under standard conditions with $P_{CO2} = 10^{-2.5}$ atm, $F^- = 0.3$ mg/L, $Cl^- = 10$ mg/L, $so_4^{2-} = 100$ mg/L, and $P0_4^- = 0.1$mg/L. In different pH ranges the most prevalent stable species include

$$UO_2^{2+}, UO_2(HPO_4)_2^{2-}, UO_2(CO_3)_2^{2-}, \text{and } UO_2(CO_3)_3^{4-}.$$

If reduced species of iron or sulfur are present, they could reduce U(6+) to U(4+) and precipitate the nearly insoluble mineral uranite, UO_2 This reduction could occur by oxidation of HS^- to SO_4^{2-}:

$$4UO_2(CO_3)_3^{4-} + HS^- + 15H^+ \rightleftharpoons 4UO_2(s) + SO_4^{2-} + 12CO_2(g) + 8H_2O$$

The same reduction could be accomplished by oxidation of ferrous iron to ferric hydroxide:

$$UO_2(CO_2)_3^{4-} + 2Fe^{2+} + 3H_2O \rightleftharpoons UO_2(s) + 2Fe(OH)_3 + 3CO_2$$

Because sulfur and iron are common in groundwater systems, under reducing conditions one could expect the formation of uranite, which would remove uranium from solution. Figures 6.14 and 6.15 show the stability field for uranite ($U0_2$). In the

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has a very low solubility. The primary thorium ore is monazite, which contains oxides of thorium, phosphorus, and the rare earths yttrium, lanthanum, and cerium.

The mobility of thorium is greatly enhanced if ligands are present to form complexes. Figure 6.20 shows the inorganic thorium complexes that form as a function of the pH of the solution. The solution contains 0.3 mg/L F^-, 10 mg/L Cl^-, 100 mg/L SO_4^{2-} and 0.1mg/L PO_4^{2-}. It can be seen from this figure that the most abundant aqueous species in order of increasing pH are $Th(SO_4)_2^0$,ThF_2^{2+} $Th(HPO_4)_2^0$, $Th(HPO_4)_3^{2-}$ and $Th(OH)_4^0$ However, the mobility of thorium complexes formed by organic ligands such as EDTA and citric acid are much greater than those formed by inorganic ligands (Langmuir and Herman 1980).

Adsorption of dissolved thorium increases with increasing pH above pH 2. The sorption of thorium onto clays, oxides and soil organic matter is nearly total by a pH of 6.5. Strongly complexing organic ligands such as EDTA can retard sorption or even promote desorption (Langmuir and Herman 1980). Thorium in natural waters and soil should be nearly immobile due to the low solubility of the minerals and the strong tendency for dissolved forms to be sorbed only by clays, mineral oxides, and soil organic matter.

6.9.5 Radium

Radium occurs naturally in four isotopes: ^{223}Ra, 226Ra and ^{228}Ra.^{232}Th decays into both ^{228}Ra and ^{224}Ra, whereas ^{235}U decays to ^{223}Ra and ^{238}U disintegrates to ^{235Th}, which in turn decays to ^{226}Ra. One isotope, ^{226}Ra, has a much longer half-life than any of the others, 1599 years. Because of their short half-lives, the radium isotopes are strongly radioactive (Hem 1985).

Knowledge of the aqueous chemistry of radium is summarized in IAEA (2014). It is reportedly similar in chemical behavior to barium (Hem 1985) and calcium (Kathren 1984). It is more soluble than uranium or thorium and can be bioconcentrated by plants (Brazil nuts have an especially high radium content). Radium can be strongly exchanged in the cation exchange series. According to Kathren (1984), the cation exchange sequence for soils is

$$Sr^{2+} < Ra^{2+} < Ca^{2+} < Mg^{2+} < Cs^{2+} < Rb^{2+} < K^+ < NH_4^+ < Na^+ < Li^+$$

^{228}Ra has a much shorter half-life, (5.8 yr) than ^{226}Ra. However, its parent, ^{232}Th, is more abundant in nature than ^{238}U, the parent of ^{226}Ra. As a result, both isotopes are found in groundwater. The U.S. EPA has proposed MCLs of 20 pCi/L for both ^{226}Ra and ^{228}Ra (Federal Register, July 18, 1991). Wells with high radium levels in groundwater have been discovered to be concentrated in two areas of the United States: the Piedmont and coastal plain of the Middle Atlantic states and the upper Northwestern states of Minnesota, Iowa, Illinois, Missouri, and Wisconsin (Hess et al. 1985). Table 6.7 summarizes the distribution of ^{226}Ra and ^{228}Ra in the Atlantic coastal plain and Piedmont region.

The radium content of groundwater is a function of the rock type of the aquifer. Igneous rocks, such as granites, contain the highest proportion of uranium and thorium, the parent isotopes of radium. Granitic rock aquifers and sands and sandstones derived from the weathering of granites have the potential to have high radium. Phosphate rock is also very high in uranium. Radium is not only a problem that is naturally occurring,

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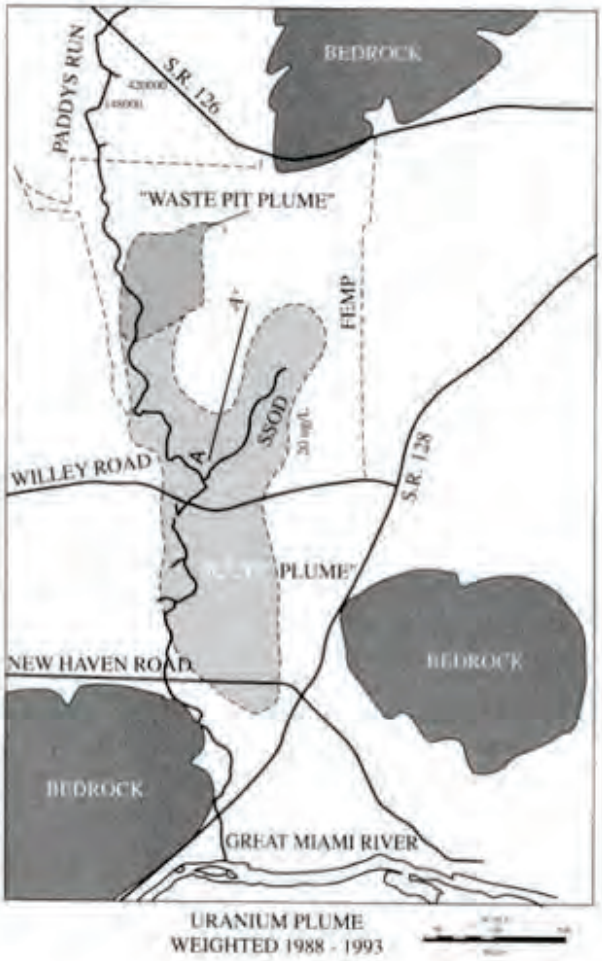
FIGURE 6.17 Composite plume of total dissolved uranium >0.20 µg/L for the period 1988 to 1993.



Source: W. C. Sidle and P. Y. Lee. 1996. Uranium contamination in the Great Miami Aquifer at the Fernald Environmental Management Project, Fernald Ohio. *Groundwater* 34:876–882. Used with permission.

Table 6.7 Distribution of 226Ra and 22BRa by aquifer type in the Atlantic coastal plain and Piedmont provinces.

		Ra – 228 (pCi/L)		Ra – 226 (pCi/L)	
Aquifer Type	Number of Samples	Geometric Mean	Range	Geometric Mean	Range
Igneous (acidic)	42	1.39	0.0–22.6	1.8	0.0–15.9
Metamorphic	75	0.33	0.0–3.9	0.37	0.0–7.4
Sand	143	1.05	0.0–17.6	1.36	0.0–25.9
Arkose	92	2.16	0.0–13.5	2.19	0.0–23.0
Quartzose	50	0.27	0.0–17.6	0.55	0.0–25.9
Limestone	16	0.06	0.0—0.2	0.12	0.0—0.3

Source: C. T. Hess, J. Michel, T. R. Horton, H. M. Prichord, and W. A. Coniglio, "The occurrence of radioactivity in public water supplies in the United States," *Health Physics* 48 (1985):553–86.

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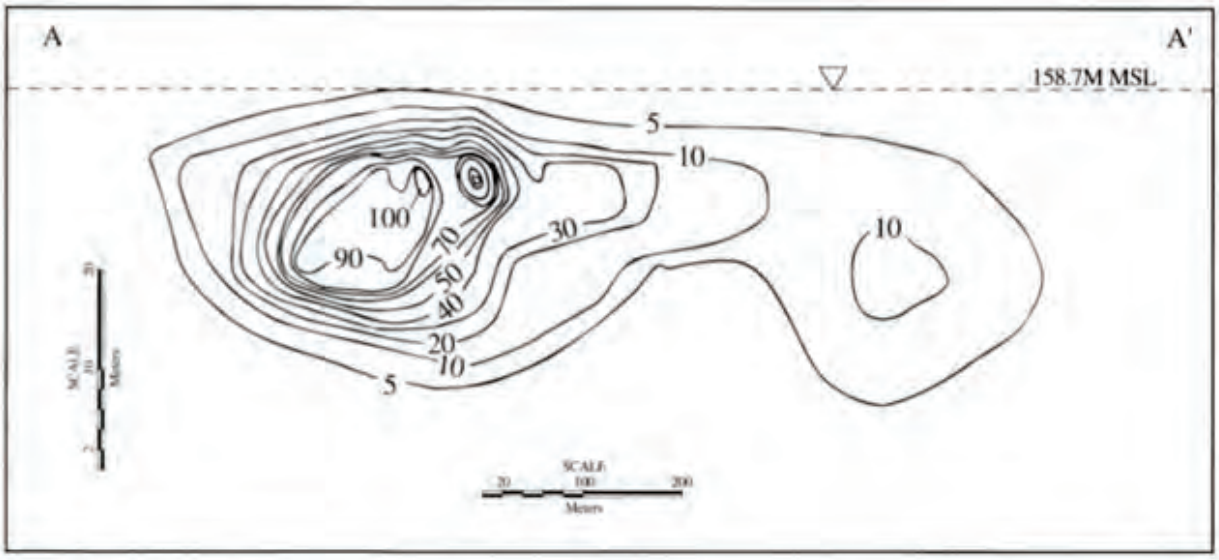
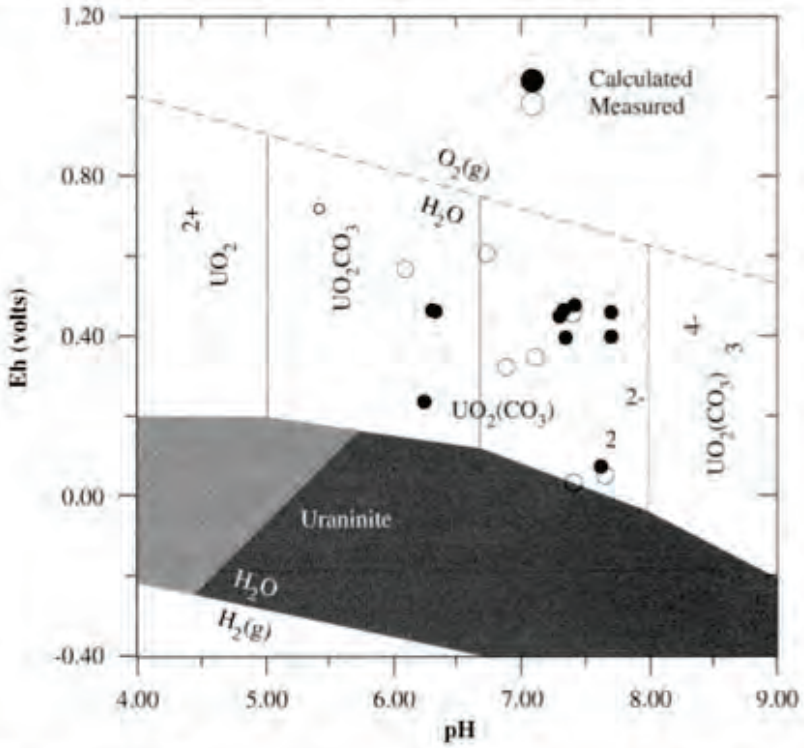
FIGURE 6.18 Longitudinal profile of total dissolved uranium along line A – A′ from Figure 6.17.



Source: W. C. Sidle and P. Y. Lee. 1996. Uranium contamination in the Great Miami Aquifer at the Fernald Environmental Management Project, Fernald Ohio. *Groundwater* 34:876–882. Used with permission.

Figure 6.19 Measured and calculated redox potential for the UO_2^{2+}/U^{4+} pair plotted on the $\Sigma U = 10^{-6}$ stability field.



Source: W. C. Sidle and P. Y. Lee. 1996. Uranium contamination in the Great Miami Aquifer at the Fernald Environmental Management Project, Fernald Ohio. *Groundwater* 34:876–882. Used with permission.

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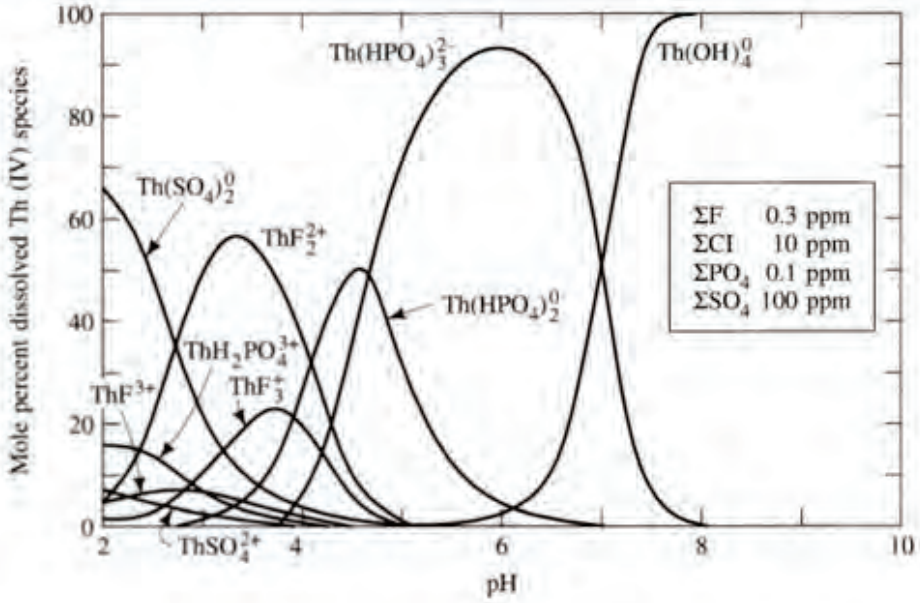
Figure 6.20 Distribution of thorium complexes as a function of pH under standard conditions for an aqueous solution containing 0.3 mg/L F^-, 10 mg/L Cl^-, 100 mg/L SO_4^{2-}, and 0.1 mg/L PO_4^{2-}.



Source: D. Langmuir and J. S. Herman. 1980. The mobility of thorium in natural waters at low temperatures. *Geochemica et Cosmochimica Acta* 44:1753–1766. Used with permission.

but there are localized areas of radium contamination from industrial operations. These are associated with uranium mill tailings as well as facilities where radioluminescent paints were prepared and used. For example, from World War I up until 1968 wrist watches with radium dials that glowed in the dark were sold in the United States.

6.9.6 Radon

There are several isotopes of radon, but ^{222}Rn is the only one that is important environmentally. The other isotopes have half-lives of less than 1 min. The half-life of ^{222}Rn is 3.8 days. ^{222}Rn is produced by the decay of ^{226}Ra, so that it is associated with rocks that are high in uranium. Radon can be associated with water that is low in dissolved ^{226}Ra, because it comes primarily from the decay of the radium in the rock. Radon is a noble gas and does not undergo any chemical reactions, nor is it sorbed onto mineral matter. Radon is lost from water by diffusion into the atmosphere and by radioactive decay through a series of short-lived daughter products to ^{210}Pb, which has a half-life of 21.8 yr.

The EPA has proposed an MCL standard of 300 pCi/L for radon in drinking water (Federal Register, November 2, 1999). However, there is also a health concern for excessive radon accumulation in homes. Radon can enter homes through emanations from the soil as well as by diffusion from tap water with a high radon content.

Owners of private water systems are most at risk from radon in drinking water. Public water-supply systems normally have storage facilities to supply water during fires. The residence time for the water in these facilities allows the radon to both diffuse and decay. Private water systems rely upon wells and usually only have a very small storage facility used to maintain pressure.

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8

Site Characterization—Groundwater and Soil Monitoring

8.1 Introduction

Characterization of a potentially contaminated site involves field and laboratory analysis of subsurface properties, with a goal of building a conceptual model of contaminant source strength and configuration, and pollutant movement and transformation with time and space. This, in turn, is done to optimize monitoring strategies, and develop advantageous and cost effective remedial solutions.

The process of characterization begins with identifying the goals of characterization and remediation, and these goals can widely vary. Site characterization approaches will be quite different if the overall goal is to identify parties responsible for pollution, versus a goal of protecting public health, versus a goal of maintaining a vibrant groundwater dependent ecosystem. Further, a site can have several prioritized goals and not just one. Objectives are often linked, for example, one objective might be to minimize costs by requiring a thorough (and perhaps costly) site characterization in order to reduce potentially higher remediation costs by strategically targeting pollutants. There are many different site characterization methodologies including phased or progressive approaches and adaptive management techniques. At a site where very little is known about the nature and extent of subsurface contamination, often a first sampling step is collection and analysis for a broad range of potential contaminants, to be narrowed and focused based on the findings of those early surveys.

It must be emphasized that each site is unique and should not be addressed in a "one size fits all" or "we did it this way at the last site" boilerplate approach. Some of the seemingly smallest changes in geologic heterogeneities at different sites can radically alter subsurface fluid flow, and if unrecognized can cause inappropriate assumptions to be made and incorrect approaches to be followed. Likewise, site-specific physical, human-made features that protrude into or affect the subsurface (e.g., building footings, buried pipeline trenches backed-filled with gravel or other non-native material, groundwater pumping, surface irrigation or paving, application of chemicals at the ground surface, chronic and slow leaks versus massive leaks) all can alter how pollutants change their distribution, phase, form, and potential threat. An underlying note of caution is that the data that monitoring provides is not always representative of the complete hydrogeological picture

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or demonstrates contaminant distribution. Not accounting for these unique properties at each site, or blindly assuming that selected monitoring data is broadly representative of actual field conditions, can cost huge sums in misspent money, useless monitoring, ineffective remediation, lost time, and misstated risks (Nielsen 2005).

There are some general perspectives and overall guiding principles regarding monitoring and site characterization that are helpful. They include the following:

1. Resources spent on proper and thorough site characterization typically save many times their investment in reduced remedial costs.
2. Incautious monitoring installation and practices can make the original environmental problem worse by allowing cross-contamination and short-circuiting of contaminant migration.
3. It is standard to have well-defined goals for characterization and remediation before embarking on site activities.
4. It is very helpful to calculate a good mass balance of contaminants early on, including an estimate (or range of estimates) in source mass, amount retained in vadose zone, amount reaching the water table, mass dissolving into water, mass volatilizing into the gaseous phase, amount sorbing onto soils, mass transforming and/or chemically or biologically degrading, and other sources and sinks of contaminant mass.
5. Typically assessment should begin with noninvasive methods (methods that do not appreciably disturb the subsurface at a site) in order to optimize subsequent invasive methods (such as monitoring well installation).
6. Employing an "outside-in" approach where possible is advantageous to reduce equipment contamination or to prevent contaminant spreading, (e.g., drilling monitoring wells first in areas suspected of low contamination rather than "hot spots," or the practice of sampling wells deemed to be cleanest with low contamination first to reduce the possibility of cross contamination).
7. Phased approaches have benefits in allowing adjustment in monitoring strategies as more information is learned.
8. Consider early/interim remedial action as monitoring and monitoring plans are progressing (beyond just typical emergency response actions to immediate threats). Actions which are taken as monitoring plans are being completed can include: providing early source isolation, plume containment, and extraction of nonaqueous phase liquids to reduce their propensity to migrate.

There are a selection of noninvasive, or minimally invasive techniques available for initial groundwater surveys at potentially contaminated sites, and these procedures are often followed by groundwater and soil sampling. For groundwater sampling, the more invasive methods of installing monitoring wells and collecting groundwater samples have been developed with the specific intention of obtaining a representative sample of water from an aquifer (FDEP 2008; Hughes and Aarons 2014; Aller et al. 1991; NUDLC 2012; Arnold et al. 2009). These monitoring well methods minimize the potential for the introduction of contaminants into the ground through the process of installing a monitoring well. Wells and sampling devices can be constructed of materials that have a minimum tendency to leach materials into and sorb compounds from the water sample. Groundwater samples can be collected in such a manner that

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dissolved gases are not lost or exchanged with the atmospheric gases. Soil samples can also be collected for classification and chemical analysis.

Various methods of collecting samples of soil water are also available, as are procedures for determining the location and nature of subsurface contamination. Soil gas sampling can be done to give an indication of areas where volatile organic compounds are contained in the soil or groundwater. Many other forensic approaches help with the determination of groundwater and contaminant travel times, source location and timing, contaminant transformations and phase changes, geological formations and structures, and potential risk.

Proper site characterization can transform understanding and advance the development of effective remedial strategies. Australian guidance defines the "sound science" associated with contaminated site characterization and development of robust site conceptual models as being based on "organized investigations and observations conducted by qualified personnel using documented methods and leading to verifiable results and conclusions" (NSW 2010).

8.2 Noninvasive Measures

At the beginning of a site characterization program, noninvasive methods are employed to understand the site without excessive perturbation of the subsurface. Although monitoring wells are usually an essential part of characterizing groundwater contamination, their installation can trigger vertical migration of pollutants, depending on the method of installation. A site characterization process typically begins with definition of objectives and a review of site specifics and history. Records of facility operations and inventories are investigated, contaminant handling practices at the site are looked into, drains and drywells are located, surface features and drainage patterns are reviewed, buried pipelines are identified, past and present employees may be interviewed, pertinent climatic data checked, existing local wells pinpointed along with associated groundwater quality data, and applicable law and regulations reviewed. As part of this process, facility records and manifests are analyzed to understand the possible mass of contaminants handled historically at the site. Agency and utility files, and regional geologic and hydrogeologic information are evaluated. An integral part of these undertakings is an initial site water balance and contaminant mass balance. Most of these undertakings are office related and not carried out directly on-site.

Air photo interpretation, surface geophysics, and quick soil and surface water survey and screening techniques are minimally invasive field techniques. Soil gas surveys are particularly useful for volatile compounds, and there are other noninvasive and informative practices useful in initial site assessment.

8.2.1 Interpretation of Aerial Photography and Remote Sensing

A review of site surface features, both present-day and historical, are easily accessible with the advent of widely available air photo libraries, such as National Aeronautics and Space Administration (NASA) World Wind and Google Earth. Many things pertinent to site characterization can be observed from visible aerial photography. This includes past and present site structures, roads and access points, possible soil staining

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or discoloration, the proximity of nearby creeks and streams, local wetlands and reservoirs and how these change with time, vegetative changes, urbanization, local erosion, industrial surface impoundments, and evaporation ponds. In tectonically active terrain, faults can sometimes be identified by observable surface lineaments. (Faults can be crucial to groundwater flow and contaminant movement in fractured terrain). Because of the replacement of film with digital imagery, the record of aerial photography has come to have a previously unrealized permanence. It should be noted that aerial photography displays a degree of radial distortion and without correction measurements of distance and topography are not accurate. Even so, aerial observation can provide better spatial resolution and geometric fidelity than many ground-based approaches.

The electromagnetic spectrum beyond visible light can also be quite helpful, as aerial photography provides broader spectral sensitivity than the human eye. Spectral bands or individual wavelengths can help identify many site activities. For example, near-infrared radiation (reflectance) can identify plant health, and thermal infrared (emitted spectra) can show heat sources on a property. Radar scanning can identify topographic expressions of subtle features like faults and folds often better than conventional satellite images. These radar techniques include Side-Looking Airborne Radar (SLAR) and LIDAR (a combination of the word "light" and "radar") that can identify ground uplift or subsidence, and define geomorphologic features. There are also airborne geophysical techniques that are noninvasive and help define the geological surroundings of a site. Although traditionally used for geologic resource and mineral assessment, aeromagnetic, radiometric, and gravity surveys can add important information to an understanding of field geological influences on contaminant travel.

8.2.2 The Use of Surface Geophysical Techniques for Site Characterization

Noninvasive surface geophysical techniques can advance site characterization in many ways, although some techniques are expensive, and natural and human-made surface features can interfere with their efficacy. American Standard Testing Methods' ASTM D6429-(2011)e1 is a standard guide for selection of surface geophysical methods, and Olhoeft (1992) provides a Geophysical Advisor Expert System to facilitate field decisions on appropriate geophysical methods.

Electromagnetic Surveys (EM) One surface geophysical method is an electromagnetic survey that measures the magnetic susceptibility of earth materials and their variation. An electromagnetic (EM) induction sensor can detect subsurface electrical conductivity dissimilarities, and therefore is good for locating lateral changes or discontinuities in soil or rock, and fluid filled fracture zones. These heterogeneities can be extremely important in subsurface contaminant movement, particularly for nonaqueous phase liquids (NAPLs). EM techniques can directly detect: burial trenches or pits containing drums or bulk wastes, electrically conductive plumes (particularly useful in coastal saltwater intrusion and saline landfill plumes), plume movement using time-series measurements, and utility pipes/cables (which may transport contaminants through their trench backfill and/or interfere with other geophysical techniques). Electrical conductivity variation can also be an indicator of NAPL presence.

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Airborne electromagnetic surveys can explore large swaths of land, helping to delineate factors directly pertinent to contaminant hydrogeology such as large faults, paleochannels and shear zones with appreciable groundwater and/or clay gouge, and dissimilarities in the electrical conductivity of groundwater bodies. Helicopter transient electromagnetic surveys (TEM) can examine subsurface properties down to 200m depth, and have been used to identify contaminated landfill sites, model pollution and coastal hydrogeology, and optimize management of mining tailings facilities (Silvestri et al. 2009; Pellerin et al. 2010; Kirkegard et al. 2011; Christensen and Halkjaer 2014).

Direct Current Resistivity and Induced Polarization Another geophysical technique is a direct current resistivity survey that employs a constant electrical source using electrodes placed in the ground. The attenuation of voltage from between these electrodes (electrical resistance) allows calculation of depths to water tables or water-bearing horizons, freshwater/ saltwater interfaces, depth to bedrock, and stratigraphy at a site. Like EM techniques, direct current resistivity can identify electrically anomalous plumes and burial sites for bulk wastes and drums. Fencelines, pipelines, and other surface interferences can alter DC resistivity results. A related technique is induced polarization which measures the transient electrical response. This technique has been applied to locating subsurface NAPLs and tracking active or passive remediation, particularly for surfactants that might be injected for soil flushing cleanups (Personna et al. 2013; Magill 2009).

Time Domain Reflectometry Time Domain Reflectometry or TDR measures the relationship between the velocity that an electromagnetic wave moves through and between metal rods which are pushed into the ground, and the dielectric constant of the soil through which the wave propagates. This method has been used to estimate soil water content for many years, but many other applications for contaminated soil have been developed. For example, Olchawa and Kumor (2008) have used a soil's dielectric permittivity measured with TDR to measure the content of diesel oil in soil.

Magnetometry Magnetometry measures nonuniformities in the earth's magnetic field typically caused by buried tanks and drums made of ferrous material (iron and steel) and underground pipelines and utilities. Because many industrial sites have the potential to contain leaking tanks or pipes, these surveys can help locate problem areas. Even in the absence of leaking tanks and pipes, backfill surrounding underground tanks and pipes can be a conduit for some future pollutant flow and can be identified as a potential preferred pathway for fluid migration. Also, locating buried utility features is a critical step before drilling monitoring boreholes.

Seismic Surveys Reflective and refractive seismic techniques require an energy source such as a force striking the ground which generates low-amplitude waves through the earth to surface geophones that record the arrival of these waves. The time delay of wave arrival provides information that can help calculate subsurface stratigraphy, depths to both water table and bedrock, physical and elastic properties of subsurface formations, and lateral soil/rock discontinuities. Because pollution sources can either be pooled up above, or deflected by, subsurface layers, their identification is important in developing an accurate site conceptual model.

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Ground Penetrating Radar (GPR) Ground penetrating radar (GPR) in optimal circumstances also can identify depth to water table and bedrock, stratigraphy, metallic and nonmetalic buried objects, and underground tunnels and cavities. It has limitations in clayey soils because of a lack of radar penetration.

8.2.3 Rapid Noninvasive Field Surveys and Screening

If a thousand soil samples are sent to the laboratory for contaminant analysis, and only one comes back as registering detectable concentration, time and money has been wasted in site characterization. There are rapid field methods for determining the extent of soil, water, and major well contamination that can help focus and direct characterization efforts and save resources. For example, surface water sampling and analysis surveys are normally simple and quick because of easy access, and are often a first measure taken at a site suspected of contamination. Certain surface waters, such as springs, gaining reaches of streams, and wetlands, often directly reflect changes in adjacent groundwater.

Unaided Methods Some survey methods are unaided, such as when soil staining is directly visible, or inferred from directly observable problems like noxious odors, stressed or dead vegetation, and impaired or dead animals. Test pits, holes for building footings, and trenches can be an easy way to observe large cross-sections of the shallow subsurface. Pits, holes, and trenches are often available at urban and industrial sites where buildings are being put in, old underground tanks are being exhumed, or underground pipelines and utilities are being established. These open holes and trenches can provide opportunities for visible identification of contamination because of large continuous exposure of the subsurface. Direct sampling of soil and any ponded water is simple with a limited risk of vertical contaminant migration. Test pits and trenches can delineate shallow stratigraphy, waste disposal areas, grossly contaminated sites, buried pipelines and underground storage tanks. Importantly, some of these site features potentially contain health hazards (e.g., toxic gases or potential trench wall collapse), and safety measures need to always be considered in these investigations.

Colorimetric Screening Techniques Classes of contaminants, like NAPLs, can be inexpensively and immediately detected by direct visual sightings in soil and water, but can be difficult when a NAPL or another pollutant of interest is clear or colorless, at low saturation, or distributed heterogeneously. NAPLs which cannot be visually detected can be quickly discovered by a number of other simple techniques. Many NAPLs like crude oil, coal tar, creosote, and other petroleum products naturally fluoresce when exposed to ultraviolet (UV) light. The inexpensive methodology of putting a soil sample in a transparent plastic bag and placing it under a "black" (UV) light is a cost effective way to screen soils for many sorts of NAPL contamination. Also for NAPLs there are hydrophobic dyes which, when put in transparent containers with soils and shaken, give indicator colors in the presence of NAPLs. In water, hydrophobic filters or hydrophobic materials can be used to detect NAPL, or centrifugation can more clearly separate a nonaqueous phase from water. A syringe needle can also be used to extract suspected globules in a surface water or groundwater sample, and the globule can be placed in a water column to observe whether it mixes, sinks, or floats. In wells, NAPL presence can be observed in a number of ways. A simple quick

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method is dropping and retrieving a weighted string into a well and observing whether oil phases adhere to it. The weighted string should not be reused in another well to avoid cross-contamination. Hydrocarbon detection pastes (and water detection pastes for fuel storage tanks) can additionally help differentiate oils and water.

Immunological Surveys Another rapid field screening technique for water and soils are immunological surveys where polyclonal antibodies are mixed with soils and elicit a colorimetric response in the presence of certain pollutants. Polycyclic aromatic hydrocarbons (PAHs) have been shown to be detectable with about 5% false negatives and 5% false positives in one immunological survey (Knopp et al. 2000).

■ 8.3 Minimally Invasive Soil Monitoring

Monitoring techniques which have minor perturbation of field site geologic materials include soil vapor monitoring, soil water sampling, and phytoscreening. Although some of these techniques penetrate the subsurface, the disturbance is minor and at shallow depths.

8.3.1 Soil Vapor Monitoring—Introduction

Soil-gas monitoring can be valuable for several reasons. Volatile organic liquids in the subsurface can partition into a vapor phase in the vadose zone and therefore be identified with soil gas measurement. A volatile organic liquid source may be pure oil phase product either adhering to a mineral surface or forming a nonaqueous phase layer on top of the capillary zone. It may also be dissolved in soil water or groundwater. The major benefit of soil gas screening is that it can locate zones of contamination. Identified locations of undissolved product present in the vadose zone can be recognized as a potentially persistent reservoir for ongoing contamination of groundwater, and infiltrating precipitation could dissolve the product in these zones and carry it down to the water table in the aqueous phase. Soil-gas monitoring can also be used to help determine the location of spills and leaks, and the horizontal extent of a layer of a volatile, nonaqueous phase liquid, such as gasoline, floating on the water table. Vapors from the gasoline can partition into the vadose zone, so that if they are detected by soil-gas monitoring in an area where product spills or leaks are not likely, this is an indication that the product may be migrating into the area. Additionally, soil-gas monitoring has been used as a screening method to evaluate the extent of a plume of groundwater contaminated with volatile organic compounds. The soil gas above the plume may contain volatile organics if the plume is at the water table.

Contaminant vapors themselves can be problematic. They can intrude into buildings and homes, sometimes with adverse health and safety implications (USEPA 2002). The restoration of a site may involve soil remediation if organic compounds are detected in the vadose zone. Soil vapor monitoring has been incorporated into guidelines for site investigation for some countries, for example Denmark (Algreen et al. 2015a). Under many conditions soil gas monitoring can be done much more quickly and inexpensively than installing groundwater monitoring wells. Soil gas monitoring is a noninvasive technique with little subsurface disturbance which can be used to optimize follow-on invasive methods such as well installation (ITRC 2007).

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The boring is then unsealed; the vapor monitor is removed and sealed in a container for shipping to the lab, where it is analyzed (Kerfoot and Meyer 1986; NSW 2010).

Soil gas monitoring to find groundwater contamination plumes works best in areas where the vadose zone is comprised of dry, coarse-grained soils. The depth to water cannot be too deep, but at least 4.6 m (15 ft) is preferable. If the water table is too shallow, the concentration gradients are very steep, and a slight difference in depth of measurement may give a great difference in measured values (Marrin 1988). It is not possible to find an exact correlation between the soil gas concentration and contaminant concentration in the underlying groundwater. At best an order-of-magnitude correlation is possible (Thompson and Marrin 1987). Soil gas measurements are affected not only by the soil gas but also by the sampling technique and the soil-air permeability. After a rainfall, soil pores may be physically occluded by infiltrating rainwater and sampling may be impossible, particularly in finer soils. If there are several volatile organic compounds in the groundwater, they will partition into the vadose zone according to their individual Henry's law constants (Chapter 3). The organic compound with the greatest concentration in the soil gas may be the compound with the greatest Henry's law constant and not the one with the greatest concentration in the groundwater. Although care must be taken when interpreting the results of a soil gas survey, these surveys are valuable screening techniques and have significant qualitative value.

Samples of indoor air in buildings are important in identifying risks from explosive or toxic vapors, but at some sites they also show a general correlation between intrusive indoor air vapor concentrations and underlying groundwater volatile organic compound (VOC) plumes. These indoor air concentrations can vary greatly seasonally or with varying barometric pressure, but still can provide useful information which mirrors groundwater concentrations. Indoor air sampling uses a vacuum-filled ampule in which a valve is released and air is drawn in. Valve release can either be rapid for a single-time sample, or can have a slow timed release that collects an integrated sample with time.

8.3.3 Soil Water Sampling—Introduction

Contamination moving from the surface toward the water table passes through the vadose zone. Monitoring of soil-water quality in the vadose zone beneath hazardous-waste land-treatment systems is required under Subtitle C of the Resource Conservation and Recovery Act in the United States. States may also require vadose-zone monitoring beneath other types of hazardous-waste facilities.

In order to determine the chemical composition and quality of soil moisture in the vadose zone, a sample must be collected. Because the soil water in the vadose zone is under tension, it cannot flow into a well under gravity the way that groundwater flows into a well. Soil water must be collected with a suction lysimeter (Wilson 1990).

8.3.4 Suction Lysimeters

A **suction lysimeter** is a porous cup located on the end of a hollow tube. The tube can be PVC or even stainless steel. The porous cup can be ceramic, nylon, PFTE, or fritted stainless steel. Tubing connects the suction lysimeter with the surface.

A suction is applied to the hollow tube and held for a period of time. If the suction is greater (more negative) than the soil-moisture tension in the soil, a potential gradient

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will develop from the soil to the porous cup. Soil-water will flow into the porous cup, from which it can then be directed through the tubing to the surface for collection. The flow of soil moisture can be slow, and it may be necessary to hold the vacuum overnight to supply a sufficient volume.

A vacuum lysimeter simply has a porous tip on the end of a hollow tube with a stopper that extends to the surface. The vacuum is applied to the lysimeter by means of a hand-vacuum pump attached to a small tube that extends down to the porous tip, and a sample is drawn to the surface when vacuum is applied (Figure 8.1). The practical depth of this type of sampler is about 1.8 m (6 ft) due to the awkwardness and cost of installing long tubes (Wilson 1990).

A pressure-vacuum lysimeter has a hollow tube that is about 5.08 cm (2 in.) in diameter and 0.3 m (1 ft) long. Two tubes run from the lysimeter to the surface (Figure 8.2). One of the tubes, the discharge line, extends to the bottom of the lysimeter and the other tube, the pressure-vacuum line, ends near the top. A vacuum is applied to the pressure vacuum line with a vacuum pump while the discharge line is shut off with a pinch clamp. The pressure-vacuum line is then sealed with a pinch clamp and the lysimeter is allowed to sit overnight so that the sample can be drawn into the cup. The pinch clamps are then removed. A hand-pressure pump is then attached to the pressure-vacuum line, and when pressure is applied, the water is forced up the discharge line to the surface. (A single pressure-vacuum hand pump can be used for this operation.) The maximum practical operational depth for the pressure vacuum pump is about 15 m (50 ft). At depths

FIGURE 8.1 Operation of a vacuum lysimeter.

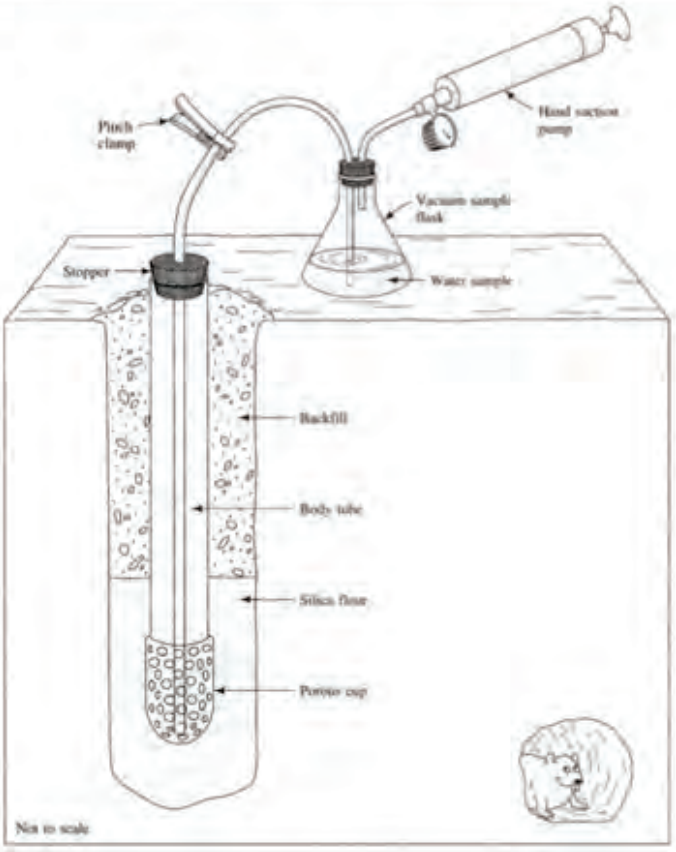

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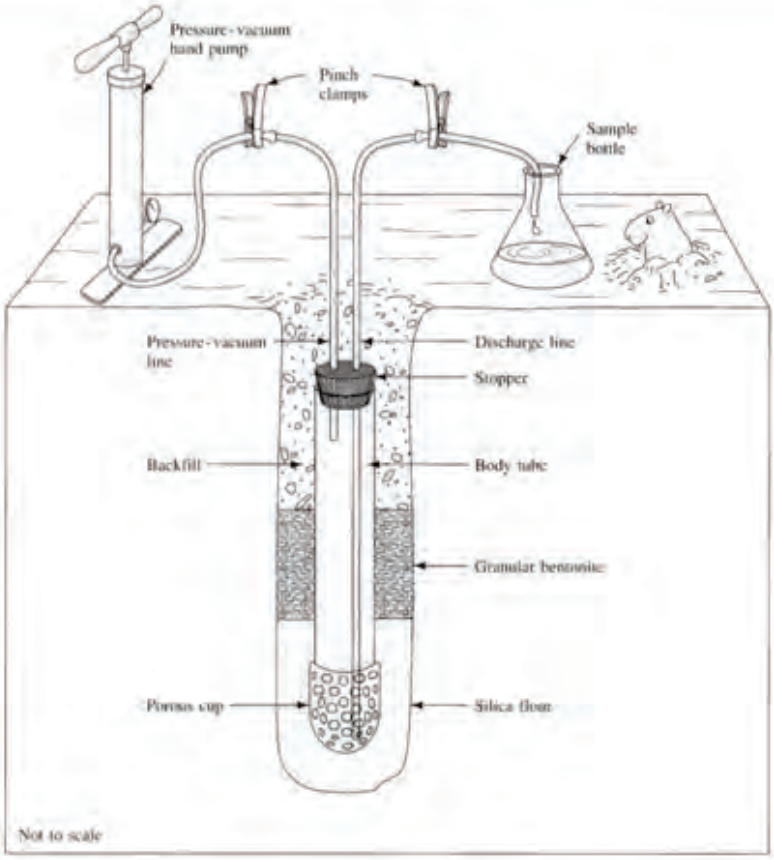
FIGURE 8.2 Operation of a pressure-vacuum lysimeter.



greater than this, the pressure needed to force the sample to the surface tends to drive it back out of the porous cup. This can be avoided by using a lysimeter with a check valve and an internal reservoir (Figure 8.3). When the vacuum is applied the water is drawn into the reservoir. When the pressure is then applied, the check valve prevents backflow into the porous cup and the sample must go to the surface.

8.3.5 Installation of Suction Lysimeters

In order for suction lysimeters to work properly, they must be carefully installed (Wilson 1991). Prior to use, new porous ceramic cups should be leached with a 10% hydrochloric acid solution for 24 hours to remove dust from manufacturing. They should then be thoroughly rinsed by passing distilled water through them. The lysimeter is then pressure tested before being installed by submerging it in water and applying a pressure of 207 kpa (30 lb/in.^{2}) to test for leaks. No leaks should appear at any fittings, and air should bubble evenly through the porous cup.

The suction lysimeter is installed in an augered hole that has a greater diameter than the hollow tube. If the suction lysimeter is placed at a shallow depth, less than about 3 m (10 ft), then the access hole can typically be made by a hand auger. If it is greater than that depth, then a hollow-stem auger-drilling rig is needed to auger a hole.

The porous tip must be well bedded in slurry made of 200-mesh silica flour or native soil material that has been dried and screened to remove the fraction larger

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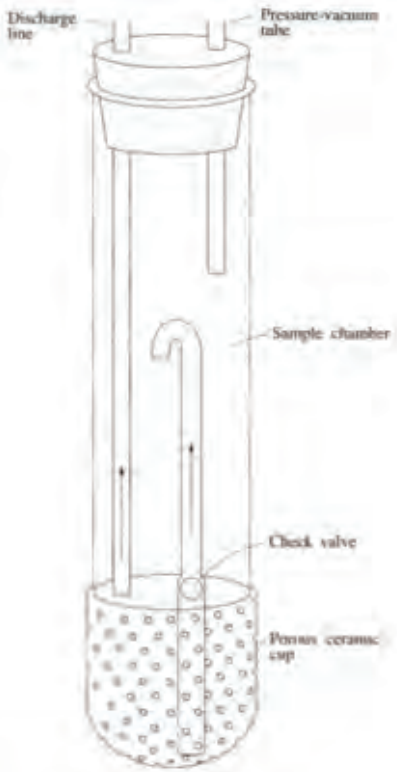
FIGURE 8.3 Design of a pressure-vacuum lysimeter with a sample chamber and a check valve.



than coarse sand. There needs to be good hydraulic contact with the porous cup, the bedding material, and the native soil. Prior to installation the porous tip should be well hydrated by soaking in distilled water.

If a hollow-stem auger is being used, the augers should first be pulled back about 0.61 m (2 ft) to expose the native soil. A slurry made from silica flour and distilled water (0.45 kg (1 lb) of 200-mesh silica flour and 150 mL of distilled water) is put into the hole with a tremmie pipe to fill the hole with about 15.25 cm (6 in.) of slurry. The suction lysimeter is then lowered into the hole and centered. The tremmie pipe is then used carefully to place the slurry around the lysimeter up to an elevation of about 0.3 m (1 ft) above the top of the lysimeter. The unit should be held in place until the water drains from the slurry. The unit is then tested to see if it will hold a vacuum of 60 Kpa (0.6 bars). If it does, the augers are pulled back another 0.91 m (3 ft); then about 0.3 m (1 ft) of sieved native soil and 0.61 m (2 ft) of bentonite granules are added. The tremmie pipe is used to add distilled water to the bentonite to hydrate it. Finally, the augers are pulled and the borehole is backfilled with native soils that are tamped down to ensure compaction. Since a lot of distilled water was added to the soil during installation, the lysimeter needs to be purged until consistent water quality is obtained.

8.3.6 Phyto-screening

Phyto-screening is based on the ability of plants to translocate contaminants from their root zone to plant tissues above ground. Because the root zones of plants can be relatively large and their capture areas in the soil ill-defined, the method is somewhat

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qualitative, but potentially useful, particularly in locales with shallow groundwater contamination at large sites. Trees can draw water from groundwater, the capillary fringe, and/or pore water in the vadose zone, and therefore phyto-screening can supplement and enhance soil gas screening techniques (Algreen et al. 2015a). Often tree coring or plant tissue harvesting is used as a collection and detection method for determining the location of subsurface pollutants. Coring and use of plant tissues has been used, with certain limitations, to locate chlorinated solvents (Vroblesky, Nietch, and Morris 1999; Orchard et al. 2000; Vroblesky et al. 2004; Sorek et al. 2008; Larsen et al. 2008; Limmer et al. 2011), BTEX compounds (Algreen et al. 2015b; Wilson et al. 2013) and heavy metals (Stefanov et al. 2012; Algreen et al. 2012; 2014).

8.4 Invasive Methods - Monitoring Well Design

8.4.1 General Information

Monitoring wells are installed for a number of different purposes. During the installation of a monitoring well, a soil boring may be made or rock-core samples may be collected to determine the basic geology of the site. Prior to the design of a well, it is necessary to determine what its use will be. Some purposes of monitoring wells include:

- Measuring the elevation of the water table.
- Measuring a potentiometric water level within an aquifer, or at several depths in an aquifer.
- Collecting water samples for chemical analysis.
- Collecting samples of a nonaqueous phase liquid that are less dense than water.
- Collecting samples of a nonaqueous phase liquid that are more dense than water.
- Testing the permeability of an aquifer or aquiclude at discrete depths.
- Providing access for geophysical instruments.
- Collecting a sample of soil gas.

The use for which the well is intended will dictate the design. For example, if a well is to be used for the collection of water samples, the casing must be large enough to accommodate the water-sampling device. However, the diameter should not be much larger than the minimum size, because prior to the sampling of a well, stagnant water must be removed from the casing; the larger the diameter of the casing, the greater the volume of water that must be pumped and properly disposed. Some slightly more expensive characterization techniques can be well worth it for understanding a site. For example, high-resolution multilevel wells can produce orders of magnitude more data and understanding than single-screened wells. Figure 8.4 is a generalized schematic of a typical monitoring well. The following factors should be specified in the design of a monitoring well:

- Type of casing material.
- Diameter of the casing.
- If there will be a well screen, multiple screens, or an open borehole.
- If there is an open borehole, how deep the surface casing should be set. Cross connections between separate aquifers should be avoided.
- Length of casing.
- Depth of the well.
- Number of target sampling depths and screened intervals necessary in each well.
- Setting and length of the well screen(s).

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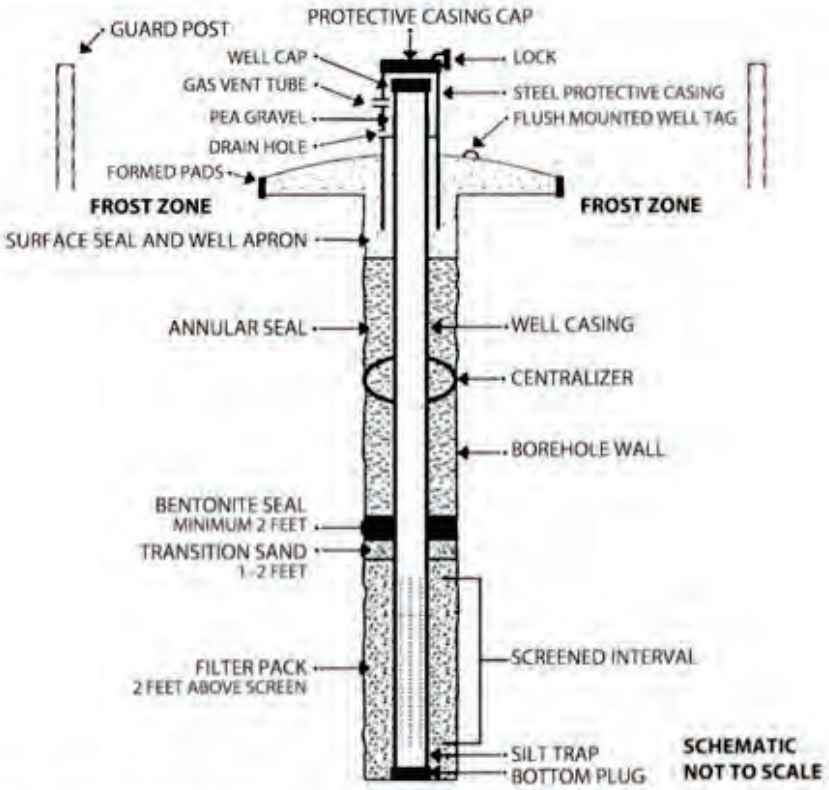
- Diameter of well screen(s).
- Type of material for well screen(s).
- Slot opening of well screen.
- If an artificial filter pack (gravel pack) is necessary.
- Gradation of filter pack (gravel pack) material.
- Method of installation of well and screen.
- Material used to seal annular space between casing and borehole wall.
- Protective casing or well vault.

Monitoring network design is determined not only by intended well uses, but physical factors in the locale. Site specific influences of geography, practical consideration of surface conditions, and subsurface variability determine network monitoring design (Arnold et al. 2009). Geographical factors include natural and human-made topographic anomalies; natural and engineered surface drainage routes; areas of potential recharge and discharge such as wetlands; factors which influence the overall water balance such as weather and climatic variability; and anthropogenic features such as buildings, pavement, and pipelines. The practicalities of site accessibility and compatibility of monitoring wells with facility operations is often an important factor in well placement. Subsurface conditions also help dictate well network design. In general, more monitoring wells with closer intervals between wells, and multilevel sampling ability are required if there is complicated geology (e.g., discontinuous structures, tight folds, closely spaced

Figure 8.4 Typical monitoring well.



Source: E. Hughes and G. Aarons. 2014. *Well Design and Construction for Monitoring Groundwater at Contaminated Sites*. The California Environmental Protection Agency.

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fractures, faults, solution channels), heterogeneous conditions (e.g., variable hydraulic conductivity, variable lithology), steep or variable hydraulic gradients, low dispersivity potential, high flow velocities, or if the aquifer is located near a recharge zone. Depths to water tables, confining layers, and bedrock surfaces are key in decisions about screen intervals and drilling depths. Lastly, the number and placement of wells often is based on prior application of noninvasive methods. These can include indirect methods (such as surface geophysics, soil gas where applicable, airborne remote sensing) or direct observation (such as existing wells, soil borings, test pits, and observation of local outcrops).

Common problems with groundwater monitoring systems include instances where wells are placed by regulatory mandate; where there is incomplete site data; when initial ideas on site (and regional) geology, hydrogeology, and water balance are not correct; and when incorrect assumptions are made regarding waste constituent migration. Difficulties also arise with improperly constructed wells, when they are not properly identified, or in cases when wells are not properly surveyed for location and elevation.

8.4.2 Monitoring Well Casing

All monitoring wells have a **casing**, whether they have a screen or terminate in an open borehole in bedrock. The casing is a piece of solid pipe that leads from the ground surface to the well screen or open borehole and is intended to keep both soil and water from entering the well other than through the screen or open borehole. Casing also prevents water from flowing from one aquifer horizon to another, provided the annular space outside the casing is properly sealed.

The diameter of the casing for a monitoring well is determined by the use for which the monitoring well is planned. If the only purpose of the monitoring well is to measure water levels, then a 2.54 cm (1 in.) inside-diameter casing is all that is needed. An electric probe to measure water level or a pressure transducer will fit inside the 2.54 cm (1 in.) casing. Figure 8.5 shows an electric probe being lowered into a 5.08 cm (2 in.) casing.

If a well is to be used to collect a groundwater sample, the diameter of the well needs to be such that standard well-sampling equipment can fit inside. The common standard for well-sampling equipment is a nominal 5.08 cm (2 in.) diameter. This can accommodate a wide variety of pumps that can withdraw water at rates of 0.03 to 0.13 or 0.19 L/s (0.5 to 2 or 3 gal./min). Specially designed borehole geophysical equipment can also fit inside a 5.08 cm diameter casing.

For some applications, monitoring wells may be intended for several functions such as measuring water levels, collecting water samples, pumping to remove contaminated water and perhaps floating nonaqueous phase liquids, and as a part of a vapor-extraction system. These wells sometimes have diameters larger than 5.08 cm (2 in.) to accommodate pumping equipment with a higher-flow capacity. The actual equipment to be used determines the casing diameter.

Casing diameter can also be influenced by the depth of the well. The deeper the well, the stronger the casing and screen must be to resist the lateral pressure at the final depth and the crushing force of the weight of the length of casing. Larger diameter casing can be made with thicker walls to have greater strength. It is easier to have a straight well with stronger casing. Straight wells are important in accommodating bailers and pumps.

The outside diameter of casing is standard; however, the inside diameter is a function of the wall thickness. Table 8.1 lists the wall thickness and inside diameter for

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FIGURE 8.5 Electric probe used to measure water levels in monitoring wells.



Photo credit: Jim Labre.

TABLE 8.1 Dimensions of inside and outside diameters of well casings.

		Schedule 5		Schedule 10		Schedule 40		Schedule 80	
Pipe Size	Outside Diameter	Wall Thickness	Inside Diameter	Wall Thickness	Inside Diameter	Wall Thickness	Inside Diameter	Wall Thickness	Inside Diameter
Nominal 2"	2.375"	0.065"	2.245"	0.109"	2.157"	0.154"	2.067"	0.218"	1.939"
Nominal 3"	3.500"	0.083"	3.334"	0.120"	3.260"	0.216"	3.068"	0.300"	2.900"
Nominal 4"	4.500"	0.083"	4.334"	0.120"	4.260"	0.237"	4.026"	0.337"	3.826"
Nominal 5"	5.563"	0.109"	5.345"	0.134"	5.295"	0.258"	5.047"	0.375"	4.813"
Nominal 6"	6.625"	0.109"	6.407"	0.134"	6.357"	0.280"	6.065"	0.432"	5.761"

various schedules of casing. The sizes are listed in English units (inches) as many casings and screens were produced for decades in countries not yet on the metric system. Table 8.2 lists recommendations for selection of casing and screen material. Heavier-schedule casing is stronger because it has a thicker wall. The strength of a casing also depends upon the material from which it is constructed. A schedule 5 casing

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TABLE 8.2 Recommendations for selection of casing and screen material.

	Do Not Use:	Use:
1	PTFE if well depth exceeds 225–375 feet (68.6–14 meters)	PVC, ABS, SS
2	PVC or ABS if well depth exceeds 1200–2000 feet (366–610 meters)	SS
3	SS if pH < 7.0	PVC, ABS or PTFE
4	SS if D.O. > 2 ppm	PVC, ABS or PTFE
5	SS if H_2S > 1 ppm	PVC, ABS or PTFE
6	SS if TDS > 1000 ppm	PVC, ABS or PTFE
7	SS if CO_2 > 50 ppm	PVC, ABS or PTFE
8	SS if Cl^- > 500 ppm	PVC, ABS or PTFE
9	PVC if a neat PVC solvent/softening agent* is present or if the aqueous concentration of the PVC solvent/softening agent exceeds 0.25 times its solubility in water	SS, PTFE
10	Solvent-bonded joints for PVC casings	Threaded PVC casings
11	Welding stainless joints	Threaded SS casings
12	Any PVC well casing that is not NSF-ASTM approved—D-1785 and F-480	NSF-ASTM approved PVC well casings—D-1785 and F-480
13	Any stainless steel casing that is not ASTM approved—A312	ASTM approved SS 304 and SS 316 casings—A312
14	Any ABS well casing that is not ASTM approved	ASTM approved ABS casings—F-480

*Known PVC solvents/softening agents include:
Tetrohydrofuran, cyclohexane, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, trichloromethane, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, benzene, toluene, acetone, and tetrachloroethylene.

ABS Acrylonitrile butadiene styrene
D.O. Dissolved oxygen
ppm parts per million
PTFE Polytetrafluoroethylene
PVC Polyvinyl chloride
SS Stainless steel
TDS Total dissolved solids

Source: E. Hughes and G. Aarons. 2014. *Well Design and Construction for Monitoring Groundwater at Contaminated Sites*. The California Environmental Protection Agency.)

made of stainless steel is stronger than a schedule 40 casing made of polyvinyl chloride (PVC), yet leaves a greater inside diameter.

There are a number of materials used to make well casings and screens. These materials vary in chemical inertness, strength, durability, ease of handling, and cost. One must always consider the intended use of the monitoring well before selecting a material. What is the chemistry of the groundwater and associated contaminants?

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Will any compounds present in the groundwater react with any of the possible casing materials? How deep will the well be? What are the strength requirements? Is the well intended for a short-term monitoring project or will it remain in service for many years?

Well casings are available in a variety of materials: fluoropolymers, such as PTFE, or polytetrafluoroethylene (Teflon® is the brand name of one manufacturer of PTFE), mild steel, galvanized steel, stainless steel, polyvinyl chloride (PVC), acrylonitrile butadiene styrene (ABS), fluorinated ethylene propylene (FEP), fiberglass-reinforced epoxy (FRE), polypropylene, and fiberglass-reinforced plastic (FRP). The ideal casing material is inexpensive, strong, not subjected to degradation in the environment, and will not affect water-quality samples by either leaching chemicals into or sorbing them from the groundwater (Ranney and Parker 1997). Mild or galvanized steel is often used for water-supply well casings but is not as frequently found in monitoring wells because it may react with the groundwater to leach metals from the casing (Barcelona et al. 1983). Polypropylene, FEP, and ABS are not widely available. Most monitoring wells are made of stainless steel or PVC, with PTFE being less common. PVC casing is the least expensive. Relative casing costs for other materials, compared with PVC, are mild steel = 1.1, polypropylene = 2.1, type 304 stainless steel = 6.9, type 316 stainless steel = 11.2, and PTFE = 20.7. Type 316 stainless steel is more resistant to corrosion than type 304 under reducing conditions (Aller et al. 1991).

Stainless steel has the greatest strength, followed by mild steel. Both are also resistant to heat, but they are heavier than the plastics and are, therefore, more difficult to install. The lower strength of the plastics is compensated for by using a heavier-schedule casing than necessary with steel. Most monitoring wells are shallow enough that schedule 40 or 80 PVC has sufficient strength. PTFE is more brittle and has less wear resistance than PVC or polypropylene and is hence less durable. PTFE also has a low tensile strength and high weight per unit length, which limits its use to shallow depths. Even there, PTFE casing tends to bow under its weight when installed in monitoring wells and may not be straight and plumb. Although its nonstick properties are good in frying pans, the neat cement grout used to seal the annular space between the casing and the borehole may not bond to the PTFE casing (Nielsen 1988). Table 8.3 gives comparative strengths of casing materials.

Groundwater monitoring wells can come into contact with pure organic compounds (LNAPLs and DNAPLs) as well as highly acidic and highly basic conditions. Ranney and Parker (1997) tested six different materials that are used or could be used as monitoring well casings in order to test their resistance to pure (neat) organic chemicals and acids and bases. (Stainless steel and galvanized steel are known to be unaffected by organic compounds but susceptible to corrosion by acids and bases.) They found that PTFE and FEP were unaffected by any of the 28 different organic chemicals in which they were immersed. The other four materials—PVC, ABS, FRE, and FRP—were affected to some degree by some, or in the case of ABS, all of the 28 chemicals. This study suggests that if contact with neat organic compounds is possible, PTFE, FEP, or stainless steel casings should be considered, although some PTFE materials are slightly porous, and are deformable and "ductile" under loading.

In the selection of casing material for groundwater monitoring wells, we must consider the potential chemical reactions between the casing material and the groundwater. Ideally, casing material should neither leach matter into water nor sorb

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TABLE 8.3 Comparative strengths of casing materials. Note: 1 lb = 0.454 kg and 1 lb/in^2 = 0.07 kg/cm^2.

Material	Casing Tensile Strength (lb)		Casing Collapse Strength (lb/in^2)	
	2-inch diameter nominal	4-inch diameter nominal	2-inch diameter nominal	4-inch diameter nominal
Polyvinyl chloride (PVC)	7,500	22,000	307	158
PVC casing joint[b]	2,800	6,050	300	150
Stainless steel (SS)[c]	37,760	92,000	896	315
SS casing joint[b]	15,900	81,750	No data	No data
Polytetrafluoroethylene (PTFE)	3,800	No data	No data	No data
PTFE casing joints[b]	540	1,890	No data	No data
Epoxy fiberglass	22,600	56,500	330	250
Epoxy casing joints[d]	14,000	30,000	230	150
Acrylonitrile butadiene styrene (ABS)	8,830	22,000	No data	No data
ABS casing joints[d]	3,360	5,600	No data	No data

a Information provided by E. I. du Pont de Nemours & Company, Wilmington, DE.

b All joints are flush-threaded.

c Stainless steel casing materials are Schedule 5 with Schedule 40 joints; other casing materials (PVC, PTFE, epoxy, ABS) are Schedule 40.

d Joints are not flush-threaded, but are a special type that is thicker than Schedule 40.

Source: E. Hughes and G. Aarons. 2014. *Well Design and Construction for Monitoring Groundwater at Contaminated Sites*. The California Environmental Protection Agency.)

chemicals from water. Table 8.4 shows general recommendations for casing/ screen material selection.

Reynolds and Gillham (1985) studied the sorption from aqueous solution of five halogenated organic compounds by several polymer materials. The organic compounds used were 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, hexachloroethane, perchloroethene, and bromoform. The materials tested were PVC, PTFE, nylon, polypropylene, polyethylene, and latex rubber. Nylon, polypropylene, polyethylene, and latex rubber rapidly absorbed all five compounds. PVC absorbed all the compounds but 1,1,1-trichloroethane, although the rate of absorption was low. PTFE absorbed all the compounds but bromoform; although the rate of adsorption of three of the four remaining compounds was low, PTFE absorbed 50% of the perchloroethylene in 8 hours.

Parker, Hewitt, and Jenkins (1990) evaluated the suitability of PVC, PTFE, stainless steel type 304 (SS 304), and stainless steel type 316 (SS 316) as casing material for monitoring metals in groundwater. They evaluated the interaction of four trace elements that are of concern in groundwater studies: arsenic, cadmium, chromium, and lead. The metals were tested at concentrations of 50 and 100 μg/L dissolved in groundwater. Figure 8.6 shows the results of this study. If the concentration relative to

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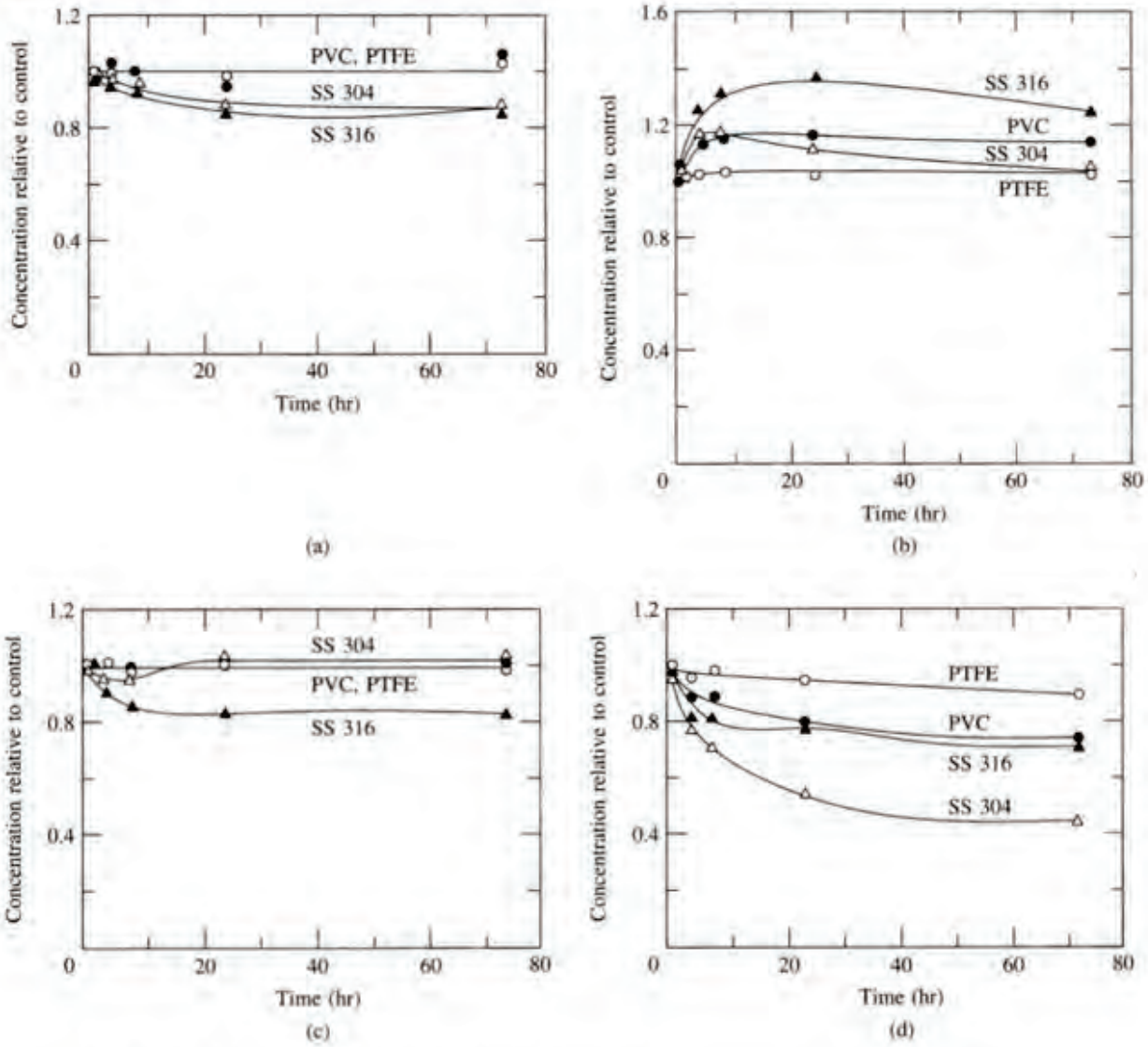
FIGURE 8.6 Sorption and leaching of a. arsenic, b. cadmium, c. chromium, and d. lead by well casings made from PVC, PTFE, type 304 stainless steel, and type 316 stainless steel.



Source: L. V. Parker, A. D. Hewitt, and T. F. Jenkins. 1990. Influence of casing materials on trace-level chemicals in ground water. *Groundwater Monitoring & Remediation* 10:146–156. Used with permission.

for well casing should be used, and in the United States it should carry the designation *NSF wc*, which indicates that the casing conforms to National Sanitation Foundation Standard 14 for potable water supply (National Sanitation Foundation 1988).

However, PVC should be avoided if organic compounds are present in the ground as nonaqueous phase liquids. Likewise, PVC casing should also never be joined with solvent-glued joints. These solvents include compounds such as methylethylketone and tetrahydrofuran and they may leach into groundwater samples. Threaded joints that are machined directly onto the PVC are the preferred method of joining casing sections and casing to screen. Joints should be flush on the inside of the casing to prevent equipment being lowered into the casing from hanging up in a projecting joint inside

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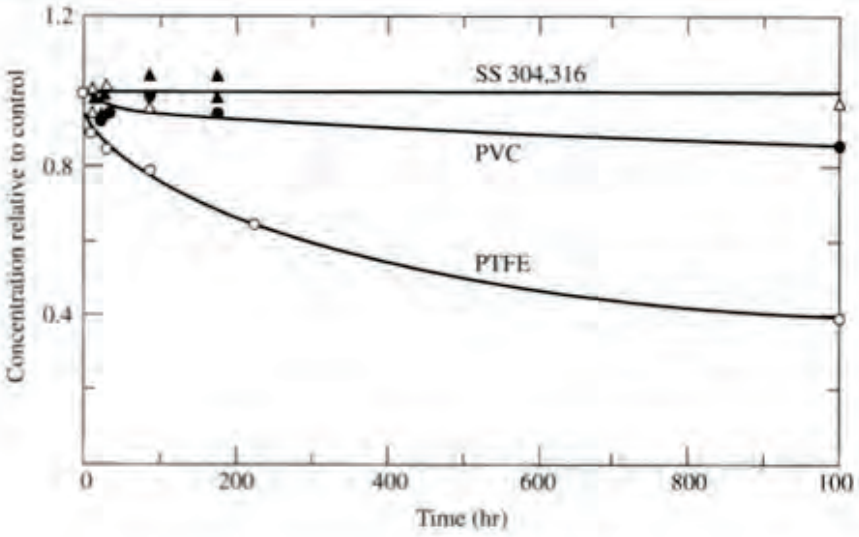
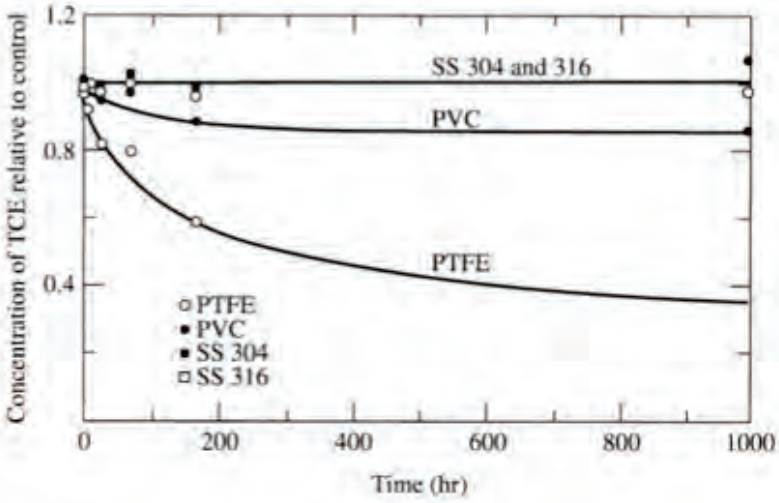
FIGURE 8.7a Sorption of trichloroethylene in the part per million range from groundwater by PVC, PTFE, type 304, and type 316 stainless steel well casings.



(a)

Source: L. V. Parker, A. D. Hewitt, and T. F. Jenkins. 1990. Influence of casing materials on trace-level chemicals in ground water. *Groundwater Monitoring & Remediation* 10:146–156. Used with permission.

FIGURE 8.7b Sorption of trichloroethylene in the part per billion range from by PVC, PTFE, type 304, and type 316 stainless steel well casings.



(b)

Source: L. V. Parker and T. A. Ranney. 1994. Effect of concentration on sorption of dissolved organics by PVC, PTFE and stainless steel well casings. *Groundwater Monitoring & Remediation* 14:139–149. Used with permission.

the well, or bridging and stoppage of grout or filter pack material in the annular space outside the well.

There are groundwater contaminants other than either metals or dissolved non-polar organic compounds. Many chemicals associated with agriculture are strongly

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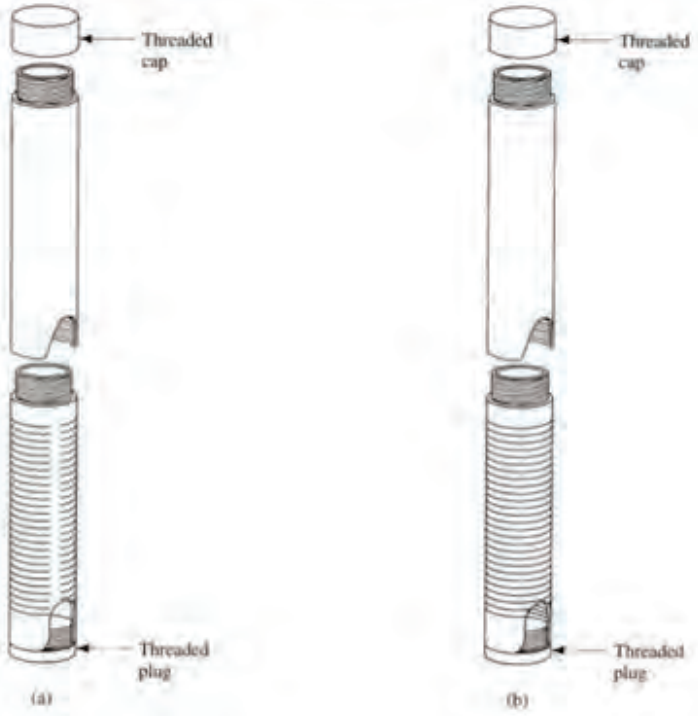
polar or ionic. Papiernik, Widmer and Spalding (1996) studied the impact of using various materials to sample agricultural contaminants, including nitrate-N, atrazine, diethylatrazine, diisopropylatrazine, cyanazine, alachlor, metolachlor and butachlor. They found that other than butachlor (which is not in common use in the United States) there was no significant difference in absorption of the target by either polytetrafluoroethylene (PTFE), rigid PVC, flexible PVC, stainless steel, high density polyethylene (HDPE), or low density polyethylene (LDPE). For any of the chemicals tested, other than butachlor, any of the materials could be used. The least expensive would be HDPE, LDPE, and rigid PVC.

8.4.3 Monitoring Well Screens

If the monitoring well terminates in an unconsolidated formation, a **screen** is necessary to allow the water to enter while keeping the sediment out. In most monitoring well applications, the well screen is the same diameter as the casing to which it is attached by a threaded coupling. Likewise, the well screen is normally made of the same material as the casing. The considerations that go into deciding the material to use for the casing also apply to the screen. In many cases multilevel sampling will provide crucial information and multiple, isolated screened intervals are necessary.

The screen or screens will have openings to permit the water to enter. Manufactured well screen should always be used rather than hand-cut slots or drilled holes in plastic pipe. The two common screens for monitoring wells are slotted pipe, which is available in PVC and PTFE, and continuous wire wrap, which is available in stainless steel. Figure 8.8 illustrates these two screen types.

FIGURE 8.8 Slotted (a) and continuous wire-wrapped (b) monitoring well screens.



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The width of the slot or wire-wrap opening is precisely controlled during the manufacture of the screen; the screen is available in a variety of opening sizes, generally ranging from 0.02 to 0635 cm (0.008 to 0.250 in.) A screen with an opening of 0.010 in. (0.0254 cm) is referred to as a 10-slot screen. Many manufacturers carry only a limited number of slot sizes in stock—for example, 10- and 20-slot. Since the casing and screen are typically ordered in advance of the well construction, the hydrogeologist usually has settled on a standard design prior to going on the job. Decisions on slot sizes are important in that too large a slot size without proper filter pack can allow sediment to enter the well during pumping. Conversely, a small slot size can inhibit nonaqueous phase liquids (NAPLs) from entering a well. NAPL must have enough thickness and fluid pressure to supplant water in small slots, overcoming capillary pressure. If well screen slots have small opening sizes, NAPL outside the well in a thin pool may not be able to enter through the screens.

8.4.4 Naturally Developed and Filter-Packed Wells

The casing and screen may be placed in the borehole and the native sediment allowed to cave around the screen. This is called a **naturally developed well** and is often used in sandy sediment with very limited amounts of silt and clay present, but is most realistic for wells with single screens. At least 90% of the sediment should be retained on a 10-slot screen before a naturally developed well is considered (Aller et al. 1991). When water is withdrawn from such a well, it may initially be cloudy due to suspended silt and clay, but the water should eventually clear as the fines near the screen are removed by a process called "well development." In a naturally developed well the slot size is selected to allow some of the fine sediment to enter the well during development; this leaves only the coarser sediment outside the screen.

In designing a water well, it is very important that the well be hydraulically effective—i.e., there should be a minimal loss of energy as the water flows into the well. As mentioned, the selection of the slot opening for naturally developed water wells is very important and is based on a grain-size distribution curve of the sediment opposite the well screen. Monitoring wells are designed to retain much more of the natural formation than water wells because they are much more difficult to develop (Driscoll 1986). Monitoring wells are not usually designed with the precision necessary for a water-supply well. The well should be hydraulically efficient as well as being as clear of silt and clay as possible. If preliminary investigations indicate that the aquifer to be monitored has reasonably coarse sand or gravel and few fines, a standard slot size may be preselected for all the monitoring wells. Ten-slot screen is frequently used under these conditions.

If the formation is cohesive—that is, has a high clay content—or if it is sandy with a high silt content, it will be necessary to use an **artificial filter pack**. Filter packs have also been referred to as "sand packs" or "gravel packs." Filter-pack material is typically medium to coarse sand that is predominately silica with no carbonates. It is mined and graded to have a specific grain-size distribution. Manufactured filter-pack material comes washed and bagged and is far preferable to native sand as artificial filter pack. The filter-pack material is placed in the borehole opposite the well screen. Its purpose is to stabilize the natural formation and keep it out of the screen. This will reduce the amount of silt and clay that enters the well when it is developed. There are also

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dual-screen well intake systems (pre-packs) that have a small diameter screen within a larger, second larger diameter screen, and the space in between is filled with filter pack material. Dual screen intakes are sometimes used when there is a propensity for fine-grained material to enter the well. A major disadvantage of these systems is that the two screens can compound the inhibition of NAPLs to enter a well.

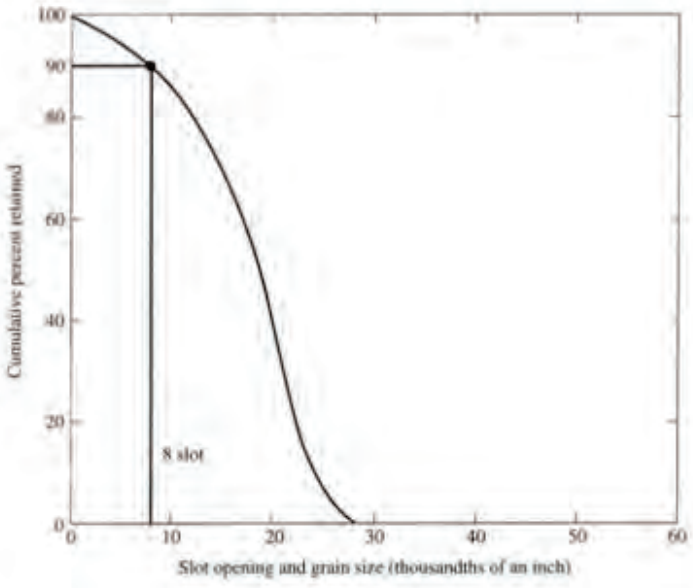
The grain size of the filter-pack material is based on the nature of the formation opposite the screen. If the formation is fine sand, then the grain-size distribution is determined. The filter pack material should have an average grain size that is twice the average grain size of the formation and have a uniformity coefficient (ratio of 40% retained size to 90% retained size) between 2 and 3 (Driscoll 1986). The screen-slot opening is then selected to retain 90% of the filter pack. The minimum practical slot size for monitoring well screens is 0.02 cm (0.008 in.) Figure 8.9 shows a grain-size distribution curve for a filter-pack material designed for an eight-slot screen. If the monitoring well is in silt or clay, all one can do is install an 8 slot screen and appropriate filter pack.

The filter-pack material should be approximately 5 to 7.5 cm (2 to 3 in.) thick. This means that a 5 cm (2 in.) diameter well screen should be installed in a borehole about 10 to 15 cm (6 to 8 in.) in diameter. The filter-pack material is normally extended 0.61 or 0.91 m (2 or 3 ft) above the top of the well screen to allow for settlement of the material during development.

8.4.5 Annular Seal

The **annular space** in the borehole above the filter pack must be sealed to prevent the movement of surface water downward to the filter pack. It may also be sealed to prevent vertical movement of groundwater from one zone to another or to isolate a discrete sampling zone. The seal should be made of a material that has a low permeability, bonds well to the natural formation and the casing, and expands after it has been

FIGURE 8.9 Grain-size distribution curve used to select an eight-slot screen for a monitoring well.



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emplaced to ensure a tight seal. It should set up within a day or so and be durable and permanent.

Materials typically used for an annular seal are bentonite pellets, granular bentonite slurry, neat cement grout, bentonite-sand slurry, and neat cement grout with a powdered bentonite additive.

Neat cement grout is a mixture of 42.5 kg (94 lb) of type I Portland cement with about 19 to 23 L (5 to 6 gal.) of water. Granular bentonite slurry is a mixture of 13.6 kg (30 lb) of untreated bentonite powder mixed with 56.7 kg (125) lb of untreated bentonite granules with 378.5 L (100 gal) of water. Bentonite-cement grout is a mixture of 2.3 kg (5 lb) of untreated powdered bentonite with 42.5 kg (94 lb) of type I Portland cement and 32 L (8.5 gal.) of water. Bentonite-sand slurry is a mixture of 25 kg (55 lb) of untreated powdered bentonite with 378.5 L (100 gal.) of water and 10 to 25% sand by volume to make a slurry that weighs 9.6 kg/L (11 lb/gal.) All water used to make these slurries should be from a source that is fresh and known to be uncontaminated and free from floating oil.

Bentonite is a clay containing at least 85% sodium montmorillonite; it will swell to several times its original volume when thoroughly hydrated. This hydration takes place below the water table. However, bentonite has a high cation-exchange capacity and can affect the chemistry of water that comes into contact with it. Portland cement is used to make cement grout. When Portland cement cures, it is highly alkaline and can affect the pH of groundwater that comes into contact with it. Neat cement grout will shrink by at least 17% when it cures. The addition of bentonite to make a bentonite-cement grout significantly reduces the shrinkage problem. If neat cement grout or bentonite cement grout is used, the casing material should be either stainless steel or schedule 80 PVC due to the heat generated as the cement cures.

The materials available for an annular seal are not ideal. Although they can be used to make an impermeable seal, there is a chance they might affect groundwater quality in their immediate vicinity. This problem is mitigated if 0.61 m (2 ft) of fine sand is placed in the annular space above the filter-pack material or native sand opposite the screen. This keeps the annular seal material from coming into contact with the water entering the well screen.

Many hydrogeologists place a 0.61 m or 0.91 m (2 or 3 ft) layer of bentonite pellets above the fine sand if the pellets will be below the water table. The pellets will swell and keep the grout material from entering the filter-pack material. Clay pellets should not be used in the vadose zone due to lack of hydration and lack of swelling; a clay slurry should be used instead. If the top of the 0.61 m (2 ft) fine-sand seal is above the water table, then 0.61 m (2 ft) of granular bentonite may be placed prior to the addition of the annular seal.

8.4.6 Protective Casing

In order to provide physical protection for the investment in a costly monitoring well, as well as to protect from vandalism by individuals accidentally or intentionally putting foreign fluids and objects into a monitoring well, a locking protective steel casing or well vault is needed.

A protective casing extends several feet above the ground surface. It extends above the top of the monitoring well and has an inside diameter sufficiently large so that the

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hydrogeologist can reach inside and unscrew a cap from the monitoring well. It is set into a surface cement seal. For monitoring wells installed in freezing climates, a drain hole at the bottom of the surface casing is desirable to prevent accumulation of moisture that could freeze in the annular space between the protective casing and the monitoring well. (One of the authors has seen a stainless-steel monitoring well casing pinched shut by water that accumulated in a protective casing without a drain hole and then froze!)

In some applications, it is not practical to have a monitoring well that extends above ground—for example, in the driveway at a gas station. There are small well vaults available that can be used for protection for monitoring wells. However, they should be in places that are not going to flood; otherwise floodwaters could enter the aquifer via the monitoring well. If a well vault is used in a gas station or similar location, it should be clearly marked and should be distinctive from the fillers for underground storage tanks so that an inattentive person does not try to fill it with gasoline! A locking well cap without a vent hole should also be used.

8.4.7 Screen Length and Setting

The hydrogeologist must decide on the length of the screen and the depth to which it will be set, based on the objectives of the monitoring program. Objectives could include monitoring the position of the water table, measuring the potentiometric head at some depth in the aquifer, collecting representative water samples from various depths in the aquifer, and detecting both light and dense nonaqueous phase liquids. Moreover, monitoring might be intended to detect the migration of groundwater containing contaminants into an aquifer or evaluating the effectiveness of removing contaminants from an aquifer. All might require different approaches.

To monitor the position of the water table or to detect the presence of LNAPLs, the screen must be set so that it intersects the water table. The screen must be long enough to intersect the water table over the range of annual fluctuation. In addition, the screen must be long enough so that when the water table is at its greatest depth below the land surface, there is enough of the screen remaining below the water table to contain sufficient water for a water sample. A water-table monitoring well will also be able to detect the presence of light nonaqueous phase liquids. In most applications the minimum length of the screen for a water table–monitoring well is 3 m (10 ft) with about 1.5 m (5 ft) above and 1.5 m (5 ft) below the water table. If the water table has more than 1.5 m (5 ft) of annual fluctuation, a longer well screen is needed. However, some governmental guidance specifies a maximum screen length of 3 m (10 ft) or less. Figure 8.10 shows examples of incorrect (a and b) and correct (c) placement of a multipurpose monitoring well intended to measure the position of the water table, detect floating nonaqueous phase liquids, and collect water samples from the upper part of the aquifer.

If the purpose of a monitoring well is to measure the potentiometric pressure at some depth in the aquifer, then the well is called a **piezometer**. A piezometer should have a relatively short screen length, 0.6 to 1.5 m (2 to 5 ft), so that the pressure that is recorded is representative of only a small vertical section of the aquifer. A piezometer can also be used to collect groundwater samples that are representative of a small vertical section of the aquifer.

Monitoring wells utilized to collect groundwater samples should be designed with respect to a specific groundwater monitoring goal. The concentration of groundwater

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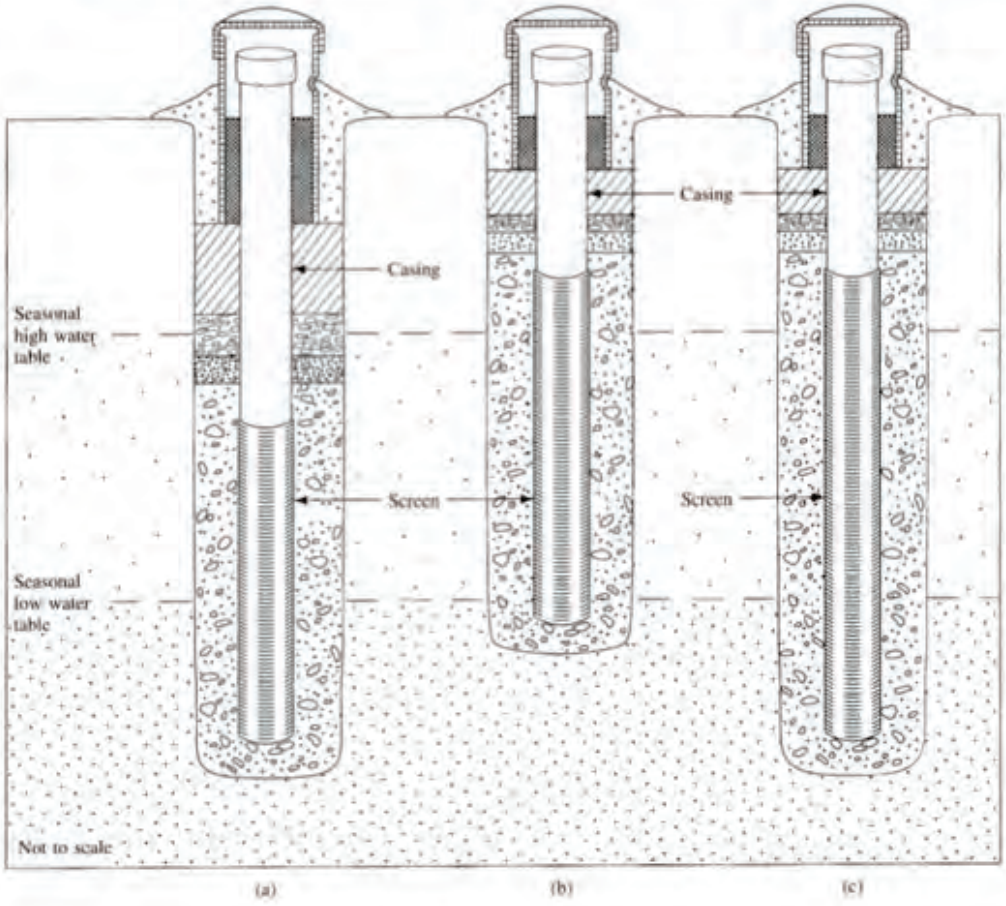
FIGURE 8.10 (a) Incorrect placement of water table–monitoring well screen. Seasonally high water table is above the top of the screen and floating, light nonaqueous phase liquids would be above the screen and not detected. (b) Incorrect placement of water table–monitoring well screen. Seasonally low water table is so far down in well that there is not enough water in well to collect a sample for chemical analysis. (The water table elevation could still be determined.) (c) Correct length and placement of water table–monitoring well screen.



contaminants can vary vertically. If a monitoring well has a long well screen, it has a greater probability of intersecting a plume of contamination. However, a water sample taken from such a well may draw water from both contaminated and uncontaminated parts of the aquifer, resulting in a reported concentration that is less than that of the groundwater in the plume. This is illustrated in Figure 8.11.

The collection of such unrepresentative water samples may have serious implications for the implementation of groundwater regulations. While monitoring groundwater in order to find the actual concentration of contaminants in a plume, it may be necessary to use several monitoring wells or piezometers screened at different depths at the same location (well cluster). Alternatively, several nested wells or piezometers can be placed in a single large borehole, each well with a screened interval and surrounding filter pack at a different depth, and with impermeable grout placed in the borehole between the screened intervals of the individual wells. These clustering and nested techniques can be expensive, not only due to the initial cost of the wells but also due to the costs of multiple chemical analyses for each round of sampling. However, such

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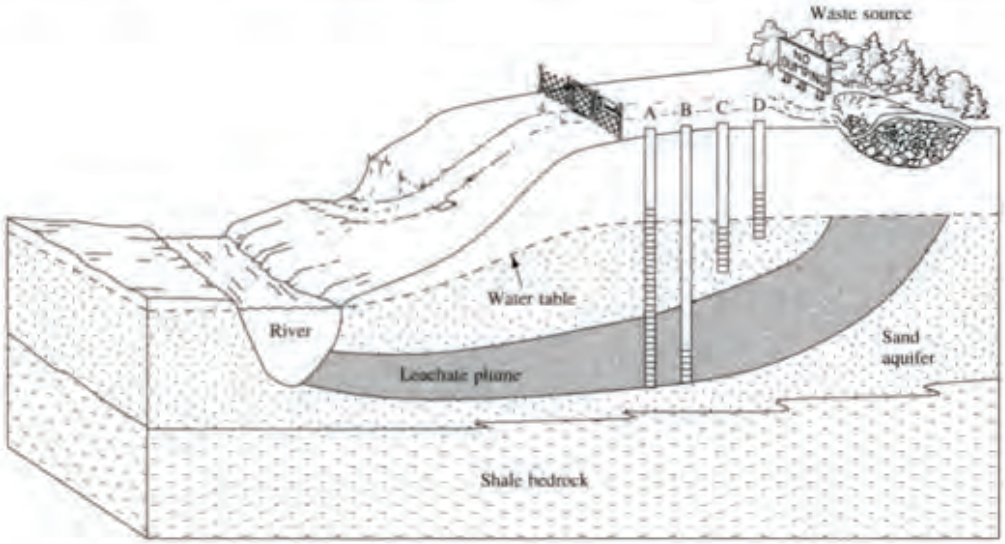
FIGURE 8.11 Effect of monitoring well–screen length on water-quality sampling. Monitoring well A is fully screened through the thickness of the aquifer. It intersects the plume of leachate but the reported concentration will be less than the actual concentration as water is withdrawn from both contaminated and uncontaminated parts of the aquifer. Piezometer B is also screened to intersect the plume of leachate. The reported concentration will be representative of the leachate. Piezometer C and water-table monitoring well D don't intersect the plume, indicating that it is deep in the aquifer.



a configuration will yield the greatest amount of information about the hydraulic head as well as the water quality, and is typically a recommended regulatory approach for groundwater monitoring. Additionally, there are multilevel monitoring wells that allow discrete vertical sampling in a single borehole, along with measurement of other hydrogeologic properties such as hydraulic conductivity and fluid pressure (head). Multilevel sampling will be discussed further in Section 8.4.9.

If a monitoring well is intended to serve as a warning that a plume of contamination is escaping from a potential source, then it should be screened in the most permeable parts of the aquifer initially to intercept rapid excursions, with the understanding that measured concentrations may be diluted and not representative of the most contaminated parts of an aquifer. Groundwater, and contaminants that it may be carrying, not only preferentially travel through the most permeable material but travel faster there as well. Hence, the leading edge of a plume of contamination will follow the most permeable pathway.

If the plume of contaminated water is following a zone or direction of high hydraulic conductivity, it may flow in a direction that is not parallel to grad h. This may mean that the location of the plume is not exactly down-gradient from the source. (Likewise, as has been discussed in earlier chapters, nonaqueous phase liquids can pool up and deflect off low permeability geologic layers in down-dip directions totally inconsistent with the directions of groundwater flow).

On the other hand, long term monitoring can have different priorities. If an aquifer is contaminated and a monitoring well has been installed to monitor the progress of a remediation effort, the well should not be screened in the most permeable part of the aquifer. Many contaminants can become trapped in low permeability regions, and

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can become sequestered for long periods of time. The eventual slow release of these trapped pollutants can cause a classically observed "rebound" in aqueous concentrations long after the high permeability zones appear to have been clean. In pump and treat systems, the water will preferentially travel through and flush out the more permeable zones. A well screened in a permeable zone may indicate that the aquifer is rapidly being cleaned, but in fact less permeable zones located nearby may still have high concentrations of contaminants that have yet to be removed. Therefore in contaminant investigations, monitoring low permeability zones is also typically carried out.

In general, the concentration of a solute obtained from a monitoring well will be less than the maximum concentration present in the aquifer. The well screen provides a vertically averaged value of the solute in the aquifer over the length of the screen. If the contaminant plume is thinner than the length of the screen, then the vertically averaged concentration of the solute that is obtained from a monitoring well will be less than the solute concentration in the plume as the monitoring well will be drawing in some uncontaminated water and diluting the contaminated water. Chiang, Raven, and Dawson (1995) found that if a monitoring well is purged continuously for 24 hours prior to sampling, it will draw in uncontaminated water from the aquifer below the well screen, and the concentration of solute in the well could be as much as an order of magnitude lower than the vertically averaged solute concentration in the aquifer.

8.4.8 Summary of Monitoring Design for Single Screened Wells

Figure 8.12 illustrates a comparison of the final design of a water-table observation well and a piezometer illustrating the design elements discussed in this section for single well screen designs.

8.4.9 Multiple-level Wells and Multilevel Devices for Groundwater Monitoring

Because many field studies have suggested that most contaminant plumes exhibit significant concentration changes over small vertical distances (Smith et al. 1987; Dumble et al. 2006; Biswas et al. 2014; USDOE 2015), multilevel monitoring wells (particularly high resolution techniques) often produce orders of magnitude more information and more accurate results than single, long-screened wells. Natural hydraulic gradients within long-screened wells can create vertical flow and cross-contamination within the well, and make definition of the vertical distribution of dissolved contaminants impossible (Reilly et al. 1989; Church and Granato 1996; Elci et al. 2001; Neilsen 2005; McMillan 2014). This message has not gotten through to all municipalities, industries, and regulators, however. The U.S. Nuclear Regulatory Commission (NRC), in its 2003 NUREG 1569 Guidance (pages 5-42 and 5-43) for in situ uranium leaching operations correctly states:

> *"Fully screened monitor wells sample the entire thickness of the aquifer. Therefore, excursions could not pass above or below the well screens. However, the concentration of the indicator parameters might be diluted and therefore may not provide timely warning that an excursion is occurring.*

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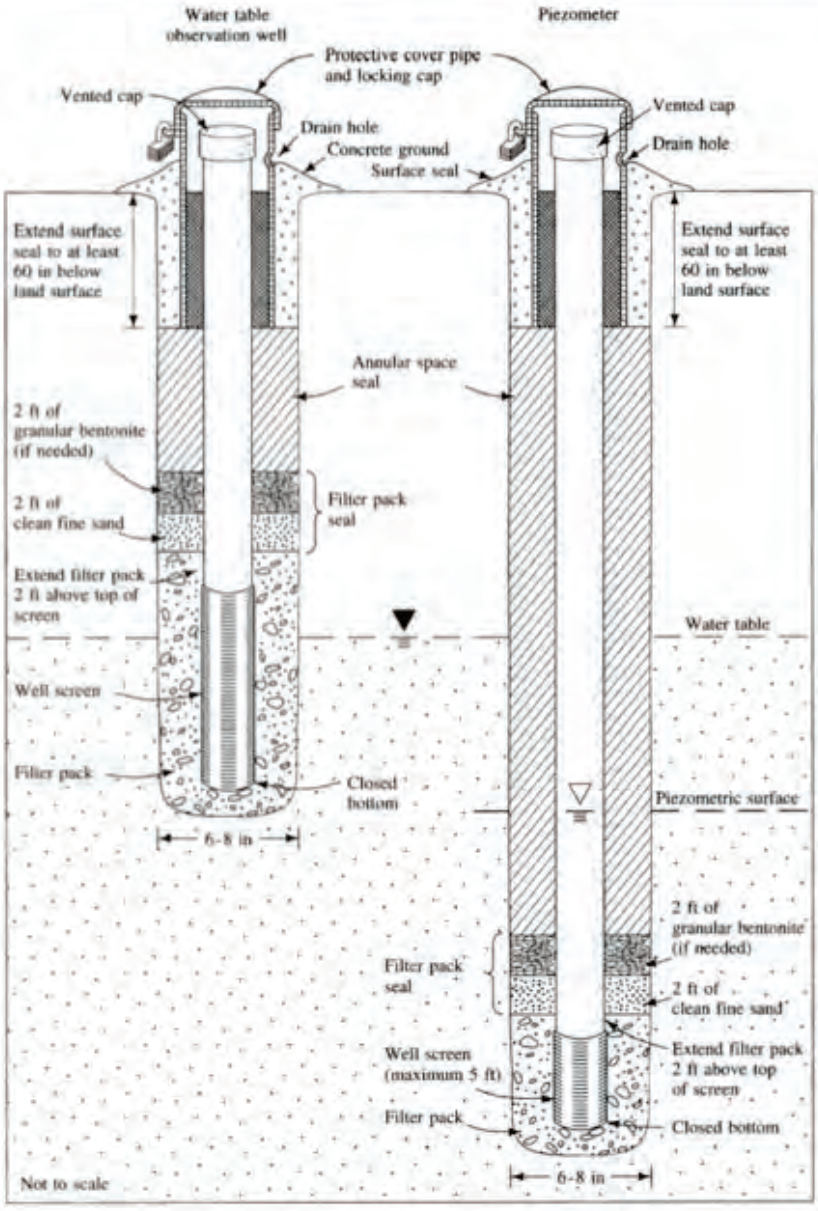
But then the NRC Guidance continues:

"Partially screened monitor wells only sample the zone of extraction within an aquifer. These wells might miss some excursions, but would suffer less from dilution effects than fully screened wells. For most situations the staff favors fully screened monitor wells."

In this document the U.S. Nuclear Regulatory Commission misrepresents multilevel sampling and does not recognize that high resolution multilevel monitoring: (1) is less likely to "miss" contaminant excursions than wells screened the entire aquifer

FIGURE 8.12 Construction details of a water-table observation well and piezometer.



Source: Wisconsin Department of Natural Resources.

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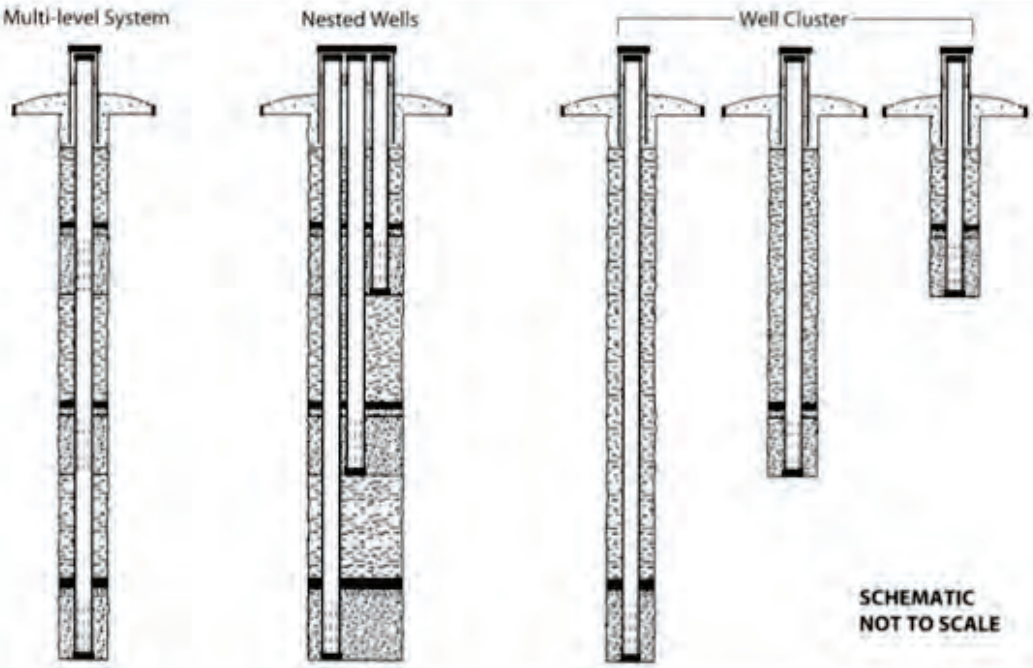
length, (2) has more possibility of accurately intercepting and quantifying excursions without bias, (3) reduces the possibility of contaminants migrating vertically within a monitoring well, (4) is many times more useful in post-mining remediation and site stabilization (both in directing cost-effective cleanup efforts and documenting their success), and (5) is much more protective of public health and ecological well-being.

Nested and Clustered Wells As mentioned in Section 8.4.7, to reduce dilution effects of long-screened wells and to preserve vertical sampling integrity, usually monitoring wells are installed in nested or clustered configurations (also called "multiple completions"), or with other types of multilevel sampling devices in a single borehole. Figure 8.13 illustrates multilevel sampling systems, nested wells, and well clusters. For nested wells, there is typically a single large borehole with several piezometers or wells placed in the same hole with screened intervals at different depths below the water table and with grout separating each different sampling depth. There has been some concern with the integrity of grout sealants in nested wells, and some criticism has been leveled at using these nested configurations. This is because of the difficulty in achieving effective and impermeable grout layers. These problems can be significant where the grout layers are thin because of many vertically close-spaced screen and grout intervals, or where there are many casing riser pipes in the nested well requiring grout to be placed effectively between the many pipes without void spaces developing. Clustered well groupings, on the other hand, sample different depths at the same locality by having several, closely spaced monitoring wells or piezometers with each in its own individual borehole. These individual wells typically can be placed within 1.5 m

FIGURE 8.13 Multilevel sampling systems, nested wells, and well clusters with above ground completion.



Source: E. Hughes and G. Aarons, 2014. *Well Design and Construction for Monitoring Groundwater at Contaminated Sites*. The California Environmental Protection Agency.

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(5 ft) of each other. Under these circumstances it is possible to obtain an excellent seal to prevent vertical movement of water along the casing.

In nested wells, two or more monitoring wells or piezometers are placed in a large-diameter borehole with grout seal between screened intervals at different depths. For example, this could be done in an unconsolidated formation by (1) driving a 25.4 or 30.5 cm (10 or 12 in.) diameter casing with a cable tool rig to the depth of the bottom piezometer, (2) installing the deepest piezometer, (3) pulling back the casing and installing the filter pack and seal for the deepest piezometer, (4) pulling back the casing and grouting up to the level of the next piezometer, (5) allowing the grout to harden, (6) installing the next piezometer, (7) pulling back the casing and installing the filter pack and seal for the second piezometer, and (8) pulling back the casing and grouting up to the level of the third piezometer, etc.

Simple Manufactured Multilevel Samplers It is possible to install inexpensive multilevel sampling devices in a sandy aquifer. One early manufactured model of such a device consists of a rigid PVC tube, inside of which are multiple tubes of flexible tubing. Each tube leads from the surface and ends at a different depth. Each has a port into which a groundwater sample can be drawn. Sampling ports can be closely spaced vertically, so that very detailed vertical sampling can be accomplished. Water is withdrawn from the tubing by applying suction, so the water table had to be less than 7.6 m (25 ft) below the surface in these simple early multilevel sampling wells. These rudimentary methods include a variation by fastening a bundle of flexible tubes, each of a different length, to the outside of a rigid PVC pipe that acts as a spine. Several types of simple manufactured multilevel samplers have been developed (Pickens et al. 1978; Cherry and Johnson 1982; Ronen et al. 1986).

Barker et al. (1987) evaluated the bias in samples that can be introduced by the use of multilevel piezometers constructed out of flexible tubing. Leaching of plastics from the plastic tubing is one problem. Another problem is the sorbing of organics by the tubing. Both these problems can be minimized by using Teflon® tubing and thoroughly purging the tube prior to sampling, although Teflon® is porous and can have some minimal memory effect. Many types of flexible tubing can actually transmit organics from groundwater through the tubing wall to the sample water in the tubing. This is especially true for polyethylene tubing. Samples drawn from below an organic plume may indicate contamination, when in fact the organics are being transmitted across the plastic tubing from adjacent contaminated groundwater. This can apparently occur even with Teflon® tubing. For this reason, multilevel piezometers, designed so that the flexible tubing is exposed to groundwater, may not be appropriate for monitoring plumes of organic contaminants. If the flexible tubing is contained within a casing, such as in Figure 8.14, this should not be an issue because the tubing doesn't come into contact with the groundwater.

A simple multilevel sampler can be installed by using a hollow-stem auger. The device is constructed at the surface and lowered to the desired depth through the augers. It is not possible to develop the sampling ports, so this device is best suited for clean, sandy sediment. No filter pack or grout is used in this very simple construction. The augers are withdrawn and the native sand is allowed to slump around it. One disadvantage of this device is that it is usually not possible to measure water levels with it.

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generally expensive, these multilevel wells have advantages of allowing fewer wells and subsurface disturbance at each site, collection of fluid samples without repeated purging, prevention of vertical flow within the borehole, less possibility of cross contamination with discrete depth sampling, and options for automated sampling at any number of multiple depths in a single well.

Flexible Liner Systems Another type of multilevel sampling practice employs the flexible liner system (developed by FLUTe™) and represents a significant advancement over a simple multilevel system. Similar to the simple system above, it has a series of internal tubes inside a liner which allow sampling and pressure measurement at selected intervals down hole in uncased wells. In hard rock consolidated systems, downhole television logging in uncased boreholes can identify exact locations of fractures (and other depths of interest) and tubing can be customized to sample those depths. In this system, a flexible polyurethane–coated, nylon fabric liner is emplaced with eversion (turning inside out) from a shipping reel. The liner is pressurized (pneumatically or hydraulically), inflated, and extends downward from internal pressure head. The liner deploys from the ground surface downward, creating a sealing pressure that prevents vertical flow outside the liner, and has tubing (usually made of polyvinylidene fluoride—PVDF) inside the liner from ground surface to vertically displaced subsurface ports. The system is versatile in that the inflating liner can be placed in boreholes that change direction due to directional drilling, and can move in varying diameter boreholes, such as narrow, shallow surface casing to wider uncased sections below, or narrowing or telescoping boreholes. Interestingly, this system can be modified to measure discrete depths of nonaqueous phase liquids (NAPLs) by use of a hydrophobic "ribbon" sampler. In this application, a porous, continuous, hydrophobic sleeve, that is impregnated with a powdered oil dye (Sudan IV), is deployed concurrently on the outside of the flexible liner. The hydrophobic material readily "wicks" NAPLs and when retrieved identifies depths of NAPL contamination. The hydrophobic sleeve is replaceable for additional deployments on the same flexible liner (Riha et al. 2000; USEPA 2004).

Packer Systems A type of multilevel sampler optimal in bedrock boreholes involves straddle packers, which when inflated isolate a section of a borehole for hydrological testing and sampling. In this design (Figure 8.15) packers are located above and below each sampling port; when they are inflated, they seal off that part of the borehole and are particularly effective in segregating individual fractures or groups of fractures for analysis in uncased boreholes. Packers can also be used within well casing in less consolidated material. Packers can be permanently installed, or they can be removed and reused if desired. Though designs vary, the inside of a typical single packer is a perforated pipe forming the inner packer body, covered with a porous plastic sleeve and an expansion sleeve. External to that is a gum rubber inner sheath, often enveloped in woven Kevlar® and encased in a durable gum rubber outer sheath, with the assembly secured on either end with stainless steel clamps. One type is the Solinist® Waterloo System with includes multi-purge manifold well heads and dedicated sampling pumping and transducers.

Interesting specialized variants of packer systems have been constructed for specialized applications. Packers have been used in small, bedrock boreholes in conjunction with seals created by injecting grout into a flexible cylindrical impervious fabric liner. These liners have a diameter slightly larger than the borehole, ensure that the

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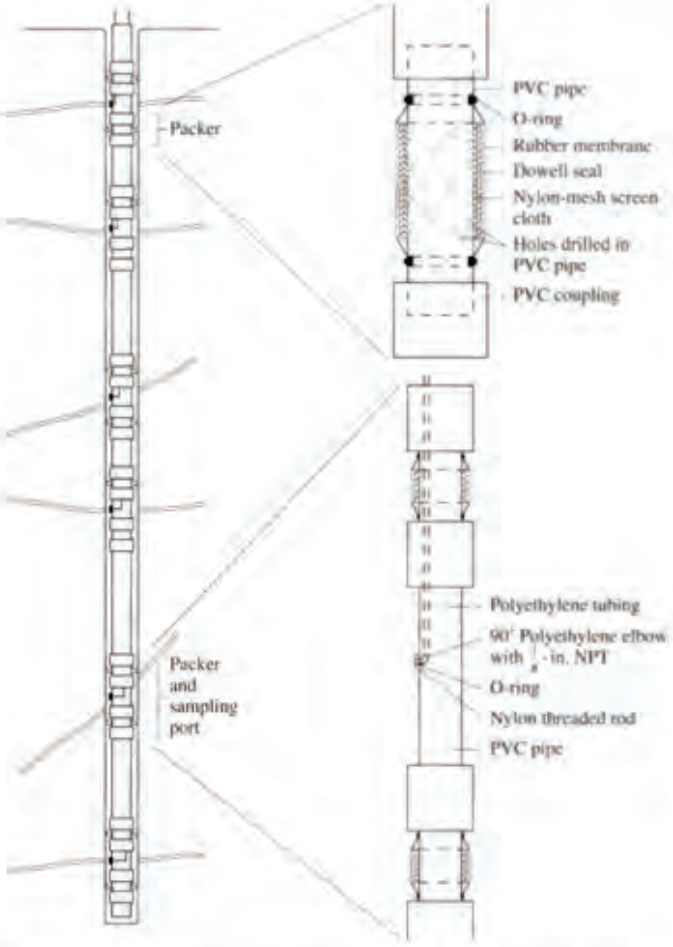
FIGURE 8.15 Multilevel groundwater sampling device for use in fractured rock aquifers.



Source: J. A. Cherry and P. E. Johnson. 1982. A multilevel device for monitoring in fractured rock. *Groundwater Monitoring & Remediation* 2:41–44 Used with permission.

entire borehole above a screened interval is sealed, and prevent grout from entering fractures and altering groundwater chemistry (Parker et al. 2015; Pierce et al. 2015).

■ 8.5 Installation of Monitoring Wells

8.5.1 Decontamination Procedures

Because the purpose of drilling a monitoring well is to collect a sample of water and analyze it for very small concentrations of chemicals, it is highly desirable not to introduce any chemicals into the aquifer as a part of the well-drilling and installation procedure. The process of cleaning the equipment and supplies that will be used is called **decontamination**.

When materials are manufactured, they may become coated with substances such as grease and oil. Therefore, unless the manufacturer specifically guarantees that the article has been decontaminated and has shipped it in a well-sealed wrapper, it should be decontaminated. Equipment that has been used at a contaminated site should be

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assumed to be contaminated and should be decontaminated before it is used at another site. Even at the same site, if a drill rig or a bailer is used at different wells, decontamination is required to prevent cross contamination (contamination from one area being introduced into a clean area) that could occur.

There is wide variability in required and recommended decontamination procedures in the United States between the USEPA and the various states (Mickam et al. 1989). The hydrogeologist must consult with the appropriate regulatory authority to determine if a specific decontamination procedure is required. In the absence of a specific requirement, the following generic procedure should adequately clean equipment and supplies. In some cases not all the steps are required. For cleaning large equipment such as a drilling rig, a specific area must be set aside and a decontamination pad must be constructed to capture all the fluids used in the process. If the rig is contaminated, wash water from it may also become contaminated. Be careful that any solvents used aren't accidentally released to the environment. Small tools such as bailers and Shelby tubes can be cleaned in buckets set on a polyethylene sheet. Sampling pumps can be cleaned by running various wash solutions through them, as well as washing the exterior.

The following steps are used to clean drilling and soil sampling equipment including drill rig, augers, drill rod, tools, sampling tubes, etc.:

1. Use a wire brush or similar equipment to remove all dried sediment and thick accumulations of grease.
2. Wash the equipment with a soft brush and water with phosphate-free detergent.
3. In extreme conditions organic residues can be removed by washing the equipment with an organic solvent such as methanol or propanol. Don't use solvents such as trichloroethene that might be expected to be found at a hazardous waste site.
4. Clean and rinse the equipment with potable water.
5. Rinse the equipment with deionized water.

Steam cleaning with a pressure sprayer can be used in step 4 for equipment that can withstand the heat and force of the spray. After equipment has been decontaminated, it should not be placed on the ground. It can be wrapped in clean paper or aluminum foil or set on polyethylene sheets.

Sampling equipment should also be decontaminated between uses. If the equipment has not come into contact with nonaqueous-phase liquids, rinsing with potable water and washing thoroughly with phosphate-free detergent, including scrubbing the inside of tubes with a bottle brush, followed by a potable-water wash and then a deionized-water rinse, should suffice. If the equipment has come into contact with nonaqueous-phase organic liquids, then an initial solvent wash may be necessary.

The cost of decontamination of sampling equipment and the uncertainty introduced by solvent washing has led many hydrogeologists to specify dedicated sampling equipment in each well. Disposable bailers are also available that are less expensive than the cost of labor involved in cleaning reusable bailers.

8.5.2 Methods of Drilling

There are a number of methods of drilling that are appropriate for installation of monitoring wells. When working in shallow unconsolidated formations, hollow-stem

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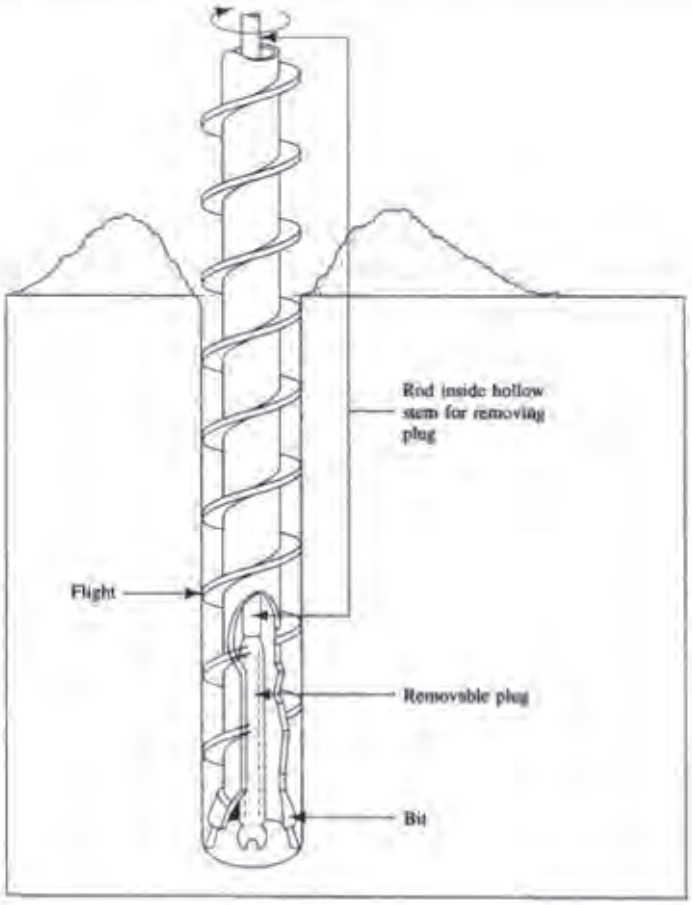
augers are commonly used. If a well is to be drilled deeper than about 30.5 m (100 ft) or into bedrock, a rotary drilling method may be appropriate. Cable-tool drilling is an excellent way of installing monitoring wells in both unconsolidated and consolidated formations, but it is slow and may be expensive. Hollow-stem augers with a bit that contains carbide teeth can also be used in weak, indurated rock. Newer techniques include sonic drilling and directional drilling.

Hollow-Stem Augers Hackett (1987; 1988) presents an authoritative discussion of all aspects of drilling with hollow-stem augers. A hollow-stem auger looks a little like a large, untapered screw (Figure 8.16). The auger flights are constructed around a hollow pipe. A drilling rig rotates the augers and a bit on the end of the auger loosens the sediment, which is then brought up to the surface by the rotating auger flights. The cuttings accumulate at the surface and must be shoveled away from the augers. Figure 8.17 pictures an auger-drilling rig. The auger is advanced into the ground as it is rotated. A plug on the end of a rod inserted through the hollow-stem may be screwed into the bit to seal the end of the opening and prevent sediment from coming up inside the hollow-stem. Alternatively, a nonretrievable plug can be placed in the end of the

FIGURE 8.16 Hollow-stem auger drill rod and bit.



Source: M. L. Scalf et al. 1981. *Manual of Ground Water Sampling Procedures*. National Water Well Association. Used with permission.

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FIGURE 8.17 Hollow-stem auger drilling rig.



Photo credit: C.W. Fetter.

bit. This plug is knocked out of the end of the augers when the final depth is reached and it is no longer needed. However knock-out plugs preclude the collection of soil and water samples during drilling.

One advantage of drilling with hollow-stem augers is that drilling fluids and mud are normally not required. Circulation of drilling fluids has the potential to spread contaminants throughout the borehole. Drilling mud is a viscous liquid needed in mud-rotary drilling that can line the borehole and partially seal it. However, when drilling in formations with cohesive layers, the auger bit may smear clay from the cohesive layers so that it mixes with sand and gravel layers at the perimeter of the borehole. Auger drilling typically can advance about 15.3 to 30.5 m (50 to 100 ft) per day if samples are

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being taken. Occasionally, downward progress can cease if a large cobble or boulder is encountered (called auger refusal).

Augers usually come in lengths of 1.5 m (5 ft). One flight is advanced into the ground and then the drill stem is disconnected and another flight is attached to the augers in the ground. At this time samples of the formation ahead of the auger bit may be taken. The plug on the end of the bit must be removed before sampling can occur. The maximum depth at which hollow-stem auger drilling can normally be used is 45.8 m (150 ft) (Hackett 1987); as a practical matter, it rarely exceeds 30.5 m (100 ft).

Some loosely consolidated sands, called heaving sands, can enter into the borehole when the plug is being removed. This problem can be avoided by keeping the hollow stem filled with potable water when the plug is removed. The potable water should not contain any contaminants that might be found in the groundwater. If no formation sampling is planned, then a knock-out plug can be used to prevent the introduction of heaving sands into the hollow-stem during drilling. The knock-out plug can be removed after the final depth is reached by pushing down with the well casing if it is stainless steel; otherwise it will be necessary to use a rod prior to the time that the well is installed.

Hollow-stem auger drilling can also be used to sample water quality at various depths during drilling. At a selected horizon the plug at the end of the hollow stem is removed. A well point on the end of a rod is lowered to the bottom of the augers and then is driven ahead of the bit by hammering or hydraulic pressure. The well point is developed by pumping until clear water is obtained. A sample of groundwater at that depth is then obtained. It is best if potable water is not used in the borehole during this procedure, because it could interfere with the groundwater quality. If there is heaving sand inside the augers, the well point can be driven through it. Alternatively, a slotted hollow-stem auger can be used (sometimes called a screened hollow-stem auger or Keck auger) which allows water to flow into the stem.

Keeley and Boateng (1987) suggested a modification of the hollow-stem auger drilling technique, in which a temporary casing that is larger in diameter than the auger bit is employed. The auger is advanced several feet and then the temporary casing is driven to the depth of the auger bit by repeatedly dropping a heavy weight on the top of the casing. The advantage of this modification is that it prevents mixing of soil horizons as the augers rotate.

Mud-Rotary Drilling Mud-rotary drilling can be used in both unconsolidated and consolidated formations. It is fairly rapid, up to 30.5 m (100 ft)/day, and can be used to depths far in excess of most that might be required for groundwater-contamination studies. A heavy drilling fluid, made by mixing various additives to water, is circulated in the borehole by pumping it down the inside of hollow drill rods. The mud rises back to the surface in the annular space between the borehole wall and the drill pipe. The rising mud carries with it the drill cuttings, which settle out in a mud tank at the surface. Figure 8.18 shows the circulation pattern for mud-rotary drilling. Alternately, reverse circulation is often used where drilling fluid goes down the annular space and returns upward through the drill pipe (opposite of Figure 8.18). This method, discussed below, can allow greater upward velocities and larger, heavier cuttings can be retrieved.

One advantage of mud-rotary drilling is that the borehole will remain open after the string of drill pipe and the bit are removed. This means that a complete suite of geophysical logs can be run on the hole, which is kept open by the weight of the mud

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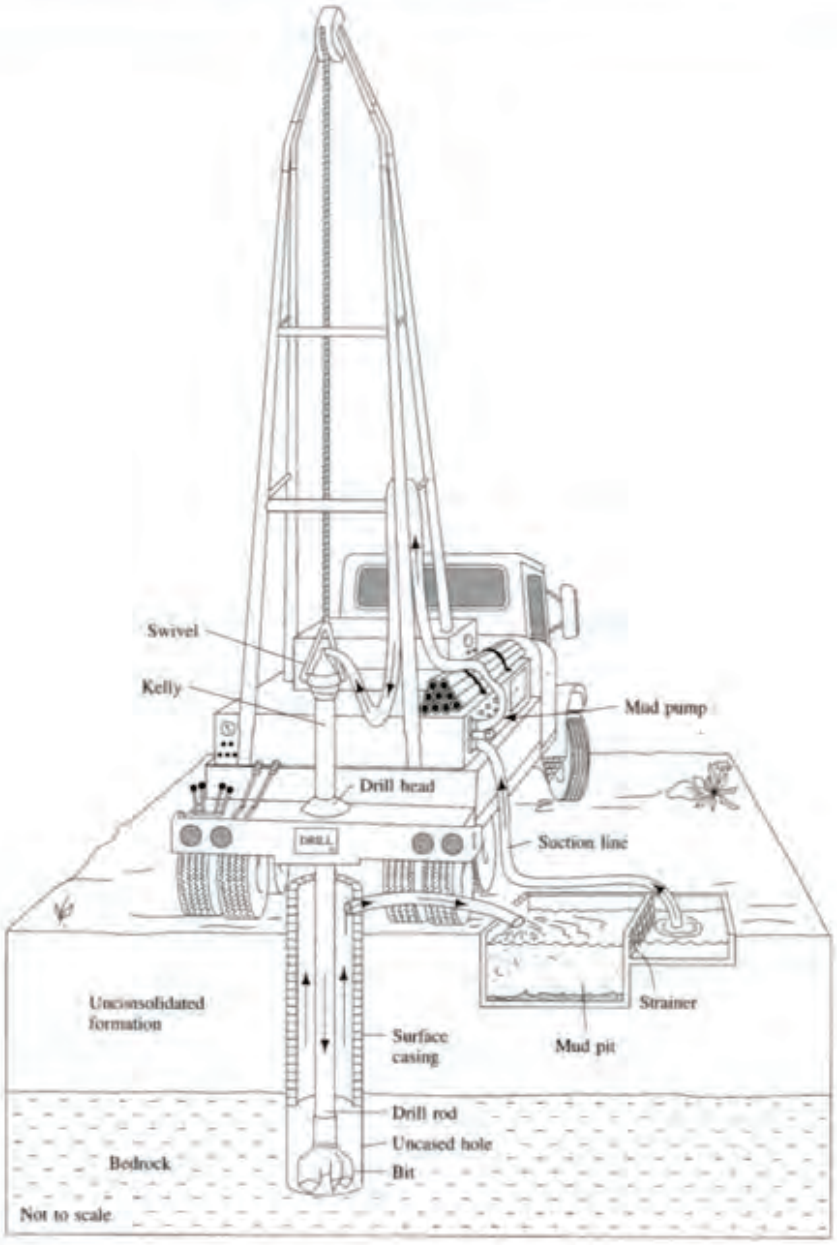
FIGURE 8.18 Circulation of drilling fluid in mud-rotary drilling.



inside it. However, the fluid in the drilling mud can penetrate the native formations and alter the groundwater geochemistry. The coating of drilling mud on the borehole walls may be difficult to remove. This can impede the hydraulic connection between the well and the formation. Bentonite-based drilling muds may remove metals from the groundwater and affect the chemistry. Certain additives to drilling mud can also be problematic from a water quality standpoint. Because of the potential problems with drilling mud, rotary drilling may not be as suitable for groundwater contamination studies as hollow-stem augers. However, under many hydrogeologic conditions it is the only drilling method that is practical. Good well development to remove the residual drilling mud in the screen zone is very important

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Air-Rotary Drilling If the monitoring well is to be installed in bedrock, then air-rotary drilling may be considered. First a surface casing needs to be installed through any unconsolidated material. Typically this is done by using mud-rotary drilling. The surface casing is large enough that the air-rotary bit can fit inside of it.

The fluid used in air rotary is compressed air, which is blown down the inside of the drill pipe. The air then blows the cuttings back up the annular space, where they accumulate around the borehole. When the water table is encountered, the air may blow groundwater out of the borehole as well. If this occurs, it is possible to determine when the water table is encountered and the relative yield of the well. However, the air may also force the water back into the formation. Air-rotary drilling using a down-hole percussion bit can drill up to 18 m (60 ft)/hr. Samples are collected as chips, which are brought to the surface with the return flow of air and water.

Air-rotary drilling is fast and can go to depths of a thousand feet of more. Because air is the drilling fluid, contamination problems are minimized. However, the drillers may want to add a foaming agent to the air (air/polymer mix) as it goes down the hole. The foam helps to float the chips to the surface, but it consists of organic chemicals such as isopropyl alcohol, ethyl alcohol, and alcohol ether sulfate, and its use should be avoided. The air compressors have air filters, which need to be in good working condition; otherwise, lubricating oil and other contaminants may be introduced into the borehole with the compressed air. Percussion hammers used for air-rotary drilling may also need lubricants.

Air-rotary drilling may introduce volatile organic compounds into the atmosphere as well as blowing contaminated dust out of the borehole.

Reverse-Rotary Drilling In reverse-rotary drilling the circulating drilling fluid drains down the annular space and then is pulled up the center of the drill stem by a suction pump located on the drill rig. Because the drilling fluid rises with a much greater velocity in reverse-rotary than in mud-rotary drilling, a much less viscous drilling fluid is used. In many cases clear water mixed with the drill cuttings is all that is necessary. This gives the reverse-rotary method an advantage over mud-rotary drilling, since it is much easier to develop the well because there is no mud wall on the borehole to break down. However, reverse-rotary drilling is more expensive than the mud-rotary method, and the minimum borehole diameter is 30.5 cm (12 in.)

Cable-Tool Drilling Cable-tool drilling is one of the oldest drilling methods and has been used widely for the installation of water wells. Although the drilling equipment is less expensive than for some other methods, the drilling is slow and overall costs may be expensive due to high labor costs.

In cable-tool drilling a heavy bit is located at the end of a tool string hanging from a cable. The drill rig repeatedly lifts and drops the hammer, which breaks up consolidated rock or loosens unconsolidated sediment. A steel casing is driven into the formation behind the bit. When the bottom of the casing fills with broken rock and sediment, the tool string and bit are removed, and a bottom-loading bailer is used to remove the accumulated cuttings. Below the water table, the groundwater and cuttings make a slurry. Above the water table, water must be added to make a slurry so that the bailer can be used. Drive casing is needed only until bedrock is reached. In most bedrock formations the hole will stay open without drive casing. Figure 8.20 shows the tools used for cable-tool drilling.

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Advantages of cable-tool drilling include the fact that no drilling fluids are used and that nothing is circulated through the well. Both factors serve to limit contamination problems. It is easy to collect representative samples of the formation during bailing of the casing. Well points can be driven ahead of the casing in unconsolidated formations for the collection of water quality samples. Cable-tool drilling can be used to depths in excess of 305 m (1000 ft). This method however can be extremely slow for deep boreholes, as the tool string and bit must be removed from progressively deeper depths to allow insertion of a bailer for the removal of cuttings, the bailer must then be removed from depth, and the tool string and bit reinserted. As depths increase the time required for this process compounds.

Sonic (Vibratory) Drilling Sonic drilling uses high frequency mechanical oscillation with rotary motion to fluidize subsurface material. As soils and formational materials experience liquefaction, temporary porosity reduction and inertial effects reduce friction on the drill string and drill. The destroyed shear strength of the subsurface formations allows rapid downward advancement in most instances. Advantages include a minimal amount of formation disturbance, reduction of drill spoils and waste compared to other methods, the method can produce continuous cores, sonic does not require circulating drilling fluids, and it can be converted to air or mud rotary or cable tool percussion techniques. Its disadvantages are that the technique is not as readily available as other techniques and is generally more expensive initially.

Other Types of Drilling Other types of drilling include percussion rotary air blast (RAB), air core drilling, and diamond core drilling. RAB combines rotary fluid circulation with the percussive impacts of a pneumatic, reciprocating, piston-driven "hammer" to pulverize rock. This is an effective way to advance drilling downhole in consolidated rock and mixed consolidated/unconsolidated terrain. Like most rotary fluid circulation techniques, circulation can be lost if a large cavity is encountered such as caverns in karst areas, lava tubes in volcanic regions, or human-made features such as subsurface mine shafts. Air core drilling cannot penetrate consolidated rock as well as RAB; it normally is used on weathered regolith or other unconsolidated material. The air core method utilizes hardened steel or tungsten blades to cut into the ground, and collects a more representative sample of solid material compared to RAB. Diamond core drilling is a very slow method used in hard, consolidated rock. It produces a rock core that can be inspected. Often fracture patterns, fracture orientation and aperture size can be determined from these cores. Diamond coring for short intervals can also be used on smaller consolidated formations encountered while drilling with other methods.

When drilling in areas with muddy or spongy soils, it may be necessary to build temporary roads, e.g., laying down a layer of crushed rocks to permit the heavy drilling equipment to reach the drilling locations without getting stuck (Figure 8.19). Alternatively, portable coring drilling machines, originally designed for mineral exploration, can be used to advantage to install hard rock monitoring wells in sites that are hard to access, in remote locations and wilderness sites, and in eco-sensitive areas. Drills, such as the Shaw Portable Core Drill and the Winkie Drill can produce small diameter holes amenable to fractured rock monitoring (Parker et al. 2015).

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FIGURE 8.19 When drilling in difficult-to-access areas or where soggy soils prevent heavy drill equipment to reach the site, a portable drill rig can be used. Shown here is the installation of an 8-inch bedrock well with a portable air-rotary drill rig in a rice field in Goa, India. The drill rig is powered by pneumatic pressure provided by a truck-mounted compressor which is safely stationed on hard ground approximately 100 m (300 ft) away.



Photo credit: T. B. Boving.

Directional Drilling Directional drilling involves the placement of nonvertical boreholes. Most of the above drilling methods are able to be used in slant drilling (excepting cable tool), where in the simplest application, the mast or drill rig tower is tilted and drilling proceeds at an angle. This modification allows great horizontal access under structures such as buildings, landfills and highly contaminated areas. Drilling through a subsurface NAPL pool, for example, can be avoided in some cases. Traditional drilling methods can be difficult to control in slant drilling because of unwanted deflection, as in slant auger drilling. As slant auger drilling proceeds, cuttings which fall on the bottom side of the hole can eventually force the bit upward into a more horizontal line.

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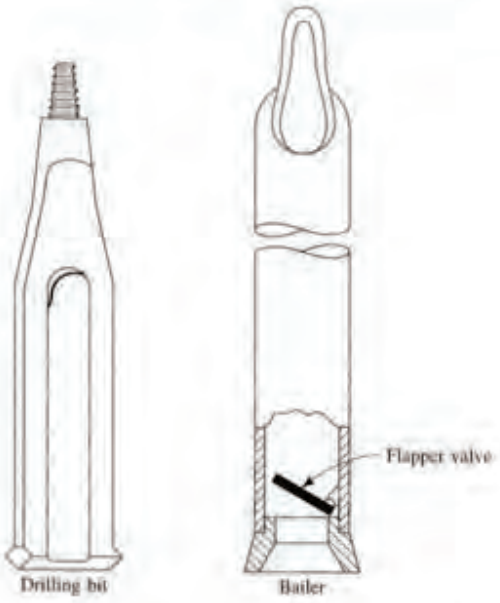
FIGURE 8.20 Tools used for cable-tool drilling.



Controlling wellbore trajectory has become more of a refined technology in recent years. Most modern directional drilling begins in a vertical direction until a desired kick off point where the well inclination is changed using drilling motors and rotary steerable systems. While the use of directional drilling is much more common in oil and gas development, its applications to contaminant hydrogeology are plentiful, particularly where surface or near-surface features or contaminant hotspots must be avoided, but geologic, hydrogeologic, and contaminant information from greater depths directly under these areas is needed.

8.5.3 Drilling in Contaminated Soil

When drilling at a contaminated site, the cuttings that are brought to the surface may be contaminated. Drilling personnel should wear appropriate protective clothing and, if necessary, use breathing apparatus. A large, heavy sheet of plastic should be placed in the work area, and the drill bit should be advanced through a hole in the center of the plastic sheet.

The cuttings augered to the surface can be collected from the plastic sheet and put into containers for proper disposal.

8.5.4 Sample Collection of Solid Material During Drilling

Samples of unconsolidated materials and rock are needed to delineate the geology of a site. They are collected by drilling **borings**. Borings may be made just for sample collection, or they may be made as a part of the process of installing a monitoring well. Borings may be made by any of the methods of drilling discussed in Section 8.5.

During the drilling process, earth materials are brought to the surface. During the augering process, soil and sediment ride up the augers; in the mud-rotary process, earth materials come up mixed with the mud; in air-rotary drilling there is a slurry of rock and

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water brought to the surface by air pressure; and cuttings are brought to the surface with a bailer in cable-tool drilling. In all cases the samples are disturbed, some (such as the samples on the augers) more than others. In addition, it may be difficult to tell the exact depth represented by the sample. Fine layering of sedimentary materials cannot be distinguished in such samples. An imprecise model of the geology can be constructed from these samples, but for more details, undisturbed samples should be collected.

A **core sample** is collected for consolidated material by obtaining a **rock-core sample** with a special drilling bit studded with industrial diamonds as mentioned above, or for unconsolidated material with special sampling tubes that are driven into the unconsolidated formations. Interpretation of hard rock cores in consolidated, fractured media suspected of contamination has become quite advanced in the last few decades and can include field geologic core analysis, and laboratory analysis (Parker et al. 2012). The initial field analysis involves determination of the number of fractures, fracture orientation and aperture size, and fracture porosity measurement. This analysis can also observe any occluding chemical precipitates filling (or "healing") the fractures. The orientation of fractures from several core holes can be analyzed to give a three-dimensional view of fractures at a site. Combined with downhole geophysics and tomographic methods, field data can give considerable insight into a fractured rock media and the potential for contaminant movement.

Laboratory measurement of bedrock cores can quantify contaminants in the core, simulate degradation microcosms, and provide core physical, mineralogical, and microbial measurements to determine contaminant phase and mass distribution. Typically, most groundwater flow in fractured consolidated rock occurs through interconnected networks of fractures and secondary porosities, surrounded by low permeability blocks of rock. In adjacent blocks with porosity greater than 1% however, particularly in sedimentary rocks, an appreciable mass of a contaminant can move into the rock matrix. This matrix diffusion in low-permeability blocks or effectively reduces the mass flux in the surrounding fractures (Parker et al. 1997; Parker et al. 2010; Kennel 2008).

Great care must be exercised in the interpretation of rock cores or unconsolidated borings, particularly in the measurement of subsurface contamination or characterization of stratigraphy based on just a few samples. The absence of contamination in a core could be the result of preferential flow (also called "funneling," "fingering," wetting front instabilities, or Rayleigh Taylor instabilities), allowing contamination to completely bypass a boring but still be present in massive amounts. Likewise, unwarranted extrapolation of meager stratigraphic data, particularly assuming continuous layers of unvarying properties, is a common problem particularly in situations where incomplete site characterization goes unchallenged. There are two main types of sampling tubes for unconsolidated samples. Both types of tubes can be used with hollow-stem augering and mud-rotary drilling if the drill rod and bit have a provision for a sample tube to be extended through them into the formation ahead of the bit. Figure 8.21 shows the sequence for the extension of a sampler through the end of the bit of a hollow-stem auger. The sampler is driven or pushed into undisturbed formation ahead of the bit. In cable-tool drilling the drill bit is removed from the borehole and the sampler is lowered on a rod or cable.

A **Shelby tube** is a thin-walled tube that can be screwed to the end of a rod, lowered to the bottom of the drilled hole, and pressed into cohesive sediments by using hydraulic pressure reacting against the weight of the drill rig. These samples are said

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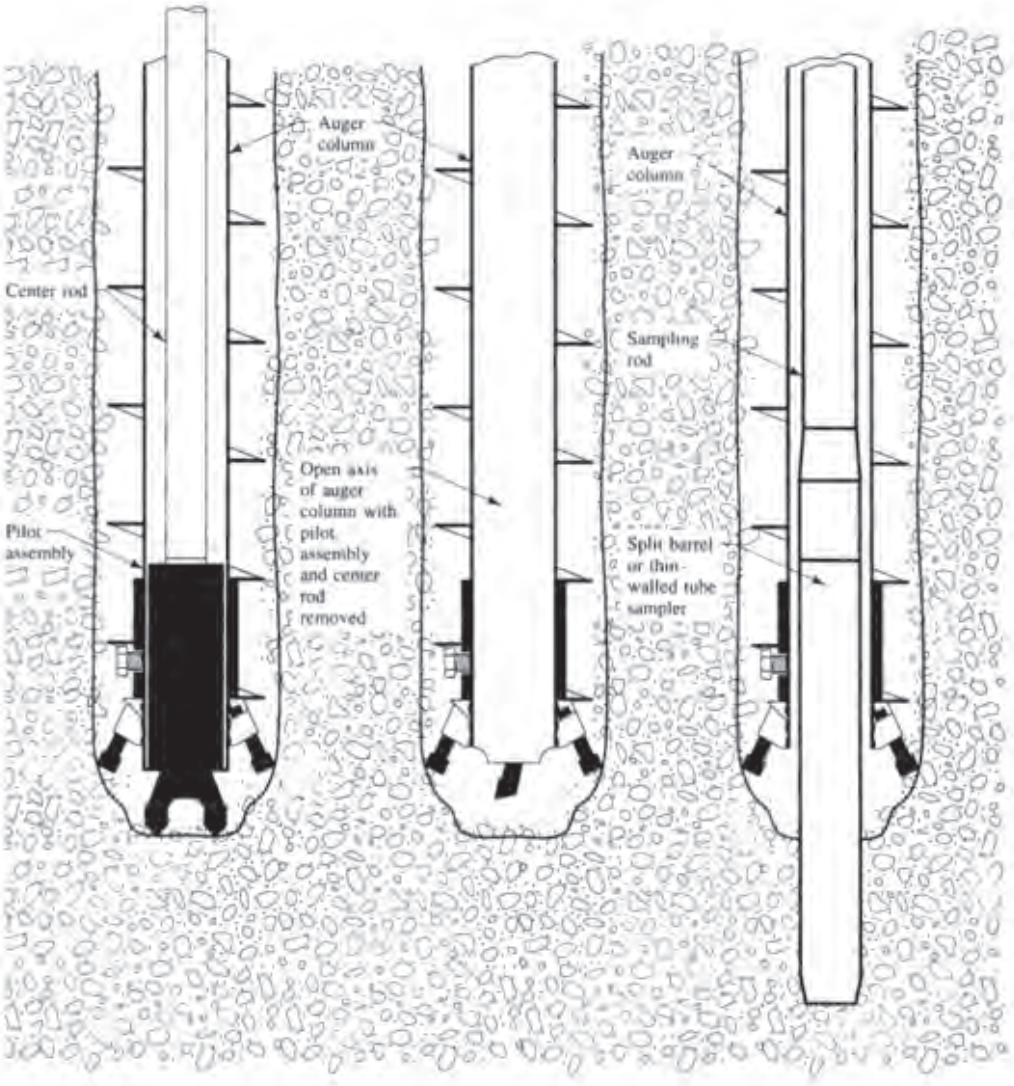
FIGURE 8.21 Sequential steps for the collection of a core sample through a hollow-stem auger.



Source: G. Hackett. 1987. Drilling and constructing monitoring wells with hollow-stem augers part 1: Drilling considerations. *Groundwater Monitoring & Remediation* 7:51–62. Used with permission.

to be *undisturbed*, although they are in fact minimally disturbed. The precise method of collecting a Shelby tube sample is described in method ASTM D1587 (American Society for Testing and Materials 1983). The sample can be extruded from the Shelby tube in the lab and trimmed into a permeameter for a permeability test. Details of the microstratigraphy can be examined as well. Shelby tube sampling does not work with noncohesive sediments.

A **split-spoon sampler** can be used for the collection of samples of both cohesive and noncohesive sediments. The split-spoon sampler consists of a split tube with thicker walls than a Shelby tube. The two halves are placed together and joined by screwing a circular drive shoe on the bottom and a head assembly on the top. The assembled split-spoon sampler is screwed to a rod and lowered to the bottom of the drill hole. A pipe-like weight of 63.5 kg (140 lb) is placed on the top of the rod.

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The weight is repeatedly raised and dropped a distance of 76 cm (30 in.) in order to drive the split-spoon sampler into the formation. The number of blows necessary to drive the sampler every 15cm (6 in.) is recorded as the sampler is driven 46 cm (18 in.) into the formation. The more dense the formation, the greater the number of blows needed to drive it 15 cm (6 in.). The process is described by ASTM 1586 (American Society for Testing and Materials 1984).

After the split-spoon sampler is driven 46 cm (18 in.), or after refusal, it is brought to the surface and opened. Frequently, less than 46 cm (18 in.) of sediment have been collected. Fine, noncohesive sediment such as sand may fall out of the sampler as it is being retrieved. Sediment greater in diameter than one-third of the diameter of the sampler may not enter it at all. A pebble may lodge in the barrel and not allow any other sediment to enter. Sediments may compact in the sampler so that a full 18-inch sample may actually occupy less than 46 cm (18 in.) of the core barrel. The hydrogeologist examining the split-spoon sample must use his or her judgment in making a log based on the split-spoon samples. Figure 8.22 is a photograph of a split-spoon sample.

FIGURE 8.22 Hydrogeologist describing a split-spoon sample.

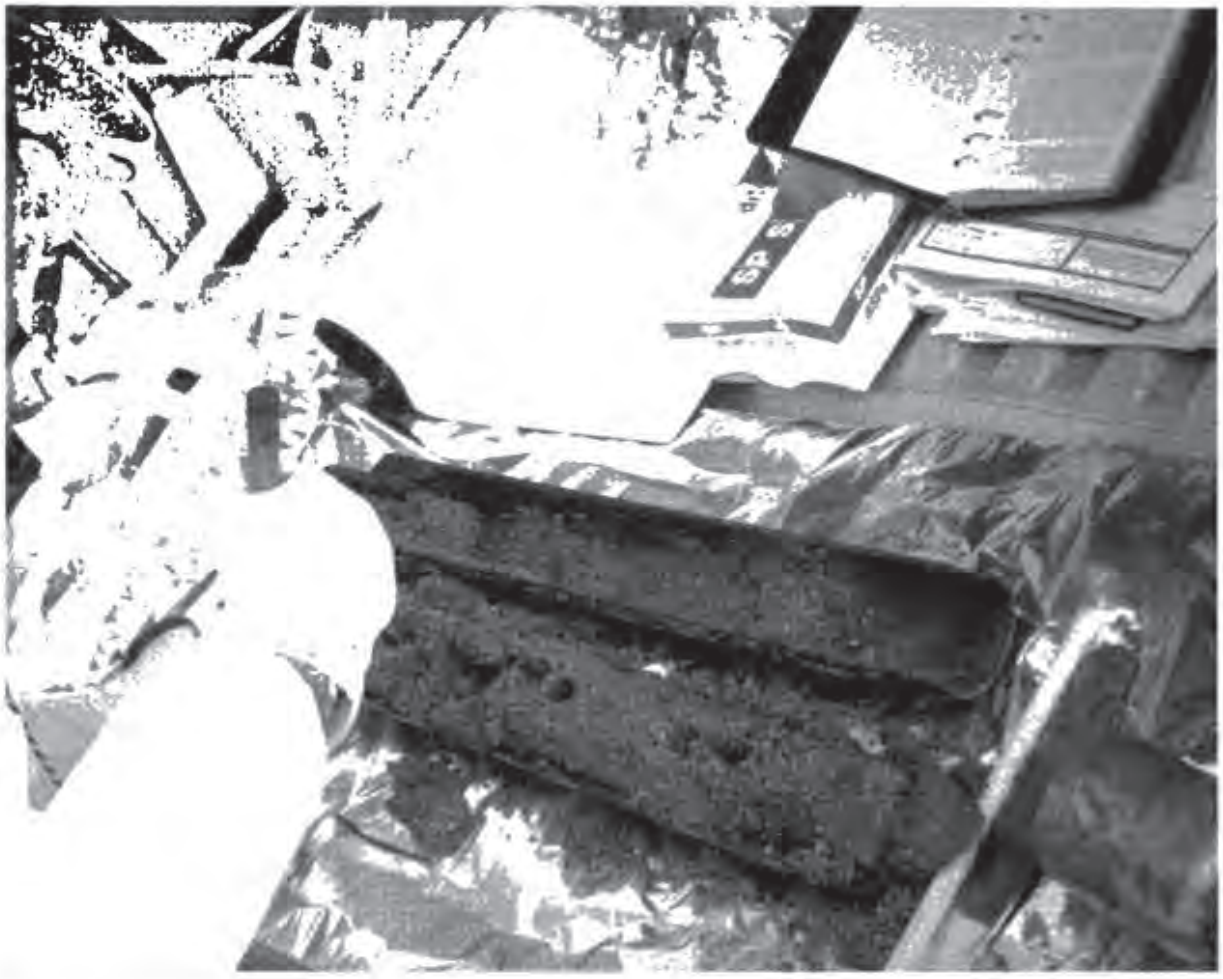

Photo credit: C.W. Fetter.

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A standard for core samples is to collect one 46 cm (18 in.) sample every 1.5 m (5 ft). This frequency of sampling is suitable for relatively homogeneous formations. However, if the microstratigraphy of the formations is important—for example, if there are permeable sand seams in a clay formation—then continuous-core samples should be collected. Continuous cores are made by advancing the drill bit to the full depth that was sampled by a split spoon and then immediately taking another core sample of the fresh formation ahead of the previous core. Continuous-core samples can also be collected in cohesive soils by using a special core barrel that collects a 1.5 m (5 ft) long sample inside a hollow-stem auger as the auger is being advanced. If a sequence consisting of a 3-inch split spoon followed by a 6.35 cm (2.5 in.) split spoon followed by a 5 cm (2 in.) split spoon is used, 1.37 to 1.5 m (4.5 to 5 ft) of continuous sample core can be collected before the augers need to be advanced.

In consolidated formation a rock-core sample is collected by use of a core barrel with a diamond-studded bit. The rotating bit grinds up rock in an annular pattern, leaving an undisturbed center of rock that enters the core barrel. There is a core lifter just behind the bit to keep the core from falling out of the core barrel when the drill rods and bit are retrieved from the borehole. For shallow soil sampling, some coring and auger soil sampling devices can be operated by hand. Helical or post-hole augers gather a disturbed, near-surface sample and are superior to coring devices in rocky soils. Soil cores can be taken by hand from the ground surface with specialized coring devices that can allow sampling for VOCs and other potential contaminants. Cores are typically extruded after sampling and readied for transport or analysis. Decontamination techniques for coring equipment between samples is required to prevent cross-contamination.

8.5.5 Installation of Monitoring Wells

Following the collection of samples during the installation of borings, a monitoring well can be installed in the borehole. Boreholes drilled with mud should stay open with the drill rod removed. Hollow-stem augers are generally left in the ground and the well is installed through them, as is drive casing in cable-tool drilling. There must be a sufficient working opening inside the casing or augers. For a 5 cm (2 in.) nominal monitoring well, this means a minimum 10.8 cm (4.25 in.) opening is needed. The casing can be offset within the auger to give the largest working opening (Figure 8.23) although care must be taken to keep the well casing and screen as centrally located as possible. With a 10.8 cm (4.25 in.) inside diameter auger and a 5 cm (2 in.) nominal casing, this creates a 4.76 cm (1.875 in.) working opening.

The first step in the installation of a monitoring well is to screw the well screen to the casing and then lower the assembly through the inside of the augers or temporary casing. Prior to installation the casing and screen should be thoroughly decontaminated. The casing and screen may be wrapped in white butcher paper after it has been decontaminated and then kept wrapped until just before it is lowered into the augers. Figure 8.24 shows a 6.1 m (20 ft) casing and screen being lowered by hand. Longer casings need to be lowered on a cable using the drilling rig. In boreholes not drilled by hollow-stem augering, it is generally important to have centralizers (mechanical collars-type devices) attached to the casing/ screen combination to keep them from contacting the wellbore walls (Nielsen 2005).

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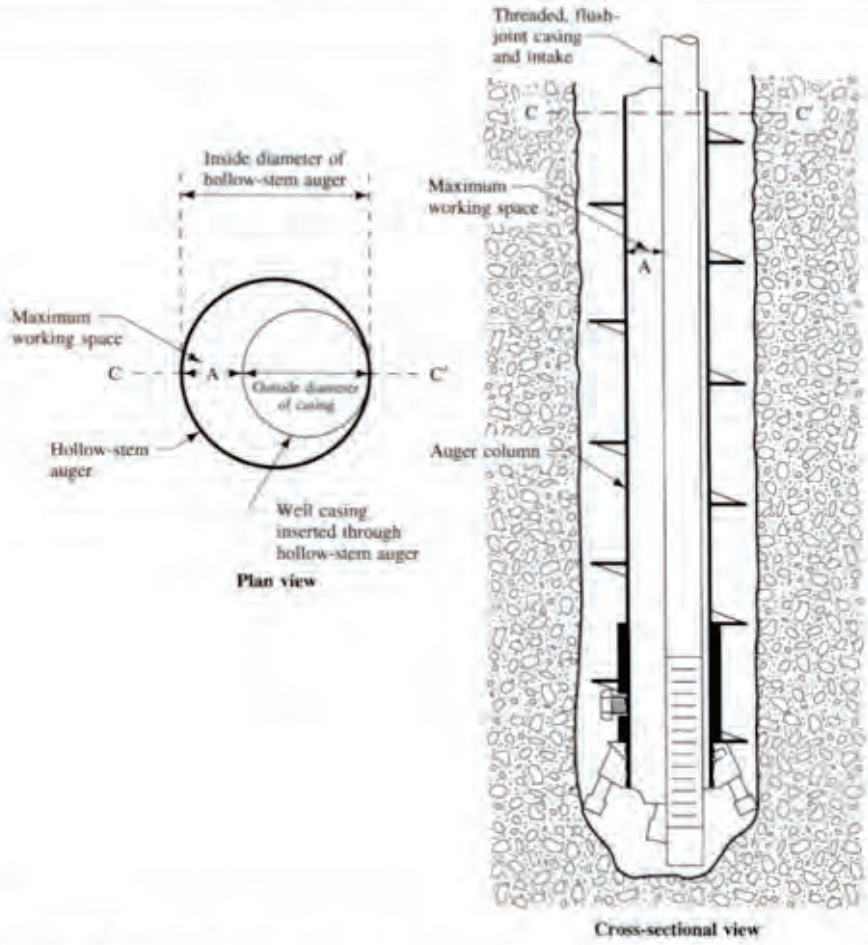
FIGURE 8.23 Casing offset inside hollow-stem auger to give greatest working opening.



Source: G. Hackett. 1988. Drilling and constructing monitoring wells with hollow-stem augers part 2: Monitoring well installation. *Groundwater Monitoring & Remediation* 8:60–68. Used with permission.

Once the casing and screen have been lowered into the well, the filter-pack material needs to be placed. The volume of filter-pack material necessary to fill the annular space between the screen and casing and the borehole wall from the bottom of the borehole to a point 0.6 m (2 ft) above the top of the screen should be computed. At least this much material must be on hand before starting the filter-pack installation. A weighted measuring tape is lowered into the working opening between the casing and the hollow-stem auger and the total depth of the borehole is measured and recorded.

If the formation is cohesive and can stand open for a short while, the augers are withdrawn 0.3 or 0.6 m (1 or 2 ft) from the bottom. Filter-pack material is then poured into the working opening, and the annular space is filled to the level of the auger bit. Care should be taken that the filter-pack sand doesn't fill the space between the casing and the augers, because it can lock the casing and hollow-stem augers together. The weighted tape is used to determine the position of the top of the filter pack. The augers are then withdrawn another 0.3 to 0.6 m (1 to 2 ft), and the process is repeated until the entire filter pack is placed. Figure 8.25 illustrates what is known as the free-fall method of filter-pack emplacement.

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FIGURE 8.24 Lowering well screen and casing into hollow-stem augers. Note the white wrapping paper around the decontaminated casing.



Photo credit: C. W. Fetter.

When filter-pack material drops through a water column, it may separate according to size. It may also bridge the space between the casing and the auger and create a void below. To avoid these problems, a **tremmie pipe** should be used wherever possible (Figure 8.26). A tremmie pipe is a pipe that extends from the surface and through which the filter-pack sand may be poured. After the augers are withdrawn a few feet, the annular space is filled with sand being poured down the tremmie pipe. The tremmie pipe is raised as the level of sand rises. The tremmie pipe can be used to tamp down the sand, and the weighted tape is used to measure the position of the top of the filter pack.

If the formation is noncohesive, it will collapse as the augers are withdrawn. Under these conditions, the withdrawal of the augers and the addition of the filterpack

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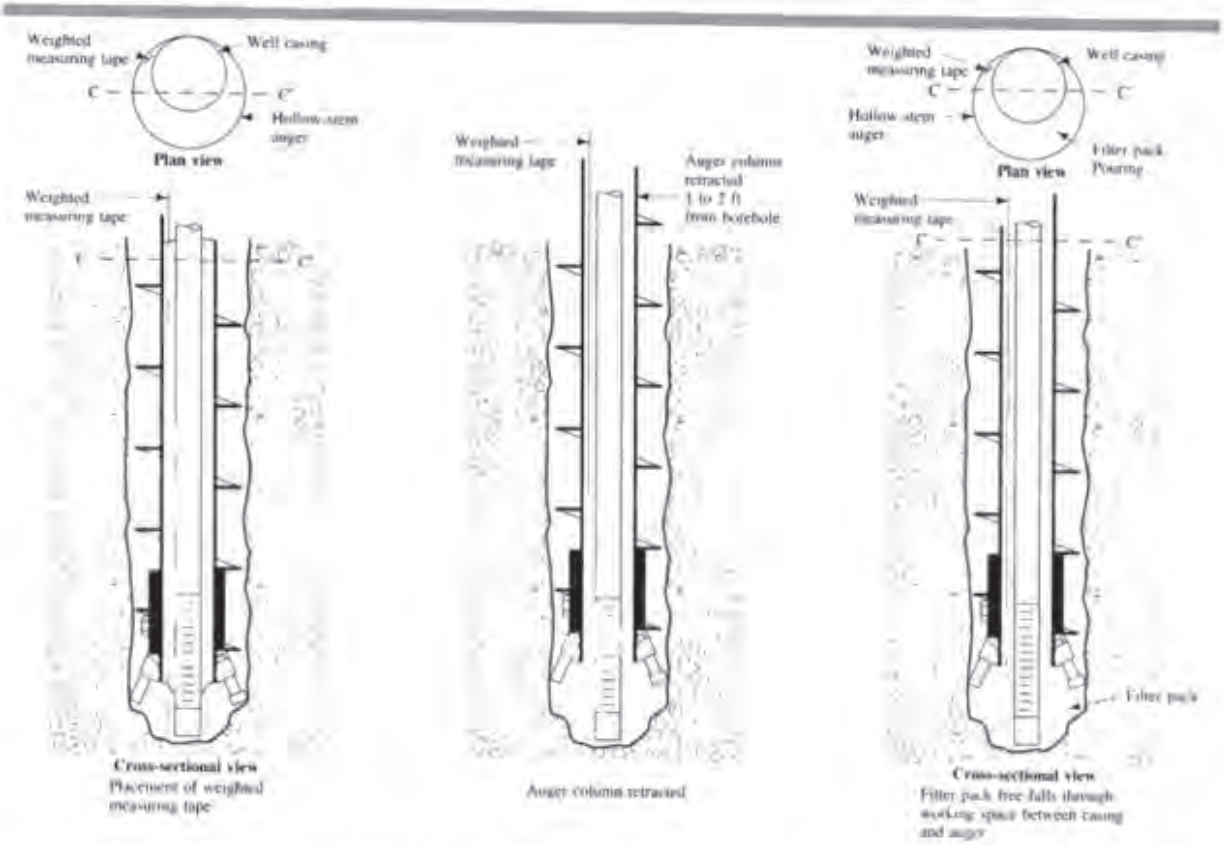
FIGURE 8.25 Free-fall method of filter-pack emplacement with a hollow-stem auger. The method also works with drive casing.



Source: G. Hackett. 1988. Drilling and constructing monitoring wells with hollow-stem augers part 2: Monitoring well installation. *Groundwater Monitoring & Remediation* 8:60–68. Used with permission.

material must occur simultaneously (Hackett 1988). A cable must be attached to the top of the auger string so that the working opening is accessible at all times. The hollow stem of the augers is filled with clean water, and a positive hydraulic head is thus maintained throughout the operation. The augers are very slowly withdrawn, and at the same time filter-pack material is added so that the top of the filter pack is within an inch or so of the bottom of the augers. This requires precise coordination of the rate of addition of filter-pack sand and the rate of withdrawal of the augers.

The final depth of the top of the filter pack is confirmed by measurement with the weighted tape. It should be 0.6 m (2 ft) above the top of the screen. The augers are then withdrawn another 0.6 m (2 ft) and 0.6 m (2 ft) of pure bentonite clay is placed by free fall through the working space. If the area is below the water table, bentonite pellets are used; if the area is above the water table, granular bentonite or slurry is used (see 8.4.5). Pellets should be dropped a few at a time so that they aren't caught in the working space as they start to swell by hydration. The weighted tape is used to confirm the final thickness of the bentonite layer after enough time has elapsed to allow the bentonite to hydrate. Bentonite pellets should not be used as grout in the vadose zone, as hydration is extremely slow even if water is poured through the pellets.

Placement of the annular seal should take place by use of a tremmie pipe. The tremmie pipe should be lowered to the top of the bentonite seal. The augers are

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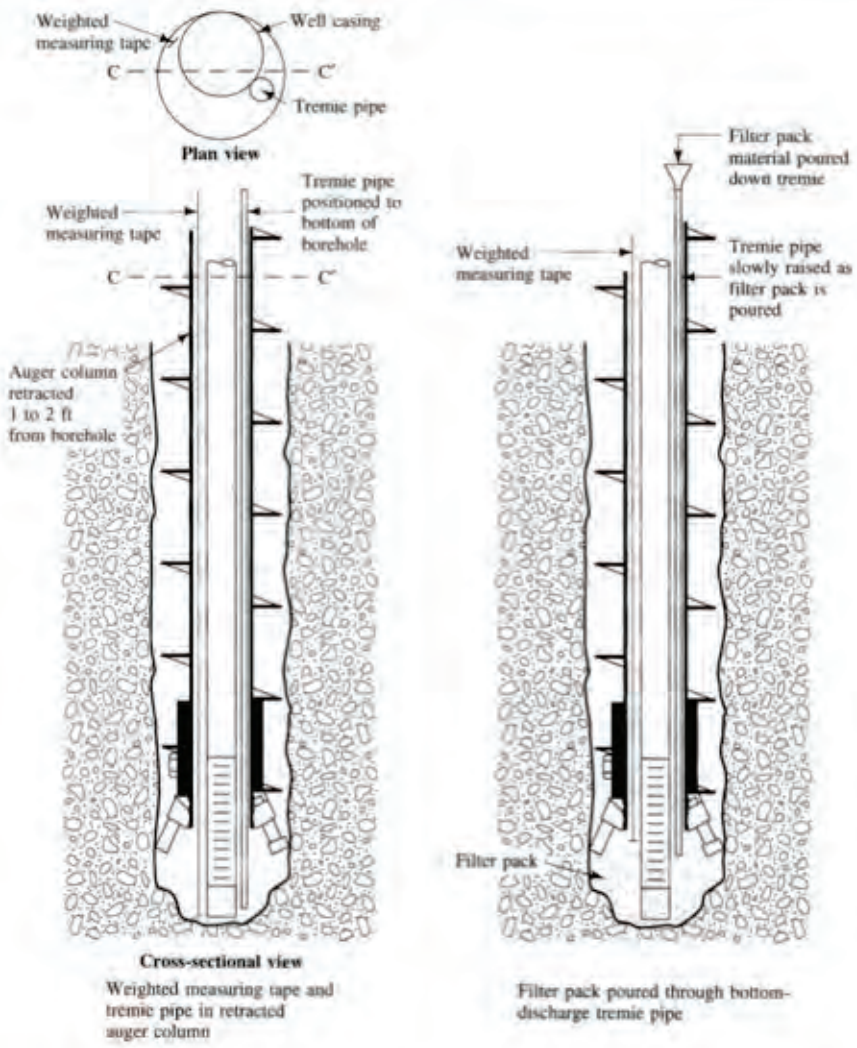
FIGURE 8.26 Use of a tremmie pipe for emplacement of filter-pack material.



Source: G. Hackett. 1988. Drilling and constructing monitoring wells with hollow-stem augers part 2: Monitoring well installation. *Groundwater Monitoring & Remediation* 8:60–68. Used with permission.

withdrawn 0.6 m (2 ft) or so and the annular space is filled from the bottom with grout, which is either pumped down the tremmie pipe or is fed by gravity (Figure 8.27). The weighted tape is used to confirm the position of the top of the grout. The augers are then repeatedly withdrawn and grout is emplaced until it is brought close to the surface. The tremmie pipe can be left at the bottom until the grout is brought to the surface, or it can be raised as the augers are withdrawn. For slumping sediments, the grout must be emplaced simultaneously and at the same rate as the augers are withdrawn.

The final step is the installation of a locking protective cap. Bentonite-cement can be brought all the way to the surface. If bentonite grout or bentonite-sand grout is used, the final few feet filling the annular space must be neat cement or bentonite-cement grout. A slight mounding of the surface grout will prevent the pooling of water at the surface next to the well. The locking protective casing can be pushed into the cement grout when

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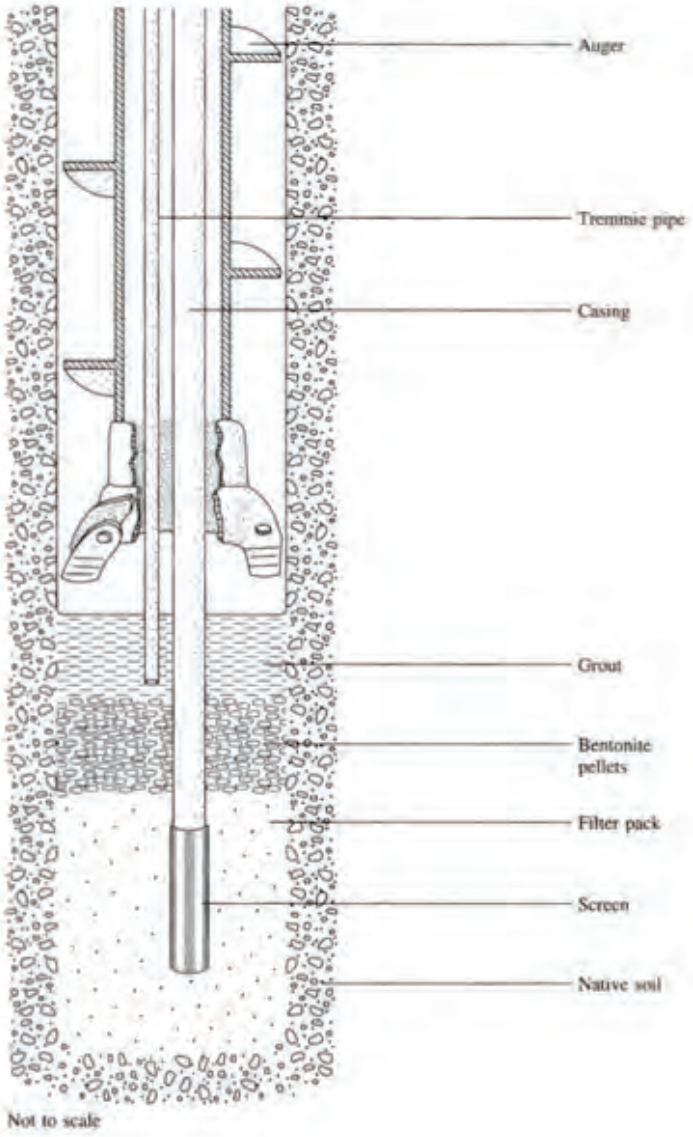
FIGURE 8.27 Use of a tremmie pipe for emplacement of grout above the bentonite pellets.



it is still soft. If the grout settles overnight, its level should be brought to the surface with additional material. A stronger surface seal can be obtained if the top 0.61 m (2 ft) of the annular space is filled with concrete, as opposed to bentonite-cement grout.

8.5.6 Monitoring Well Development

Once a monitoring well is constructed, it is necessary that it undergo development. This is a process of removing fine sand, silt, and clay from the aquifer around the well screen. If drilling mud was used, then vigorous development may be needed to break down the mud pack on the borehole wall. Development is needed to create a well that ideally will not pump silt and clay when it is sampled. It also may create a zone around the well screen that is more permeable than the native soil and that stabilizes the native soil so that the fine sediments do not enter the filter pack.

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Aller et al. (1991) made the following observations about monitoring well development:

1. Using compressed air for well development may alter native water chemistry, crack the casing, or blow the bottom cap off the screen.
2. Adding water to the well for flushing the well or surging can alter the groundwater chemistry, at a minimum by dilution.
3. Breaking down a mud wall left in the borehole from mud-rotary drilling is very difficult.
4. Developing a well when the screen is in a clean, homogeneous, high-permeability aquifer is relatively easy.
5. Developing a well when the screen is in a fine-grained, stratified, low-permeability formation is difficult.
6. Developing a large-diameter well is easier than developing a small-diameter well.
7. Shallow monitoring wells are easier to develop than deeper monitoring wells.
8. Monitoring wells that can be bailed dry tend to be turbid because of the steep hydraulic gradients that are developed.
9. In the final analysis, many monitoring wells cannot be developed to the point where a nonturbid, groundwater sample can be collected. This is especially true if the formation does not yield very much water, so that extensive development is not possible.

If the borehole is drilled into a stable, consolidated formation, especially if mud is used during the drilling, it may be advantageous to flush the borehole with potable, fresh water to wash out as much of the mud as possible prior to installation of the well and filter pack. This will greatly cut the time needed for well development. In some cases it will not be permissible to add water to the borehole, since this might alter the groundwater chemistry.

There are three procedures used for monitoring well development: bailing, surge block surging, and pumping/overpumping/backwashing. These may be used alone or in combination.

A **bailer** for a monitoring well is a section of pipe that is open on the top end and has a foot valve on the bottom end. It is attached to a line so that it can be lowered into the well. Water fills it from the bottom; then when it is raised by the line, the foot valve closes and the water inside is trapped. Figure 8.28 is a diagram of a bailer.

When developing a well by bailing, the bailer should be allowed to freefall to the water surface. When it strikes the water, a pressure wave results, which pushes water from the well screen out into the formation. After the bailer is filled with water, it is withdrawn and water from the formation enters the screen. This back-and-forth motion of water through the filter pack loosens fine sediment so that it can be drawn into the well and removed by the bailer. The bailer should be allowed to sink to the screen area so that the water that fills it contains the fine sediment that is brought into the well from the filter pack. The bailer can also be raised and lowered when it is submerged to force water to move back and forth through the screen area. Bailing can take some hours to develop a monitoring well effectively; this can translate into significant labor cost. Bailing for development can be undertaken by hand or by using a cable attached to a

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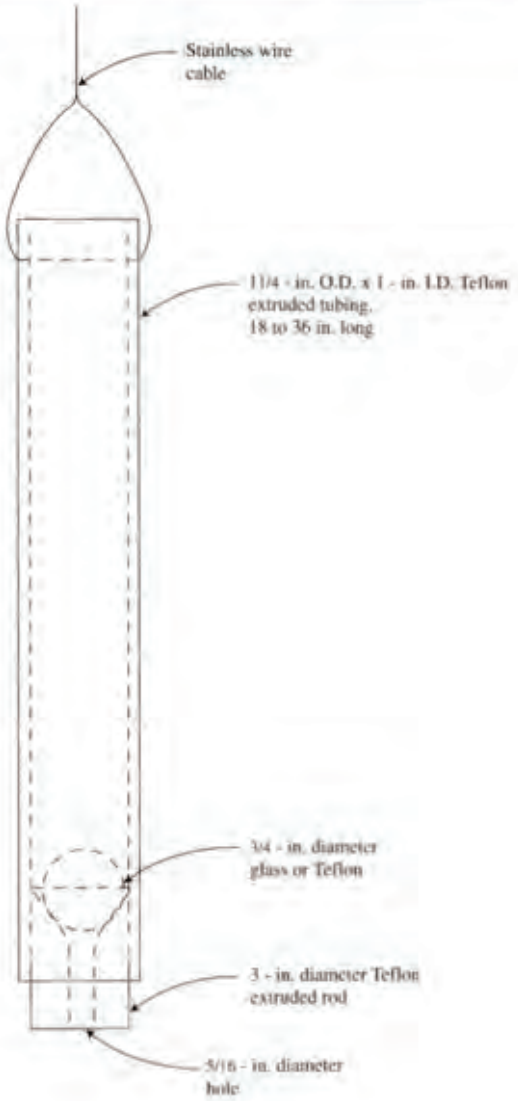
FIGURE 8.28 Diagram of a bottom-loading bailer.



power-operated drum on a drill rig or truck. Some well-development outfits have an arm that can go up and down like a walking beam to create a surging action. Care should be taken so that the surging action is not vigorous enough to collapse the well screen.

A **surge block** is a device that fits inside the well with a flexible gasket that is close in size to the inside diameter of the well. Figure 8.29 shows the design of a surge block for small-diameter monitoring wells. It is attached to a rod that is raised and lowered with a stroke of about 0.9 m (3 ft). Most of the water is moved up or down by the action of the surge block, although some fraction of the water bypasses the surge block. The surging is initiated with the surge block at the top of the well screen, and the block is gradually lowered until the entire screened area has been surged. Every so often the surge block is removed and the well bailed to remove the sediment that has been brought into the well. If too much sediment accumulates above the surge block, it can bind between the surge block and the casing wall and lock up the surge block. To avoid this, the surge block

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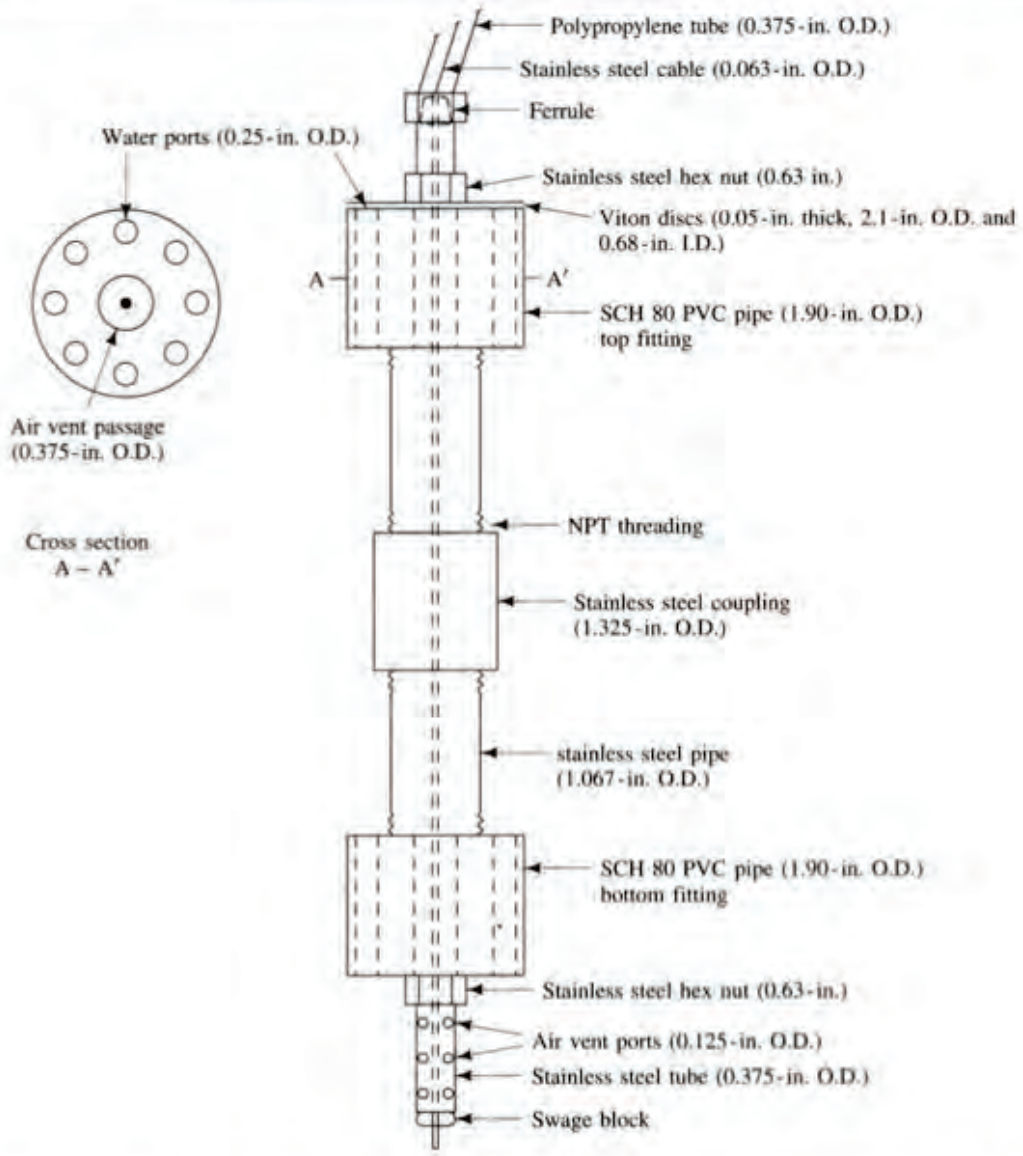
FIGURE 8.29 Design of a specialized surge block for monitoring wells.



Source: R. Schalla and R. W. Landick. 1986. A new valved and air-vented surge plunger for developing small-diameter monitor wells. *Groundwater Monitoring & Remediation* 6:77–80. Used with permission.

must be removed and the well bailed frequently. Surging begins with a gentle action; as development progresses it becomes more vigorous, with a more rapid plunging action. Again, too vigorous a surging action might cause the screen to collapse.

Pumping the well can aid in development. A number of different types of pumps are suitable. However, some pumps might be damaged by the sediment that must necessarily be removed during development. The ideal pump for development is capable of a wide range of flow velocities and does not have a valve that prevents backflow. The pump intake should be in the screen zone so that it will immediately pick up sediment that is brought into the well. The pump is started at a low velocity and is shut off every so often. When it is shut down, the water in the pump column between the water

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surface and the pump will flow back into the well and out into the filter pack. When the pump is started again, this water will be drawn into the well and will loosen fine sediment in the filter pack. With time, the rate at which the well is pumped is increased so that the water velocity through the filter pack into the screen is increased. Eventually, the well will be overpumped—that is, pumped at a rate that is greater than the flow into the well through the well screen. There will be a rapid decrease in the water level in the well during overpumping, and it cannot be sustained for very long. Eventually the water from the well should clear. Monitoring wells should be periodically redeveloped.

8.5.7 Record Keeping During Monitoring Well Construction

Many localities have detailed record-keeping requirements for monitoring well construction. Even when detailed records aren't required by statute, they should be kept as a matter of sound professional practice. Figure 8.30 shows a one-page form that can be used to record important information on monitoring well construction. Many firms have their own forms, and many states, provinces, and regions have a required form. The form should be filled out in the field as the information is collected.

Records should also be kept of well development, including the date that it occurred, the method used, the water level at the start of development, the water level at the end of development, the time spent developing the well, and the volume of water removed. The thickness of sediment on the bottom of the well can be determined by measuring the depth to the bottom of the well with a weighted tape. This measured distance is subtracted from the measured length of the well casing and screen that was installed. The difference between the two dimensions is the thickness of sediment inside the well. This thickness should be measured and recorded both before and after development. If possible, sediment should be removed with a bottom-loading bailer.

8.5.8 Monitoring Well and Borehole Abandonment

Sometimes difficulties are encountered during the construction of a monitoring well that prevent its completion. Monitoring wells may be installed for a specific time period, after which they must be removed. Test borings may be made with no intention of using the borehole for construction of a monitoring well. In all such cases, proper abandonment of the well should be undertaken. Many countries and regions have specific well-abandonment codes. In the absence of specific requirements, monitoring wells and boreholes should be abandoned in such a manner that surface water cannot drain into the aquifer. Otherwise a direct connection for contaminated water from the surface to the aquifer can result. Nor should contaminated water or fluids be allowed to move vertically within the borehole to contaminate other depths.

If a casing and screen have been installed, they should be removed if possible. This can be accomplished by pulling if the annular seal has not been filled with a cement-type grout. If a plastic casing breaks while being pulled, it can be removed by drilling it out with hollow-stem augers. Following the removal of the casing, a tremmie pipe should be used to fill the resulting borehole from the bottom with an appropriate material, such as neat cement or bentonite grout. The grout is placed while the augers are being pulled out of the hole. Material removed from a monitoring well may be contaminated and should be properly disposed of.

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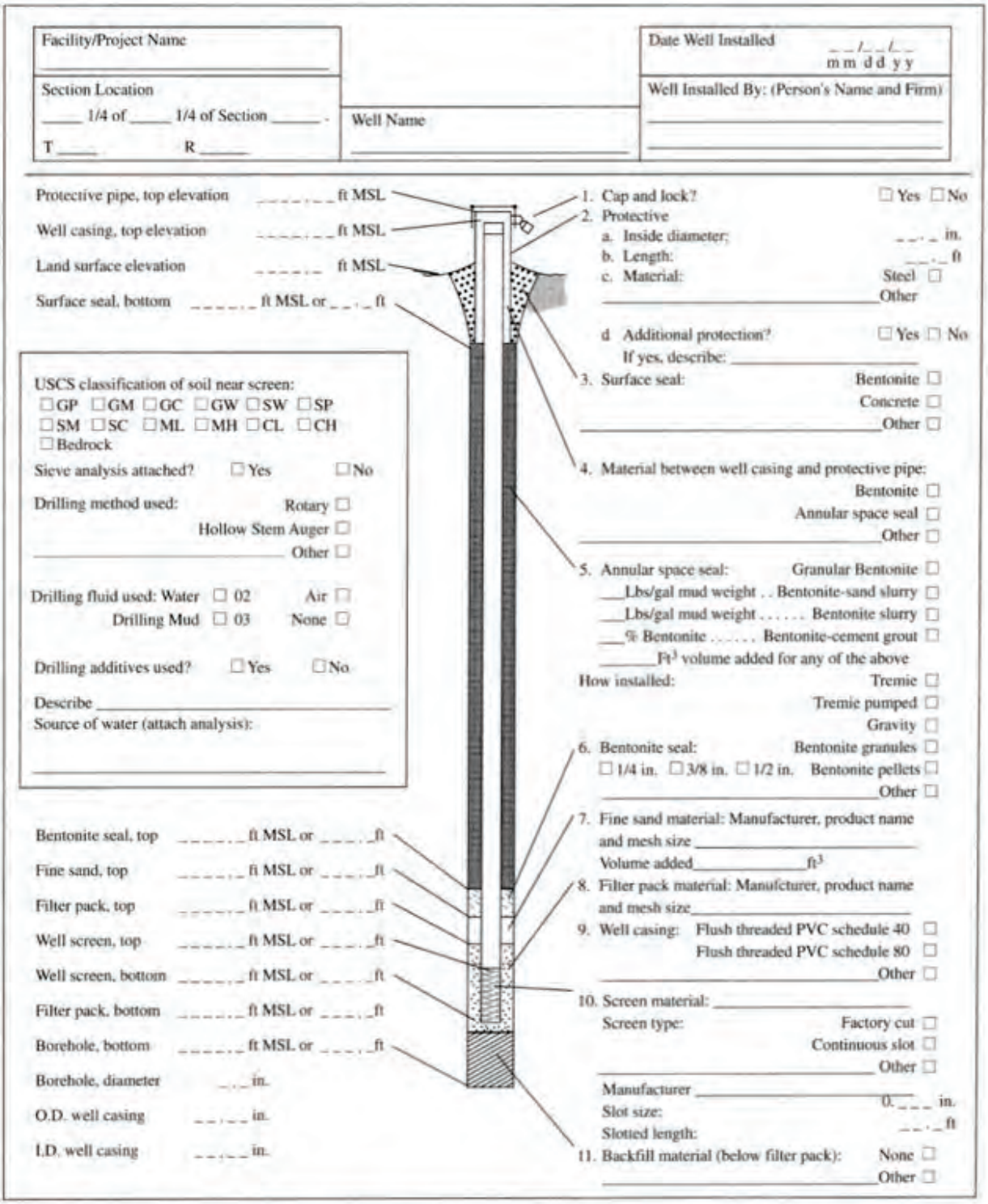
FIGURE 8.30 Form for recording information about construction details of a monitoring well.



Source: Modified from Wisconsin Department of Natural Resources.

If the casing and screen have been grouted into place, it may not be possible to remove them. If this is the case, several approaches can be used. The casing could be cut off below grade; then the screen and casing must be filled from the bottom using a

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tremmie pipe and an appropriate material such as neat cement or bentonite grout. If the casing is in poor condition it can be ripped or perforated with casing rippers allowing grout to be injected into the annular space. Alternatively, casing can be gun-perforated using either a device that fires steel projectiles through the casing and into the formation, or a jet type perforator that uses small shaped explosive charges to burn holes through the casing and allow grout injection (Aller et al. 1991).

Boreholes in sediments can be filled with grout or native soils mixed with bentonite. Boreholes into bedrock should be grouted with a cement-type grout.

8.6 Well Sampling

8.6.1 Introduction

After a monitoring well has been designed, installed, and developed, the next step is to collect a water sample. The water sample should be representative of the water in the formation; that is, the sampling techniques should collect water from the aquifer and not from water that has been standing in the well casing or screen. In addition, the sampling device should provide a sample that has not been altered by the sampling process and should not cause cross contamination.

8.6.2 Fluid Level and Pressure Measurement

Several devices are available for the downhole measurement of water levels, pore pressures and NAPL layers in wells or piezometers. Historically, steel tape was used to measure water levels in wells. Chalk would be applied to the tape at the expected water level depth, and then retrieved to the surface. The depth to water would be indicated on depth markings on the tape at the point where the chalk had been washed away by the water. Another historical method to measure hydraulic head is a "bubble tube" which is a pipe or tube sent downhole with a known air pressure to depths below land surface and below the water table or piezometric surface. The tube continues to bubble until it reaches a depth where the water pressure is equal to the air pressure within the tube and the depth below water surface can be calculated. This method is not used in situation where volatilization of contaminants is possible or LNAPLs are suspected in the wells.

Water levels are now often determined by electrical probes with depth demarcations which are lowered in a well or piezometer until a peeping sound indicates that the water level has been reached. For more exacting and quantitative NAPL determinations in wells, depth-discrete and transparent bailers can be sent downhole, or interface probes can be used. An interface probe is a modified electrical water level probe which has an ability to give separate acoustic and visual signals for water and NAPL in the fluid column (Mercer and Cohen 1990; Cohen and Mercer 1993). Unlike the bailer, however, interface probes cannot retrieve a NAPL sample for analysis, but only measure the vertical thickness of NAPL in a well.

Long term water level measurements are now often made with a recording transducer which measures temporal pressure changes in a well at a specified depth, which correlates to overlying water levels. Vibrating wire piezometers are useful in measuring well water levels and pore pressures for geotechnical applications.

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8.6.3 Well Purging

Water that has been standing in the well has been in contact with atmospheric gases and the well casing and screen. This contact can affect the water chemistry. Oxygen can diffuse into the water and dissolved gases can volatilize or oxidize. Trace elements may be leached from the well casing. Organics may be sorbed by the well casing. In order to be sure that the water being drawn into the sampling device comes from the aquifer, the well must be purged of standing water prior to sampling. The goal of purging is to remove all the water that has been standing in the well. The volume of water that must be removed to accomplish that goal depends upon the method of purging and formation permeability.

The first step in well purging is to measure the depth of water in the well, the total well depth, and the inside diameter of the well casing. These measurements are used to compute the volume of water standing in the casing. If a well is purged by a method that withdraws water from the top of the water column, then theoretically only one well volume needs to be withdrawn. For example, purging with a bailer that is lowered slowly into the well to a depth no greater than the length of the bailer will remove water only from the top of the column. If a pump is used to purge the well, the pump intake should be as close as possible to the top of the water column. Although one well volume would theoretically remove all the standing water, good practice suggests that at least three well volumes should be removed to be sure that the standing water in the casing and screen is totally removed. This also removes water from the filter-pack area. If a well is bailed dry, or nearly so, it is not necessary to attempt to remove multiple-well volumes. As soon as the well has recovered enough to contain sufficient sample volume, the sample can be collected.

If the pump intake is lowered to the level of the screen in the well during purging, then most of the water will come from the screen area, and an area of stagnant water will develop in the water column above the pump intake. Under such conditions up to five well volumes need to be pumped to remove all of the stagnant water in the well (Gibb et al. 1981). Keeley and Boateng (1987) advocate a staged technique when purging with a pump. The pump intake is lowered to just below the water surface at the beginning of the purging process and then is gradually lowered through the water column until it is at the screen zone, when purging is complete. Purging three well volumes with this technique should be adequate.

Electrical conductivity and pH can be monitored during the well-development procedure. If they vary widely during the well-purging process, this may mean that water from different sources is being withdrawn. If these values do not stabilize, this does not necessarily mean that the stagnant water has not been withdrawn from the well. There may be instrument drift, or the water quality in the aquifer may be changing as water from different parts of the aquifer is being withdrawn. If possible, the well should be purged until it is not turbid.

The water being purged from the monitoring well may be contaminated. If so, it must be properly disposed of in a treatment facility. For this reason, purging techniques that limit the amount of water withdrawn are desirable.

8.6.4 Well-Sampling Devices

There are a large number of sampling devices available for monitoring wells. They operate under different physical principles and designs and have different applications.

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Most are available in a variety of materials. The following is a partial list of available devices (Nielsen and Yeates 1985; Pohlmann and Hess 1988):

1. *Open bailer*: This device is a rigid tube with an open top and either a closed bottom or a check valve on the bottom. It is attached to a line and is lowered and raised by hand. It withdraws the sample from the top of the water column.
2. *Point-source bailer*: This device has a check valve on both the top and bottom and can be lowered on a line to a given depth below the surface, where the valves can be closed by a cable. It can collect grab samples from any depth in the water column. Some bailers are intentionally disposable to prevent cross-contamination from multiple sampling, and some are transparent or translucent allowing visual identification of colored NAPLs or other compounds in the bailer.
3. *Syringe sampler*: A medical syringe, or similar device, is attached to a length of tubing and is lowered to a selected depth in the water column. A suction is applied to the tubing and the syringe, which was lowered in the "empty" position. The syringe fills as the water comes into the needle because of the vacuum being developed by the suction on the tubing.
4. *Gear-drive pump*: This device is similar to a traditional submersible electrical pump. There is a miniature electrical motor attached to the pump, which rotates a set of gears to drive the sample up the discharge line via positive displacement. A continuous flow of water under positive pressure is developed.
5. *Bladder pump*: This sampler has a rigid tube containing an internal flexible bladder. There are check valves on either end of the rigid tube. When the bladder is deflated, water enters the lower end of the tube through the check valve. When the tube is full, the bladder is inflated with an inert gas pumped down from the surface. The bottom check valve closes, the top check valve opens, and the water sample flows up the discharge line. When the bladder deflates, the water in the discharge line can't drain back into the rigid tube because of the check valve. The water is under positive pressure at all times and doesn't come into contact with the gas.
6. *Helical-rotor pump*: This pump has a submersible electrical motor. It rotates a helical rotor-stator, which drives water up the discharge line under positive pressure.
7. *Gas-drive piston pump*: A piston that pumps the water is driven up and down by gas pressure from the surface. The gas does not contact the sample.
8. *Submersible centrifugal pump*: A submersible electrical motor drives an impeller in the pump, which creates a pressure and forces the water up a discharge line.
9. *Peristaltic pump*: Unlike the others, this is a pump located at the land surface. It is a self-priming vacuum pump that can draw a water sample up tubing under suction. Loss of volatile compounds and dissolved gases may occur due to the vacuum developed.
10. *Gas-lift pump*: A constant stream of gas or air is used to force the water up a discharge tube. The water comes into contact with the gas or air and oxidation and loss of volatiles can occur.
11. *Gas-driven pump*: An inert gas is used to alternately pressurize and depressurize a sample chamber. The sample chamber has check valves to create a one-way flow

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of water up a discharge line. This is similar to a bladder pump except that there is no bladder, so the gas comes into contact with the water sample.

12. *Passive samplers*: Consist of an organic phase, such as a plastic film or polymer, which accumulates contaminants from the aqueous phase or (soil) air. Passive samplers are useful for sampling the water column as well as interstitial water (ITRC 2005; USEPA 2012).

Figure 8.31 is a matrix of sampling devices and the suitable applications for collection of groundwater samples.

Pearsall and Eckhardt (1987), Yeskis et al. (1988), and Tai, Turner, and Garcia (1991) evaluated the efficacy of a number of different sampling devices in collecting representative samples of volatile organic compounds in groundwater. The first two studies were performed by withdrawing water from monitoring wells with different devices and comparing the results. The authors had no controls—that is, they did not know the actual concentration of the contaminants in the aquifer.

Yeskis et al. (1988) tested a bailer, a bladder pump, a piston pump, a submersible electric impeller pump, and a submersible electric helical stator-rotor pump. They found very little variation in the results except for the bailer. The bailer samples were in general less than half of the values obtained by the other devices. Pearsall and Eckhardt (1987) evaluated two 5 cm (2 in.) submersible helical stator-rotor pumps made of different materials, a 4-inch submersible electrical water-well pump, a cast-iron centrifugal suction pump, a peristaltic pump, and a bailer. The submersible pumps all gave similar results; the peristaltic and centrifugal suction pumps gave somewhat lower results. Silicon and PVC tubing appeared to give lower results than Teflon® tubing when used with the same pump. The bailer gave variable results, depending upon the concentration.

Tai, Turner, and Garcia (1991) built a 30.5 m (100 ft) tall, 12.7 cm (5 in.)-diameter, stainless-steel, vertical standpipe with sampling ports at various depths. They were able to use a sampling device to collect a sample from the standpipe, at the same time drawing a control sample from that depth through a sample port. They tested a Teflon® point-source bailer, a manual-driven piston pump, a motor-driven piston pump, a submersible helical-rotor pump, a peristaltic pump, and a bladder pump. Teflon® tubing was used to convey samples to the surface from the pumps. Because they had control samples, they were able to calculate a percent recovery for each sampling device. Table 8.5 shows the percent recovery for each sampling device at different depths. Examination of this table shows that the submersible pump, the peristaltic pump, and the bladder pump all had excellent recoveries, ranging from 98.5 to 100.5%. The other three devices were not as accurate, with the bailer having the lowest recovery.

The low recovery using the bailer was probably due to agitation of the sample as it was being transferred from the bailer to a 40 mL sample bottle for volatile organic analysis. Although it is a simple piece of equipment, an experienced operator is needed for correct use of a bailer.

On the basis of available research (Parker 1994) the piston pump, the bladder pump, and the electrical submersible helical-rotor pump appear to be the best devices for the collection of water samples containing volatile organic compounds. Peristaltic pumps are also suitable for metals and semivolatile organics if used with a rheostat to

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FIGURE 8.31 Matrix showing applications of a number of groundwater sampling devices.

Portable Sampling Devices		Device	Approximate Maximum Sample Depth	Minimum Well Diameter	Sample Delivery Rate or Volume	Ground Water Parameters: Inorganic: EC	pH	Redox	Major Ions	Trace metals	Nitrate, Fluoride	Dissolved Gases	Organic: Non-volatile	Volatile	TOC	TOX	Radioactive: Radium	Gross Alpha & Beta	Biol.: Coliform Bacteria
	Grab	Open bailer	no limit	$\frac{1}{2}$ in.	Variable	•			•	•	•		•				•		•
	Grab	Point-source bailer	no limit	$\frac{1}{2}$ in.	Variable	•	•	•	•	•	•		•	•	•	•	•		•
	Grab	Syringe sampler	no limit	$1\frac{1}{2}$ in.	0.01–0.2 gal	•	•	•	•	•	•		•				•	•	•
	Positive displacement (submersible)	Gear-drive	200 ft	2 in.	0–0.5 g/min									•					
	Positive displacement (submersible)	Bladder pump	400 ft	$1\frac{1}{2}$ in.	0–2 g/min	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Positive displacement (submersible)	Helical rotor	160 ft	2 in.	0–1.2 g/min	•	•	•	•	•	•	•	•	•	•	•	•	•	
	Positive displacement (submersible)	Piston pump (gas-drive)	500 ft	$1\frac{1}{2}$ in.	0–0.5 g/min	•			•	•	•		•				•	•	
	Positive displacement (submersible)	Centrifugal	variable	3 in.	variable	•			•		•						•	•	
	Suction lift	Peristaltic	26 ft	$\frac{1}{2}$ in.	0.01–0.3 g/min	•			•		•		•				•		•
	Gas contact	Gas-lift	variable	1 in.	Variable														
	Gas contact	Gas-drive	150 ft	1 in.	0.2 g/min	•			•		•		•				•		

Source: K. F. Pohlmann and J. W. Hess. 1988. Generalized ground water sampling device matrix. *Groundwater Monitoring & Remediation* 8:82–84. Used with permission.

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TABLE 8.5 Percent recovery of sampling devices compared with control samples.

	Water Depth					
	17.5 ft		54 ft		92 ft	
Sampler	Low[a] Conc.	High[b] Conc.	Low[a] Conc.	High[b] Conc.	Low[a] Conc.	High[b] Conc.
Submersible pump	97.8	99.7	99.5	98.5	100.1	100.1
Peristaltic pump	97.7	98.7	98.7	98.5	97.7	100.0
Bladder pump		101.5		100.5		99.9
Teflon bailer	93.9	96.3	92.4	93.9	92.7	91.4
Manual-driven piston pump	102.2	—	102.5	101.1	102.3	103.5
Motor-driven piston pump	97.4	96.8	99.8	98.4	100.9	100.7

Source: Tai et al. 1991.

create a low pumping rate. A bailer is acceptable if used properly with a minimum of agitation so as not to create splashing in the well and loss of volatiles. Bailers should have a bottom-emptying device. Such a bailer should be able to recover 90% of the volatile organics in the water.

Parker and Ranney (1996) examined the effect on using various rigid and flexible tubing used in water sampling devices on trace-level dissolved-organic compounds present in groundwater. They found that fluorinated ethylene propylene (FEP), FEP-lined polypropylene and polyvinylidine fluoride (PVDF) were the least absorptive of the rigid tubing. In addition, they do not leach constituents into water. Of these, PVDF is the least expensive. Where a flexible tubing is necessary, such as the head of a peristaltic pump, fluoroelastomer tubing and a copolymer of vinylidine fluoride and hexafluoropropylene were much less sorptive than the other flexible tubing. They also leached the fewest constituents into the water. The copolymer is less expensive than the fluoroelastomer.

Wherever possible, dedicated sampling equipment should be used in each well. This prevents the possibility of cross contamination between wells. It also eliminates the cost of decontaminating the equipment between wells and the possibility of interference from solvents used for decontamination. Inexpensive disposable bailers are available and may be an acceptable sampling device for many studies where the cost of dedicated sampling equipment in each well is not justified.

8.6.5 Methods of Collecting a Groundwater Sample Without Drilling a Well

The installation of a monitoring well is a costly proposition, generally in the range of $5,000 to over $15,000 USD for shallow wells in unconsolidated materials. Moreover, the process can be disruptive to the property owner and can damage lawns and crops. At some sites there may be limited knowledge about the direction of groundwater movement and the existence and location of contaminated groundwater. The hydrogeologist may find it desirable to perform some type of screening investigation prior to the installation of permanent monitoring wells. During the screening the

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hydrogeologist may try to find the location and depth of groundwater contamination. There are devices that one can use to collect a groundwater sample without installing a monitoring well. These devices, as well as a standard sandpoint piezometer, can be used during the installation of a test boring.

These methods all allow the collection of discrete samples in a vertical profile which gives one the ability to construct a vertical-concentration profile similar to that of a multilevel sampler. However, they have a drawback in that the samples cannot be replicated at a future date because the sampler is withdrawn after use.

The HydroPunch™ is one such device, a direct-push sampler, that can be used to collect a groundwater sample from a discrete depth in the earth (Edge and Cordry 1989). It consists of a pointed sampling probe that is attached to a hollow drill rod. The rod is pushed into the earth by the hydraulic ram of a drilling machine or cone penetrometer rig, or is driven into the earth by the dropping of a weight using a drilling machine. Such a device will obviously only work in unconsolidated materials. Moreover, HydroPunch I™ cannot be used in very coarse sediment. As a general rule, if a 2-inch split-spoon sampler cannot be driven into the earth, then the HydroPunch I™ will most likely be damaged if an attempt is made to drive it. A sturdier HydroPunch II™ has been made which can be used with cone penetometers or in conjunction with drill rigs. When the probe has been advanced to the target depth, the drive pipe is retracted about 1.5 ft (0.5 m). This raises a shield on the probe which exposes a stainless steel well screen that is 10 in. (25 cm) long. The probe has to be pushed at least five feet below the water table to completely fill the sampler. Hydrostatic pressure in the aquifer forces water to flow into the screen where it will rise into the probe until it reaches equilibrium with the hydrostatic pressure in the aquifer. Figure 8.32 illustrates the HydroPunch™ in both the closed and open positions. The screen openings in the HydroPunch™ are relatively large, and although water will enter relatively rapidly, the sample may be turbid. A check valve in the probe prevents water from draining back out of the screen and the entire assembly is withdrawn from the ground in order to retrieve the groundwater sample.

The BAT Enviroprobe™ is another type of discrete depth sampler (Mines et al. 1993). It is manufactured by Hogentogler & Co. Inc. of Columbia, Maryland. It is also pushed or driven into the earth to the desired depth by a drilling or cone penetrometer rig. When the drive pipe to which the probe is attached is pulled back about 1 ft. (0.3 m), a stainless steel sleeve is moved upward which exposes a 4-inch (10 cm) long screen. Figure 8.33 shows the BAT Enviroprobe™ in both a closed and an open position. There is a septum on the top of the screen which prevents groundwater from rising higher than the screen. The sample is collected by lowering a device with a double-ended hypodermic needle with an evacuated glass vial, which also contains a septum. The hypodermic needle penetrates both septa, and the water can move from the screen zone into the evacuated vial. The vial containing the groundwater sample is then withdrawn. Should this not contain sufficient sample volume, additional vials can be lowered through the riser pipe.

In the case of both the HydroPunch™ and the BAT Enviroprobe™, the water entering the screen is formation water and there is no need to either develop the well or purge it prior to sampling. This reduces the cost as the sample collection is quicker and also there is no contaminated purge and development water to dispose. Zemo et al. (1995) field-tested both the HydroPunch™ and BAT Enviroprobe™ and found that there was no statistically significant difference in trichloroethylene concentration found in

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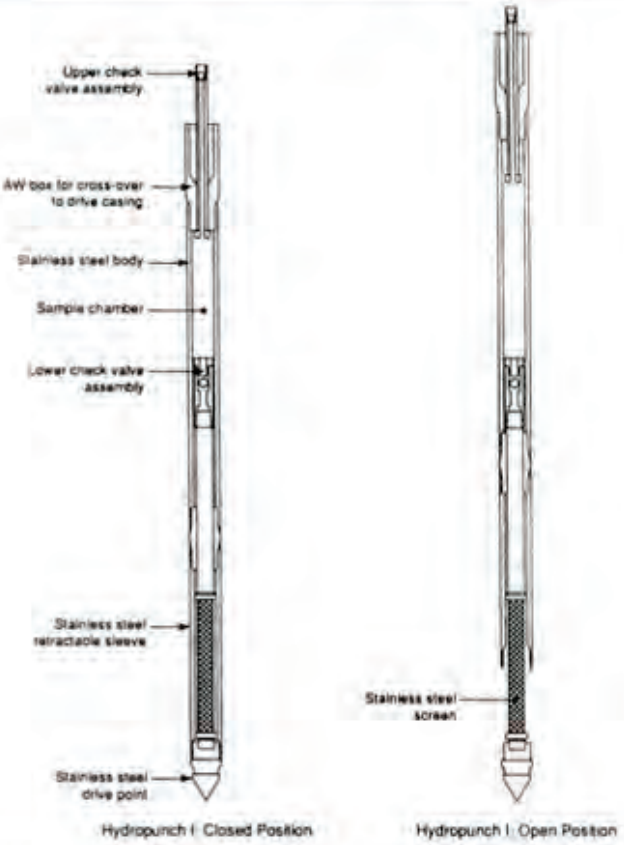
FIGURE 8.32 Closed and open position of the HydroPunch™ probe.



Source: Zemo et al. 1995. Field comparison of analytical results from discrete-depth ground water samplers. *Ground Water Monitoring & Remediation* 15:133–141. Used with permission.

groundwater samples collected from either probe. However, they did find that there was a difference in chlorobenzene concentration. They were unable to determine why such a difference should exist.

If the unconsolidated material is too coarse for the sampling probes to be pushed very far into the earth, then they can be used with a hollow-stem auger drilling rig. The drilling rig is used to install a test boring. At selected depths, either probe can be advanced within the augers and ahead of the drill bit to collect a groundwater sample. This approach has the distinct advantage of gathering stratigraphic data along with water-quality data. In the absence of a specific sampling probe, a standard 2-foot long sandpoint piezometer can be driven ahead of the drill bit to collect a water sample. In this case a bailer is used to collect the groundwater sample. After the water sample has been collected, the device is withdrawn from the borehole and the augers advanced.

8.6.6 Low-Flow Purging of Monitoring Wells

An important advance in contaminant hydrogeology field methods is the development of micropurging or low-flow purging techniques (Puls and Paul 1995). The purging techniques presented in section 8.6.3 are designed to remove all of the stagnant water in both the screen and the casing above the screen. The micropurging technique withdraws

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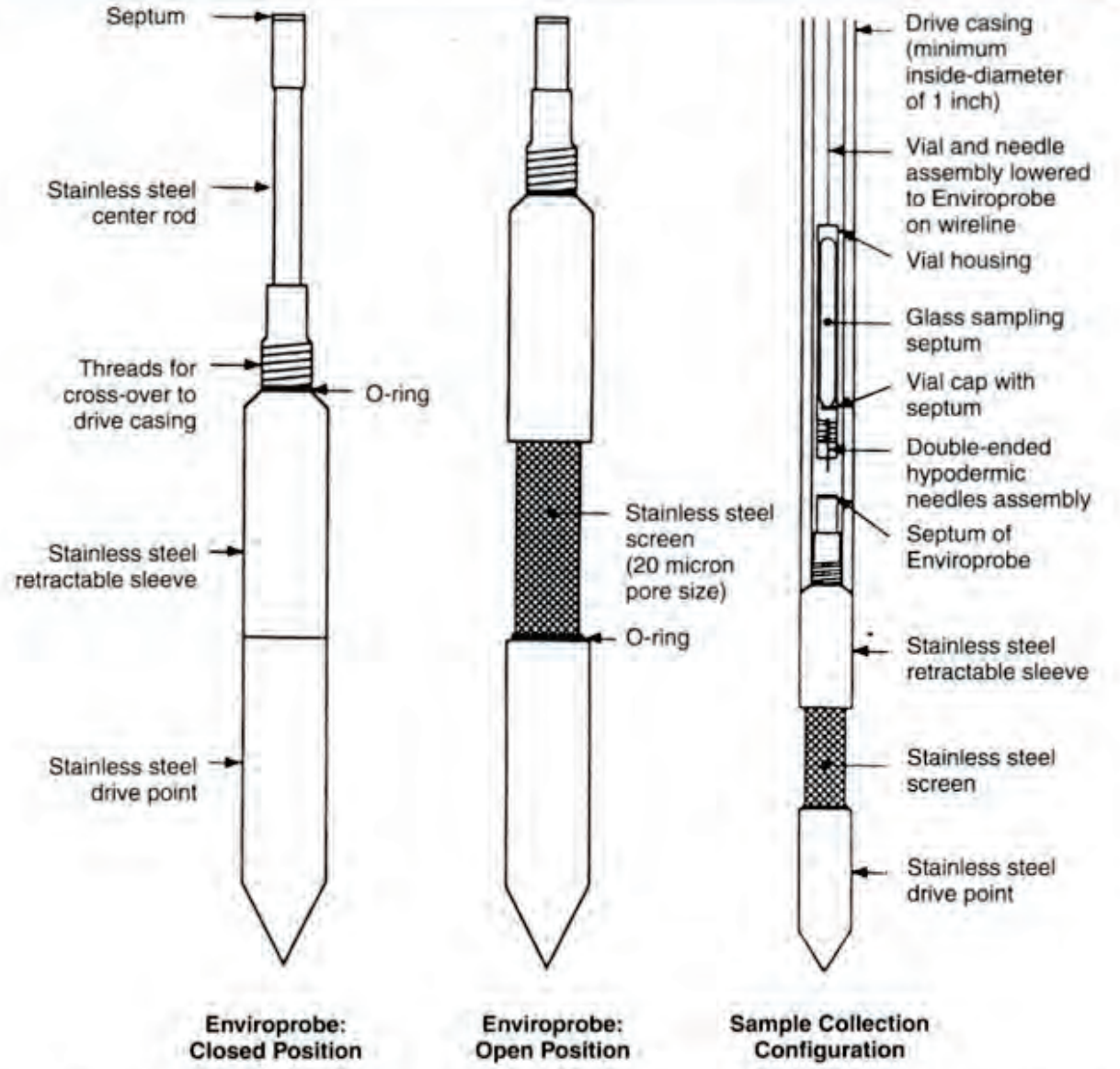
FIGURE 8.33 Closed and open position of the BAT Enviroprobe™ probe.



Source: Zemo et al. 1995. Field comparison of analytical results from discrete-depth ground water samplers. *Ground Water Monitoring & Remediation* 15:133–141. Used with permission.

water directly from the screen zone at a rate that is less than the recharge rate from the aquifer into the screen. The stagnant water in the casing does not mix with the fresh water entering the screen (Powell and Puls 1993). This purging rate is less than 1 L per minute; a suggested rate is only 100 mL/min. At this rate there is minimal drawdown in the pumping well and the water chemistry of the purged water tends to reach a constant value within one-half of a casing volume (Barcelona, Wehrmann, and Varljen 1994).

Micropurging is accomplished by using either a dedicated bladder or submersible pump with the intake set in the center of a well screen or a peristaltic pump with the end of the sample tubing set in the screen zone (Kearl et al. 1994). If a dedicated pump is not used, the pump should be placed in the well at least 24-hours prior to the time that the sample is collected. The purge rate should be about 100 mL/min, although

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somewhat higher rates could be used for very permeable formations. Two volumes of water contained in the pump and the tubing should be removed prior to collecting the sample. This will be much less than the volume of water in only one well casing. Samples do not need to be field filtered.

One of the problems that arises when sampling groundwater for metals occurs when the water sample is turbid. The turbidity is due to suspended mineral grains. These particles may contain sorbed metals. Some U.S. EPA programs and some U.S. state agencies prohibit the filtration of samples used for metal analysis as it is known that metals can travel in the groundwater with colloids (Puls and Powell 1992). However, turbidity in a sample can be caused by the process of lowering sampling instruments into the monitoring well (Kearl, Korte, and Cronk 1992) or by high screen-entrance velocities developed when significant drawdown occurs during purging. Micropurging techniques utilizing dedicated sampling equipment in each well will provide a sample with the least amount of artificially introduced turbidity. This will provide the best sample for use in determining total metals.

Kearl et al. (1994) compared samples collected by micropurging with samples collected by traditional purge and sample techniques. For most inorganic analytes and all organic analytes, there was no statistically significant difference between the two methods.

In addition to the ability to collect a nonturbid sample, there are other advantages of the micropurging technique. In some monitoring wells located in low permeability formations, traditional purging may withdraw most or all of the water from the well. This means that one must wait for a day or more for the well to recover enough water to yield a sample. This means that the sampled water was still stagnant for a period of time before being withdrawn. With a micropurging technique, a very low pumping rate could draw fresh formation water into the screen zone without much lowering of the water level in the casing.

There are two variable costs associated with groundwater sampling: personnel time and the expense of disposing of the contaminated purge water (Schilling 1995). With dedicated pumping equipment, the time for micropurging is generally less than that needed for traditional purge and sampling, hence the cost will be lower. The amount of contaminated water which must be disposed is much less in micropurging, hence the cost will be less.

While the impact of turbidity in a groundwater sample can have a significant effect on the concentration of metals in the sample, the same is not true for at least some chlorinated solvents. Paul and Puls (1997) examined the impact of sample turbidity on the concentration of trichloroethylene, cis-1,2-dichlorethylene and vinyl chloride. In both field and laboratory samples they found that solids entrained in the sample had no significant impact on the measured concentration of any of the three compounds. On this basis they concluded that turbidity in the sample does not appear to be of significance when sampling for VOC analysis. They did note that if the turbidity was the result of sample agitation that factor might result in loss of volatiles.

8.6.7 Sampling Frequency

Groundwater sampling is carried out commensurate with efforts to understand the nature and extent of groundwater contamination, predict future movement, ensure that harmful excursions of pollutants do not occur, facilitate remediation, and other goals

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pertinent to site characterization. Many regulatory agencies specify and sometimes codify periodic time frames for sampling of monitoring well arrays, such as monthly, quarterly, or annual sampling. These periodic samplings have the benefits of allowing practitioners to predict many costs in advance, and look for long-term trends in water quality. From a regulatory standpoint this makes sense, although natural events that can alter water quality are not always periodic. For example, in karst systems great changes in subsurface water quality can occur during pulse flow events, and perhaps in many cases the best monitoring strategies for cave systems include sampling immediately before, during, and after intense rainfall and infiltration. Regulatory monitoring requirements are sometimes wrongly viewed as the maximum effort necessary to understand and deal effectively with groundwater contamination, particularly if monitoring costs are to be minimized. In reality, although standardized monitoring intervals make regulatory expectations clear, a one-size-fits-all sampling frequency is not always the best way to understand subsurface contamination at a particular site. Long-term costs are typically reduced with a clear understanding of contaminant distribution and movement, and sometimes this necessitates more frequent, strategic sampling before remedial action and site closure is attempted.

■ 8.7 Other Site Characterization Methods and Groundwater Contamination Forensics

8.7.1 Introduction

Site characterization is much more than just identifying groundwater pollutants and measuring their occurrence in the subsurface. A challenge is that many well-defined characterization goals and objectives require a deep understanding of a site's geology, an understanding of groundwater travel times, knowledge of the chemical characteristics of potential contaminants, and awareness of logistical and safety concerns, just to name a few necessities. These complex objectives are often resolved by geologic testing, detailed environmental chemistry analysis, and environmental forensics.

There are many wide-ranging applications of site characterization techniques and groundwater forensics that support a robust understanding of source water protection, the potential for contaminant movement and transformation, groundwater vulnerability, and the integrity of aquitards or barriers which are relied upon to isolate waste. Numerous monitoring and characterization techniques have been, and continue to be developed, adding to the arsenal of methodologies to characterize subsurface contamination, and many of these methods rely on probes to be driven into the subsurface, measurements to be taken from boreholes, or samples to be taken from wells. In some cases contamination can be suspected based on field conditions. Field observations for NAPLs illustrate this point. For example, if DNAPL chemical concentrations in groundwater increase with depth in a pattern inconsistent with advective groundwater flow, or increase counter to a hydraulic gradient, there is support for the possibility of DNAPL being spread in its free phase. Other indicators of free-phase NAPL include situations where the aqueous concentration of NAPL compounds in groundwater is greater than 1% of the pure phase (for a single NAPL compound) or effective solubility limit (for NAPL mixtures). Note that the opposite is not true; concentrations

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below 1% may or may not be associated with free-phase NAPL. In soils where NAPL concentrations are greater than 10,000mg/kg (1% of soil mass) free phase can be suspected. Other qualitative signs of free-phase NAPL include erratic concentrations of NAPL chemicals in groundwater, soil, and soil gas; rebound of elevated dissolved NAPL concentrations after a pumping system is turned off; the presence of DNAPL chemicals in groundwater that is older than potential release dates; and observed deterioration of pumps and well components.

Quantitative methods can often be used as evidence in legal proceedings and the field of environmental forensics is based on efforts to distinguish pollutant sources (Morrison and Murphy 2006). Environmental forensics is defined by Hester and Harrison (2008) as "a combination of analytical and environmental chemistry, which is useful in the court room context. It therefore involves field analytical studies and both data interpretation and modeling connected with the attribution of pollution events to their causes." There are a vast number of techniques to determine the source and pathways of groundwater contamination that fall into the realm of forensic hydrogeology.

8.7.2 Borehole Geophysics and Downhole Techniques

Many geophysical techniques originally developed for oil and gas exploration are often used in drilled boreholes to define subsurface geology and hydrogeology, directly identify pollutants, and/or understand the potential movement and distribution of contamination. Downhole logging approaches will "ground truth" surface geophysical techniques and results can be directly compared to borehole cuttings or core samples. Like borehole cuttings and core, downhole geophysics provides vertically continuous data, but geophysical methods sample a greater subsurface volume with relatively little bias. As more boreholes are logged at a site and cross-borehole techniques are used, 3-dimensional imaging techniques (tomography) can assist visualization of contaminants and subsurface geological structures, faults, and formations (Obiadi et al. 2012). Downhole surveys have assumed great importance in contaminant site surveys because the specific site characteristics and heterogeneities in porous media and fractured rock can profoundly influence the distribution and the potential for remediation for a host of contaminants. Borehole geophysics can provide information directly applicable to site characterization, including delineation of hydrogeologic properties, subsurface water quality, and determination of a well's construction, status, and condition.

Physical, Visual, and Acoustic Borehole Geophysics Several techniques can measure the physical, visual, or acoustic properties of boreholes. One of the most straightforward downhole techniques is television (TV) logging where a color optical image is made of the borehole walls. This is particularly effective in identifying and characterizing fractures in hard rock materials, but can also identify lithology, water level, cascading water from perched zones (which could transmit contamination vertically), well construction failure, and water quality indicators such as suspended particles, gases, and chemical precipitates. TV logging can be viewed real-time and/or be stored and archived, and cameras and focal lengths can be adjusted to view either straight downhole, angled, or side-looking for inspection of borehole walls. An extension of TV logging is acoustic-televiewer logging which records a photographic, digital image of the acoustic reflectivity of the borehole, oriented magnetically. These televiewer logs

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are used in water or mud-filled open holes, and can identify geologic contacts between different strata, and fault location, strike, and dip. Televiewers use a rotating transducer which can transmit and receive many samples per revolution and have azimuthal information from magnetometers on the device. This acoustic or sonic logging can help determine the porosity of a rock, aid in identification of lithology, facilitate estimation of secondary porosity and fracturing, and help assess rock permeability. Seismic logging, which transmits sound at lower frequencies, can be extended to cross-borehole tomography where images of seismic velocity between boreholes is generated, and geologic and hydrologic properties between the boreholes can be better understood.

Another type of physical downhole measurement is a caliper log which measures the varying diameter of an uncased borehole. Variable borehole diameter can indicate the potential for material to fracture or slough away from the walls and into a borehole, and therefore be a sign of media which may transport contamination. Alternatively, hydrogeologically transmissive zones can be directly identified with flowmeter monitoring. Vertical flowmeter testing in a single hole involves moving a flow measuring device up and down a hole during pumping or during nonpumping times, pinpointing zones of high and low groundwater transmissivity. Single-hole flow metering can also measure the rate and direction of vertical flow which can cause pollutants to migrate, and show relative vertical hydraulic gradients. In cross-hole flowmeter profiling, a flowmeter is placed in one hole while water is added or withdrawn from another borehole at a constant rate, allowing calculation of transmissivities, head differences, or storage coefficient between the boreholes. Packer systems (see section 8.4.9) can further isolate individual fractures and/or test hydrologic properties at individual depths between holes. Impeller flowmeters (rotameters, spinners) are most commonly used for these measurements, but have less resolution than heat-pulse or electromagnetic flowmeters. Vertical measurement of water temperature in a borehole can also be useful. These temperature measurements can define hydrostratigraphic layers, vertical flow, and water-bearing zones. Vertical borehole flow is implied by temperature gradients that are inconsistent with the regional geothermal gradient which is typically about 2.5°C per 100 m (1°F per 70 ft.). Distributed temperature sensing (DTS) has been used in boreholes to delineate hydrostratigraphic heterogeneities by synoptically profiling temperature distribution changes from thermal dilution tests. These tests do not disturb the fluid column (Leaf, Hart, and Bahr 2012).

Gamma and Neutron Logging Other borehole logging techniques are useful in site characterization. Downhole gamma logging records the amount of natural gamma radiation emitted by a formation in the vicinity of a borehole. Specific sources of gamma emission are potassium-40 (^{40}K) and daughter products of uranium and thorium decay series which are common in clays and shale. This is because these geologic materials contain weathered products from potassium feldspar and mica, and are apt to concentrate uranium and thorium. Importantly, clay and shale typically have low permeability and are barriers to contaminant flow. Another technique, neutron logging, measures the amount of water in any particular vertical section of borehole. Energetic or "fast" neutrons are sent out into the formation surrounding the borehole usually from an Americium Beryllium (Am-Be) or Plutonium Beryllium (Pu-Be) source, and these neutrons are slowed down by collision with hydrogen ions associated with water. The returning "slow" neutrons are measured by a detector and indicate water bearing strata in the vadose zone, and water-filled porosity below the water table.

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Electrical Techniques in Borehole Geophysics Several borehole electrical techniques are available for site characterization. These include single point resistance logs, normal-resistivity logs, spontaneous-potential logs, electromagnetic induction logs, and fluid-resistivity logs. Single point resistance logs measure the electrical resistance between selected points in the borehole and an electrical ground on the surface, and are useful for understanding lithology, water quality and the amount of fracturing in hard rocks. Interpretation involves identifying zones of increasing resistance associated with small diameter boreholes, whereas lower resistance is related to saline water, large borehole diameter, and highly fractured media. Normal-resistivity logs record the resistance to electrical flow immediately outside an open, uncased borehole, and interpretation generally is similar to that of single point resistance measurement. Normal-resistivity logs typically involve deployment of a string of vertically displaced electrodes in a single hole.

Electromagmetic-induction (EM) logs also measure electrical conductivity or resistivity immediately outside a borehole and are excellent for indicating porosity, permeability, clay content, and total dissolved solids in fluids. Further, EM and other electrical techniques are proficient in identifying landfill leachate and saline water intrusion. EM borelog techniques are designed to optimize readings outside the borehole and minimize influence of the borehole and borehole fluids. Conversely, fluid-resistivity logs are geared toward examining borehole fluids, particularly the dissolved salt and solid concentrations.

Other Borehole Geophysical Techniques One versatile monitoring procedure for organic compounds is laser induced fluorescence (LIF) that uses laser light to excite fluorescent molecules in petroleum products. The excitation is specific for PAH compounds, but nearly all petroleum products contain some PAHs. LIF field measurements utilize a direct push logging arrangement which allows vadose zone and aquifer material to be examined at depth below ground surface. Further, LIF can distinguish different NAPLs in the subsurface using the intensity of the fluorescence in the media, its spectral signature, and the lag time between the laser pulse and emission of fluorescence. The laser light is transmitted down and uphole by two separate fiber optic threads, and the signal is processed and analyzed in real time.

Fiber optic chemical sensors (FOCS) are a variant of LIF and have been developed using a sensor for analysis of soil, air, or water that records changes in light absorbance, reflectance, fluorescence, and light polarization of the medium. Unlike LIF which just uses fiber optics to transport light down and uphole, FOCS uses the fiber optic cable as an integral part of the sensor. Specifically, part of the fiber optic cladding is removed from the cable in the sensor and replaced with a chemically selective layer that, when placed in the sample media, reacts with a specific analyte of interest. Raman spectroscopy is used to identify specific metals and organic chemicals. The detection limits are typically in the ppm range for VOCs.

8.7.3 Water Quality Indicators of Groundwater Provenance and Movement—Tracers

Beyond sampling water for contaminant concentrations and conducting geophysical surveys for defining subsurface geology, there are many other methodologies and water-quality indicators pertinent to site characterization. The chemical mixtures in measured contaminants and certain characteristic compounds (or "tracers") can be

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key indicators of pollutant source, travel pathways, and transformation. Tracer techniques for groundwater can be divided into water quality surrogates that are either (1) chemicals added to aquifer systems or to potential contaminants in regions where subterranean flow is expected to be rapid, or (2) "environmental tracers" which are groundwater quality changes which have occurred over longer periods of time in groundwater. The former includes dyes and chemicals intentionally added to track movement and flow, and the latter refers to "natural or anthropogenic compounds or isotopes that are widely distributed in the near-surface environment of the Earth, such that variations in their abundances can be used to determine pathways and timescales of environmental processes" (Cook and Böhlke 2000).

Payne et al. (2008) and Suthersan et al. (2014) present guidance for tracer selection, tracer test design, and data interpretation. An optimal groundwater tracer is highly detectable, mimics either groundwater or pollutant movement, is chemically stable for a desired length of time, has little background concentration in the groundwater being investigated, is not sorbed or filtered by the geologic media, and does not have adverse health or ecological effects (Davis et al. 1980). Conservative compounds that are not sorbed or retarded in their flow are particularly useful and these include chloride, bromide, iodide, nitrate, sulfate, and boron. These compounds can reflect groundwater origins with less ambiguity than other dissolved species, because they are often present in groundwater and some, like boron, are relatively unaffected by evaporation or chemical reactions (Barth 1998; Bassett et al., 1995; Vengosh 1998).

Dyes and Injected Tracers, Artificially Introduced Tracers In many fast-flowing (e.g., karst, carbonate rock, and caves) groundwater systems, tracer dyes can be released to track direction and travel times of flow. Optimal systems typically transmit water and pollutants quickly, which is advantageous because a long waiting time for the re-emergence of injected tracers is not favorable. Tracers can be artificially injected into wells, sinkholes, caverns, and disappearing streams in karst terrain. Popular tracer dyes include fluorescent dyes such as fluorescein which was developed over 145 years ago, pyranine, lissamine FF, photine CU, amino G acid (7-amino 1,3 napthalene disulphonic acid), optical brightners, and a variety of rhodamine dyes. A downside of some of these dyes is that some have negative health effects. Dyes can be used either qualitatively by visual observation, or collected with adsorbing devices to quantitatively measure flow. A simple adsorption apparatus involves placement of a charcoal packet along expected pathway of subterranean flow. More sensitive devices include filter fluorometers and spectrofluorometers which can determine specific fluorescent wavelengths, quantify flow more accurately, and distinguish background fluorescence and other interferences. In addition to the tracing of natural waters, dyes can help determine pipeline leaks. Nonpolar fuel dyes can be added to demarcate different fuel types and are required in some countries. This can help distinguish the individual impacts of multiple fuel leaks of similar types, but from different sources.

Things other than dyes can be injected as tracers of groundwater flow. A common tracer for groundwater is chloride (Cl^-) which is a component of common table salt. Care must be used when using ionic tracers so that the concentration of salts added to groundwater does not change its density and subsequently impact natural groundwater flow. A more unusual tracer that has been used in cave systems is a signal emitting float which has a delayed explosion. The seismic signals emitted from these generated

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impulses can help locate subsurface passages. Other tracers that have been used with varying degrees of success include silicic acid, boric acid, phosphoric acid, acetic acid, alcohols including ethanol, sugars (sucrose, maltose, dextrose, glucose), and glycerol (Davis et al. 1985). Each of these tracers has disadvantages: acid can react with aquifer material, sugars decompose rapidly, and alcohols tend to be absorbed onto organic material (which can actually be used to advantage by measuring partitioning into suspected organic contaminants).

Tracers developed for contaminant hydrogeology include a class of compounds called partitioning tracers. These newer methods involve circulating a suite of tracer compounds, not just a single tracer, in the subsurface to measure how some tracers are slowed by contaminant mass, particularly a mass of nonaqueous phase liquids. Partioning tracers measure groundwater flow and the mass of a stagnant immiscible liquid pollutant blocking groundwater's path by observing the differential tracer retardation. The underlying principles of this tracer method have been discussed in Chapter 3.

Scientific developments include the study of colloidal tracers and smaller, nanoparticle tracers. These colloidal tracers have included yeasts, bacteriophages (viruses), fluorescent latex microspheres, bacteria (living and dead), spores (Lycopodium and vegetative spores), and other nanoparticles (Davis et al. 1980; McKay et al. 2000; Zhang et al. 2015). Solid tracers are larger than dissolved aqueous tracers and have the negative possibility of being sieved or filtered through porous media and small-aperture fractured media. Larger particle tracers do, however, have the positive quality of not being absorbed in the rock matrix. Occasionally, solid tracers have been observed to move faster than average groundwater velocity—this has been explained by the notion that larger particles move through larger pore spaces or fracture apertures where groundwater velocities are higher than average (Zhao 2015).

Gases can be used as tracers of vapor migration, and of liquid migration by injection and dissolution of gases into groundwater. Inert radioactive tracer gases have been considered, such as xenon (^{133}Xe) and radon (^{222}Rn), particularly in identifying groundwater/surface water interaction, but health concerns and a short half-life for radon are inhibitory (Xie et al. 2016). Noble gases of helium, neon, argon, krypton, and xenon are other potential tracers as their natural background in the environment is low. Chloroflourocarbons (CFCs or Freon® compounds), also have low environmental background and have been used for both groundwater and gaseous tracer experiments (Thompson et al. 1974, Weeks et al. 1982; Kreamer et al. 1990).

Environmental Tracers Environmental tracers which show water-quality patterns and changes do not have to be injected by site investigators, and are directly relevant to understanding a contaminated site. Some of these tracer signals arise due to natural fluctuations in local, regional, or global conditions, while others reflect anthropogenic influences and activities. Some take advantage of short term changes. For example, diurnal temperature fluctuations can be used to define gaining and losing reaches of streams. Probes placed in bottom sediments of streams that show daily temperature variation can be associated with losing reaches as water, affected by daily conditions, infiltrates. Conversely, steady temperatures in stream bottom sediments can be indicative of a gaining groundwater contribution to a stream through the sediments, as most groundwater is typically more constant in temperature. Other tracer signals arise from longer-term changes in climate, recharge differences, or substances that humans

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introduced into the environment decades ago. Compounds and isotopes that have leaked into the atmosphere from human activities (e.g., chlorofluorocarbons from refrigerants, radionuclides from testing of nuclear weapons) return through rainfall to the vadose zone and groundwater, and allow dating of groundwater age, whereas pharmaceuticals, personal care products, and specific compounds in some foods (e.g., caffeine) are not readily removed by sewage treatment and become tracers of wastewater release into the environment.

The source of a pollutant strongly influences its chemical makeup, and chemical differences from dissimilar sources can be used to trace and track environmental contamination. Biogenic gaseous mixtures containing methane are typically "dry" which means a higher concentration of methane and light hydrocarbons, whereas thermogenic gases and those from pipelines have less light 2 to 4 carbon compounds (C2s to C4s) and are "wet" with a higher concentration of 5 carbon (C5) and higher molecular weight compounds. Landfill gases are often approximately half methane and half carbon dioxide with an absence of oxygen. Natural gas derived from dewatering of coal layers, an extraction process whose retrieved product is called "coal seam gas" or "coal bed methane," is typically higher in methane than natural gas extracted from other sources and is therefore sometimes called "sweet gas." Crude oil and coal from different regions of the world have different chemical constituents which can be tracked, for example differences in the amount of sulfur compounds designates different quality of crude oil. The petroleum industry has noted that uptake of sulfur into plants is possible. Because different isotopes of sulfur can fractionate in different ways, the transport and fate of sulfur bearing compounds can be further tracked. Also, natural gas in pipelines in municipal and urban settings typically has noxious smelling mercaptan added so that leaks of this normally odorless gas are readily noticeable and are often reported. The added gases which allow leak detection and tracking sometimes have descriptive names like Cadaverine and Putrescine.

Human sewage and animal waste have a host of associated compounds and microbes which can be used to track their contamination in groundwater systems. Bacterial indicators, like Escherichia coli (*E.coli*) are useful, but often can be filtered out in porous media, whereas bacteriophages and human viruses are smaller and can travel farther. When microbes occur in groundwater they can indicate source by phenotype, genotype, and speciation (some microbes are more associated with human waste and others with ruminant species). Some genera and species of bacteria studied as indicators differentiating human from other mammalian waste include: *E.coli*, relative amounts of fecal streptococci and fecal staphylococci, *Bacteroides* spp., *Rhodococcus coprophilus* (animal herbivores), *Clostridium perfringens, Bifidobacterium adolescentis* (human), and *Bifidobacterium thermophilum* (animal). Other tracers of human and animal waste include: sterols, steroid estrogens (found in human sewage outfall), fatty acids and lipids, surfactants and detergents, caffeine (human ingestion and sewage outfall), triclosan (an antibacterial and antifungal agent found in hand soaps, body washes, toothpastes, and some cosmetics—sewage outfall), and sewage/septic tank related nonylphenol ethoxylate metabolites (Swartz et al. 2006).

Ionized substances have been used both as artificially injected tracers and measured as natural environmental tracers indicating source. There are a large number of ions which can be tracked and traced, and these substances do not decompose with

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time. Historically, those chemical species with high concentrations, easy detection, and low sorption have been the most popular. This includes negatively charged anion species which are repelled by negatively charged clay surfaces and therefore resist sorption. Traditional tracer ions include Cl^-, Br^-, Li^+, NO_3^-, NH_4^+, SO_4^{--}, Mg^{++},K^+, B, and I^-. Of these, Cl^- and Br^- are the most popular. Organic anions have been used as tracers, including benzoate. Metal complexes with chelating agents have been used to track groundwater flow, balancing the need for a detectable tracer with the potentially negative health effects of mobilizing a heavy metal pollutant (Davis et al. 1980). With the advent of Inductively Coupled Plasma Mass Spectrometers (ICP-MS) investigations of naturally occurring trace elements to identifying groundwater pathways increased (Stetzenbach et al. 1994; Kreamer et al. 1996; Johannessen et al. 1997).

Importantly, CFCs have also been used for dating recharge from precipitation, because the first wide use Freon® refrigerants began after 1930, and subsequently increasing amounts of gaseous CFCs leaked into the atmosphere and mixed with precipitation, eventually infiltrating the ground surface and recharging groundwater. CFCs were also used as aerosol spray can propellants, but because they contribute to ozone layer depletion in the atmosphere, their use has been phased out under the Montreal Protocol. CFCs are greenhouse gases with an approximate residence time in the atmosphere of 65 to 130 years and their abundance or absence in groundwater is an indicator of groundwater age. The ratio of CFCs to SF_6 (sulfur hexafluoride) has a groundwater dating age range of about 1 to 40 years.

8.7.4 Water Quality Indicators of Groundwater Provenance and Movement—Groundwater Composition, Compound Ratios, Daughter Products, Degradation Indicators, and Other Indicator Compounds

A considerable number of methods to track, trace, and date groundwater contamination rely on looking at the changing composition of pollutant compounds, associated chemicals, and differences in the chemical nature of multiple sources. Identifying and utilizing compositional differences is a powerful tool in understanding groundwater and contaminant flow.

Inorganic Indicators One of the simplest ways to distinguish different sources and transformation of contaminants is by analyzing groundwater chemical quality and compound ratios. Significant analytical chemistry advancements have been, and continue to be, made since major anions and cations were first measured in groundwater, but these ions, and the ratios between these ions (particularly the more mobile anions) continues to be a source of groundwater definition. Piper, Stiff, and Maucha diagrams visually portray the major ionic components of water quality and can indicate groundwater provenance. Ratios of ions can also be used to distinguish waters. For example, a common anion comparison used to trace groundwater has been the Cl^-/Br^- ratio. Davis et al. (1998) report on many of the uses and applications of this ratio, including determining the origin and evolution of salt water and brines, and studying salt in potable groundwater. Factors which can affect this ratio include distance from the ocean, dry lake beds, or other sources of salt, including pollution (Davis et al. 2004; Alcala

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and Custodio 2008). These ratios have been used to track septic tank pollution in the United States (Katz et al. 2011). Other useful ratios are total inorganic carbon to total organic carbon ratios, and carbon to nitrogen ratios.

Mining operations for various metals often can have more than one metallic species that can enter groundwater, or mobilizing agents and additives associated with the particular extraction method and target metal. These other species and additives can often be used to track the influence of mining operations on groundwater systems. Several metals, metalloids, and nonmetals can often be found together in metal extraction and mining (e.g., it is possible to observe combinations of uranium, copper, arsenic, gold, silver, vanadium, sulfur, thorium, lead, zinc, or others from some precious metal operations). Other types of mining undertakings have other potential tracers released into the environment. *In situ* leach mining typically uses an injected lixiviant to dissolve and mobilize extractable metals, and these lixiviants can be used as one indicator of potential contaminant migration, with the cautionary note that while a rapidly moving lixiviant can give early warning of potentially slower-moving contamination, the disappearance of the lixiviant does not necessarily indicate the disappearance of the spectrum of potential groundwater contaminants at a mining site. Metals can also be used as surrogate tracers for energetic compounds, that is propellants, explosives, and pyrotechnics (PEP) compounds. For propellants and some fuels particularly linked with the rocket fuel oxidizer perchlorate, Cr^{+3}, Cr^{+6}, Cu^{+2}, and Zn have been evaluated as surrogates. Surrogate compounds in fireworks and flares include Na, K, Ba, Cu^{+3}, Sb, Sr, Al, As, and Cr^{+5} (Motzer 2001).

Organic Indicators Organic compounds, particularly mixtures of organic chemicals, have a wide range of sources, additives, and degradation products which can be tracked in groundwater (Chapter 7). The differing rates of degradation of the compounds in subsurface organic mixtures produce changes in the ratios of those compounds and of generated daughter compounds. Many organic mixtures have unique source compositions and all eventually weather and transform with time. Hydrocarbon fuels in particular have different compositions, depending on fuel type and additives. These differences serve as distinguishing features when several different fuels have leaked or have been spilled. Fuels and oils normally consist of mixtures of hundreds of compounds, and different fuel types have different dominant ranges in the number of their carbon atoms. Crude oil has compounds that range from having one or two carbon atoms (C1 and C2) to compounds with close to sixty (C60). Crude is fractionally distillated to establish different types of hydrocarbon products, and different additives are put in for these varied purposes. Gasoline for cars (petrol) and small airplanes (aviation gas or AV-gas) typically have light hydrocarbons predominantly ranging from the 4 carbon compounds (C4) to about the 11 or 12 carbon range (C11 to C12). Kerosene is a heavier fuel with approximately the C8 to C17 compounds, diesel fuels are roughly in the C8 to C24 range, the jet fuel JP-4 is about C5 to C14, and JP-8 and Jet-A approximately C8 to C18. Stoddard solvent, which was used in the past as a dry cleaning fluid, has a typical petroleum distillate fractions of C7 to C12, heavy fuel oils are generally between C8 and C50, bunker fuel used in ships are approximately C10 to C26, and lubricating oils are even heavier with carbon numbers around the C14 to C50 range. Other residuum from crude distillation often have more than 20 carbon atoms in their constituent compounds, with waxes ranging approximately from C20 to

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Darrah et al. 2013). Recently, examining methane in concert with noble gases in stream beds has been used to identify thermogenic methane fluxes from groundwater overlying regions of shale gas development (Heilweil et al. 2015). Methane isotopes as well as dissolved organic carbon and tritium have been use to evaluate connectivity between aquifers and underlying coal seam gas operations (Iverach et al. 2015).

Quantifying the uptake of nutrient compounds during biodegradation and the resultant production of daughter products and residuals are ways to monitor the rates of transformation of organics. Petroleum degradation is normally an aerobic process which uses oxygen and produces carbon dioxide; by monitoring the extent of change in these compounds one can calculate the rate of biodegradation and, importantly, determine whether the plume is moving faster than the rate of natural or augmented pollutant attenuation.

Harmful compounds can have additives or impurities which are not only good tracers in the environment, but they can be pollutants in their own right. Chlorinated solvents have several stabilizers. For trichloroethene (TCE), 1,4 dioxane is an important stabilizer used to facilitate transport and storage in aluminum containers. It is itself considered a solvent with negative health effects. The ratios of the chlorine-35 to chlorine-37 can be another way to fingerprint chlorinated solvents. Another example of mixtures and impurities is polychlorinated biphenyls (PCBs) which are never a pure, single compound, but mixtures of PCBs by the nature of their manufacture. PCBs can also have co-contaminants of polychlorinated dibenzofurans and polychlorinated naphthalenes. The nature of the mixtures can be a good source of differentiation, and the disparity in the degradation rates of contaminants, additives, impurities, and inert compounds can indicate age and source.

Historically, pesticides were mixed with some hydrocarbon fuels to apply them to crops. Many of these pesticides have comingled substances (some inert) and trace substances (e.g., dioxins and furans) which can help fingerprint their spatial distribution at a site. Like PCBs above, the source and age of pesticide releases can be established by comparing the ratio of inert and degrading compounds.

8.7.5 Water Quality Indicators of Groundwater Provenance and Movement—Isotopic Identification of Pollution Sources and Groundwater Pathways

The measurement and evaluation of stable, radioactive, and radiogenic isotopes has played an important role in hydrologic and geologic investigations, and are equally consequential in the characterization of contaminated sites. Because physical, chemical, or biological transformation of a contaminant can alter the compound's original isotopic ratios (fractionation), transformation processes can often be distinguished from contaminant dilution (which typically does not alter these ratios). The mathematics of Rayleigh distillation to quantify isotopic fractionation accompanying phase changes and chemical reactions are well known, and make available numerical estimates of the magnitude of isotopic change. The analytical detection of isotopes in groundwater and vapors is rapidly advancing, with the required sample volumes becoming smaller, and analyses becoming faster, less expensive, and routine. From older methods like scintillation counting of radioisotopes which required large volumes of water, through

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isotope ratio mass spectrometry advances, to new analytic techniques such as Laser Isotope Ratio Infrared Spectrometry IRIS, which can be portable and field deployable, the analytical chemistry underpinnings of contaminant surveys has increased the ability of the contaminant hydrogeologist to assess a site and its properties. Accelerator mass spectrometry (AMS) can sometimes separate atomic isobars (for example nitrogen-14 from carbon-14) and makes possible the detection of many isotopes, including many that are long-lived. AMS has been applied to the analysis of many isotopes including ^{36}Cl, ^{10}Be, ^{14}C, ^{3}H, ^{129}I, ^{26}Al, ^{236}U, ^{240}Pu, and ^{210}Pb.

Applications of isotope hydrology to challenges of groundwater movement and source are numerous, diverse, and are used worldwide. Isotope hydrology has been used to ascertain renewable and nonrenewable, deep groundwater in Syria (Al-Charideh and Kattaa 2016), the origin of groundwater in the Negev Desert (Vengosh et al. 2007), preferential flow along faults in Germany (Gumm et al. 2016), altered spring flow quality in Grand Canyon National Park in the United States (Ingraham, Zukosky, and Kreamer 2001), assessment of fluid inclusions at the proposed nuclear waste repository at Yucca Mountain, Nevada, as evidence of a hypogene paleohydrogeological event (Dublyansky and Spötl, 2010), baseline measurement and assessment of methane concentrations of a well in Alberta, Canada (Humez et al. 2016), and has been employed for countless other assessments at locales around the globe.

Tracing Groundwater and Pollution with Isotopes More than fifty years ago, paleoclimatologists and environmental geochemists began using the stable isotopes of hydrogen and oxygen to track meteoric water movement on the environment (Craig 1961; Dansgaard 1964). An equation showing the average relationship between these isotopes was established (the global meteoric water line) and variations due to temperature, seasonality, precipitation and recharge altitude, latitudinal relationships, and paleo-effects were key in understanding global water movement, including groundwater source and pathway. Because surface waste impoundments (ponds, pits, and lagoons) have the potential to partially evaporate water, then have the remaining surface water leak into the subsurface, isotopic fractionation during evaporation of water is particularly important to contaminant site characterization studies. Evaporated water has a lighter isotopic composition, enriching the remaining liquid with heavier isotopes which can often be tracked into the subsurface, distinguished from background groundwater isotopic signatures, and used to establish mixing ratios of leaked, contaminated water to natural background groundwater signatures. For very old groundwater, past climatic change can be observed and contribute to studies of aquifer isolation and aquitard or aquiclude integrity. Aquitard integrity and the origin of pore water has been investigated in Canada for mining operations and potential nuclear waste storage by comparing Pleistocene age versus modern stable isotope ratios, below and above thick aquitards (Hendry et al. 2013; Hendry et al. 2015). The stable isotopes of water are hydrogen and deuterium, and oxygen-16 and oxygen-18.

The stable isotopes of nitrogen (nitrogen 14 and 15) in concert with those of oxygen have been used to discern anthropogenic sources of nitrate, nitrite, and ammonium in groundwater. These contaminant sources can include septic tank effluent or wastewater, animal manure, and mineral fertilizers, and can often be distinguished by isotopic ratios. Because there is some overlap and ambiguity between isotopic composition in

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wastewater and animal manure, and denitrification processes in the subsurface can result in fractionation after nitrate release, additional indicators can be used to help tell different sources apart. Distinguishing co-contaminants from agriculture can include herbicides, pesticides, and major ions and trace elements from soil amendments. From wastewater, co-contaminants can include pharmaceutical compounds, residuals from personal care products, caffeine, and artificial sweeteners. Some animal feeds contain unique inorganic additives as well. Relatively conservative stable isotopes of boron (10 and 11) have also been used to make a distinction between wastewater and animal manure (Eppich et al. 2012). In China, stable isotopes of hydrogen, and oxygen and sulfur have been used to delineate the sources of anthropogenic nitrate and sulfate groundwater pollution (Li et al. 2006). Sulfate isotopic values indicated much of the pollution came from recharge of air pollutants from the combustion of coal, with some contribution of sulfur additives in fertilizer.

Mining residuals and mineral waste products can be distinguished by isotopic analysis. In uranium oxides, stable isotopes of oxygen can help distinguish anthropogenic mining activities from natural background as can activity ratios of uranium-234 to uranium-238. $^{234}U/^{238}U$ ratios are close to 1, (secular equilibrium) near uranium mining outfall, whereas naturally occurring uranium background in groundwater often has a higher ratio, particularly in old groundwater. Conversion of ^{238}U to ^{234}U can further be examined by its concurrent production of alpha particles, ^{4}He. Another isotope, uranium-236 is dominantly anthropogenic, is found in spent nuclear fuels and some reprocessed uranium, and can therefore help trace nuclear waste leaks. Plutonium (Pu) is also of human manufacture, and while trace amounts can be found in nature (parts per trillion in groundwater) larger concentrations of this fissile material indicate contaminant excursion. A potential nuclear waste product and tracer is technetium-99 which is the most significant long-lived fission product of uranium.

Other mining and industrial by-products, including metals and salts, can be characterized with isotopic analysis, sometimes in conjunction with other approaches. For example, stable isotopic analysis of chromium species in groundwater can give a picture of the natural reduction of mobile and harmful Cr(VI) to less problematic Cr(III). It can also characterize the extent and rate of Cr reduction during remedial activities. Another industrially produced compound which has been found in groundwater, and is an endocrine disruptor in humans, is perchlorate. Perchlorate has some naturally occurring salts, but is mostly generated by industrial processes especially for the production of rocket fuel oxidizers. Tracking the compound in the environment has included measurement of the oxygen and chlorine isotopes of perchlorate itself as well as other isotopic ratios and attendant compounds. Other useful isotopic analyses for perchlorate tracking are stable isotopes of strontium, nitrogen, and tritium, and isotopic ratios of $^{37}Cl/^{35}Cl$, $^{87}Sr/^{86}Sr$, and $^{16}O/^{17}O$. Some of perchlorate's additional surrogates in groundwater that can assist in source identification and age dating include: nitrates, sodium, chlorides, strontium, phosphate, metals, and nitroglycerins (Morrison and Murphy 2006). These methods can help determine whether perchlorate in the environment is natural or synthetic.

Isotopes and Groundwater Dating Isotopes are also used for characterizing the fate and transport of organic compounds. Processes affecting dense chlorinated solvents

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and other volatile organic compounds can be evaluated using chlorine isotopes which are fractionated during biodegradation, but are unaffected by dilution and dispersion. MTBE biodegradation can be analyzed with isotopic analysis, the difference between production methane from natural, shallow biodegradation versus leaks from pipelines or production wells can be ascertained. When a compound such as trichloroethene is discovered at a site, compound specific isotopic analysis can help determine whether it is a daughter product of previously spilled tetrachloroethene, or a leak in and of itself.

Site characterization involves understanding groundwater flow and travel times. Isotopic techniques are pivotal in age dating of groundwater, and there are different approaches depending on groundwater's suspected residence times. Relatively young groundwater is often dated by using radionuclides released into the atmosphere during past nuclear weapons testing. For example, tritium (^{3}H), with a half-life of 12.4 years, with its decay product ^{3}He, provides a useful tracer of recently recharged groundwater. When calculating groundwater age from tritium, adjustments to $^{3}H/^{3}He$ ratios must be made if there is terrigenic helium in the groundwater from the earth's mantle or crust. Tritium to helium-3 ratios are most effective at dating groundwater 0.5 to approximately 40 years old. Another dating technique for modern groundwater 10 years old or younger uses krypton-85, which is produced by nuclear reprocessing and has a similar half-life to tritium, and comparable dating range as well. Nuclear bomb-pulse chlorine-36 is also used to date young groundwater recharged after the 1950s, but in lower, natural concentrations in deep systems can also be used to evaluate submodern groundwater that is 50,000 to a million years old. Methods for dating submodern groundwater (>1,000 years since recharge) include radiocarbon dating (carbon-14). The amount of ^{14}C (half-life 5,730 years) in groundwater can indicate when it was last in contact with the atmosphere, but care must be taken to account for uncertainties due to potential groundwater interaction with carbon from other sources, such as the "dead" carbon in limestones and other carbonate rocks which has no ^{14}C. In optimal conditions ^{14}C can be used to date groundwater about 1,000 to 40,000 years old and can sometimes be used in concert with argon-39 (half-life 269 years). Silicon-32 has the beneficial aspect for groundwater dating of having a half-life of 140 years which allows it to fill a gap between tritium and carbon-14 dating, but its loss and interaction with solid phase silica in an aquifer and analytical difficulties have limited its use. Uranium isotopic ratios are also a useful groundwater dating tool. $^{234}U/^{238}U$ ratios (called uranium isotope disequilibrium) typically increase with groundwater age and can be used to give approximate ages from 10,000 to one million years old. Some isotopes with long half-lives have the potential to date very old groundwater with applications for understanding the isolation of deep contaminant burial, nuclear storage, or deep waste injection. These include iodine-129 (half-life 15.7×10^{6} years), krypton-81 (half-life 2.29×10^{5} years), and Xeon-139 (half-life 2.165×10^{21} years).

8.7.6 Water Quality Indicators of Groundwater Condition—Microbial testing and Genome Sequencing

Studying subsurface microbiology at contaminated waste sites allows groundwater professionals to calculate the rate of natural attenuation of pollutants, the efficacy of amendments added to groundwater to enhance contaminant breakdown, and the

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8.8 Summary

Site characterization involves goal setting and outcome definition, use of noninvasive techniques, followed by strategic application of invasive methods of investigation. In order to collect data for groundwater contamination studies, it is usually necessary to install monitoring wells. Such wells can permit one to measure water levels, collect water samples for analysis, and detect the presence of nonaqueous phase liquids.

Monitoring-well design considers the type and diameter of casing and screen, the material from which the casing and screen is constructed, and whether the well will have an artificial-filter pack or be naturally developed. The annular space between the casing and the borehole must be properly sealed, and the well needs a protective covering. Monitoring wells may be installed by hollow-stem auger drilling, mud-rotary drilling, air-rotary drilling, reverse-rotary drilling, and cable-tool drilling. The equipment used for monitoring-well installation and the material used for the well must be properly decontaminated. Once installed, the well needs to be developed to remove fine material from the area outside the well screen. Water-table wells are installed to monitor the water table and piezometers are used to monitor formations below the water table. Frequently, a water-table well and several piezometers are installed at the same location to form a nest of wells to sample the formations at different depths. Multilevelmonitoring devices may be used to collect samples from very closely-spaced vertical intervals.

There are a number of sampling devices that have been developed to withdraw water samples from monitoring wells. These include bailers, bladder pumps, stator-rotor pumps, piston pumps, and peristaltic pumps. The ability of these devices to collect an unbiased sample varies with the design, technique used, and material from which they are constructed. Prior to sampling a well, it is necessary to purge it to remove stagnant water from the casing. Micropurging techniques result in a water quality sample that is as free of turbidity as possible and at a lower cost than traditional purge and sample techniques due to a shorter time to collect the sample and reduced costs for disposal of contaminated purge water. Soil water must be collected through the use of a suction lysimeter. These are installed in boreholes above the water table. Soil gas vapor can be sampled through active probes that withdraw soil gas samples for analysis or passive devices that sorb soil gas onto activated charcoal devices. Monitoring soil gas can indicate areas where the soil has been contaminated and requires remediation. It can also be used to delineate areas where shallow groundwater is contaminated by volatile organic compounds and where there is a layer of a volatile, nonaqueous phase liquid floating on the top of the capillary zone. Phyto-screening, surface geophysics, and aerial photographic interpretation are other noninvasive or low impact characterization techniques that are appropriate at many sites.

There are a host of chemical and microbial analysis technologies that assist interpretation of the source, movement, and transformation of subsurface contaminants. Differences in source chemistry, generation of daughter compounds, and comparison of compound ratios lend themselves naturally to environmental forensic investigations. Chemical compound transformation, the utilization and uptake of nutrient compounds, varying chemical compound ratios, and changes in subsurface microbial communities all can be indicators of bioremediation and compound attenuation. Geophysics, groundwater dating, and borehole core analysis can define the geologic provenance and flow constraints which affect pollutants.

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9

Site Remediation

9.1 Introduction

Since the early 1980s groundwater scientists and engineers have developed a number of techniques for both containing and remediating soil and groundwater contamination. In the United States this has been driven by federal legislation including the Resource and Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The Hazardous and Solid Waste Amendments of RCRA address the storage of liquids in underground tanks. Individual states have also passed environmental regulations that may be triggered when property is sold. Regulations associated with these laws dictate when it is necessary to evaluate if a site is contaminated, and if it is, what must be done to remediate the contaminated soil and groundwater. Even in the absence of a specific regulatory requirement, many potential property buyers will require the seller to demonstrate that a property is not contaminated. This may take the form of a Phase I Environmental Study, which involves a detailed review of the historical uses of the property and a review of state records to determine if there is a likelihood of a potentially contaminating activity in the past. This may be followed by a Phase II Environmental Study, where several soil borings are drilled and one or more groundwater monitoring wells are installed. These investigations are for the protection of the buyer and the financing institution because if the property is found to be contaminated after purchase, the new owner would be responsible for some or all of the cleanup costs (Phase III).

In general, remediation of a site must address two issues. If there is an ongoing source of contamination, control of the source will be necessary. There is no point in remediating the environment if new contamination is being released to the soil or groundwater. Examples of sources include landfills, mine tailings piles, leaking underground storage tanks, pipelines, septic tanks, and sewer lines. In addition to primary sources, such as those listed above, there can be secondary sources of contamination due to contaminants which have already been released to the environment. These secondary sources include nonaqueous phase liquids (NAPLS) which may be trapped in the vadose zone, floating on the water table or trapped below the water table. Once the primary source has been removed or isolated, then secondary sources must be identified and isolated. Only after that has occurred is treatment of contaminated soil and groundwater effective.

The final goal of a remediation program for contaminated soils and groundwater is generally subject to approval of a state or federal regulatory agency. In almost all

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cases it will be impossible to completely remove all contamination so that the site returns to a pristine condition. After all, many contaminated sites have been the locus of industrial activities for decades; indeed, some sites in the eastern United States or in Europe have been used by one industry or another for centuries. In the United States of America, state agencies or the U.S. Environmental Protection Agency may have numerical standards for the soil and groundwater that must be met after site remediation. Similarly, in the European Union, the European Environment Agency (EEA) works together with national agencies on defining what are "good" and "poor" quality water bodies (Water Framework Directive 2000/60/EC of the European Parliament and of the Council). Many other countries have modeled their environmental standards on EPA or European regulations. These standards are generally based on anticipated future land use. Soil remediation standards for future residential land use will be more stringent than those for industrial use. Groundwater standards may be based on drinking water Maximum Contaminant Levels (MCLs).

The application of very stringent standards may result in the expenditure of large amounts of money to reduce extremely small or even nonexistent risks (Viscusi and Hamilton 1996). As much as everyone would like to live in a pristine environment, it simply is not practicable in the post-industrial world. There are limited funds available for environmental cleanup; we should expend those funds in a manner that is most effective in terms of reducing real risks. This has led to the concept of risk based corrective actions (RBCA). Rather than cleaning up all sites to a set standard, a risk assessment of the site is made, and risks to specific receptors are addressed. For example, if the groundwater is saline and not used as a drinking-water source, it may not be really necessary to remove a chlorinated solvent to the drinking-water standard.

Contaminant hydrogeologists in collaboration with engineers, chemists, biologists, modelers, and many other experts have developed some very powerful methods of removing contamination from soil and groundwater. However, these methods are not capable of totally removing all contamination. A zero contamination strategy is not possible, even if we were willing to commit unlimited funds.

In this chapter we will examine a number of source zone and groundwater plume remedial techniques, some proven and some experimental. Table 1 provides an overview of some of the most common technologies and their applicability and development status. There are a few textbooks (e.g., Suthersan et al. 2017) and a number of public domain resources that can guide us in the discussion of these remediation technologies. For instance, the Interstate Technology and Regulatory Council (ITRC) makes available documents ranging from technical overviews and case studies of innovative remediation technologies to technical and regulatory guidance documents for applying cleanup technologies (www.itrcweb.org/guidance). Similarly, the Federal Remediation Technologies Roundtable (FRTR) provides access to a remediation technology screening matrix for screening potentially applicable technologies for a remediation project, including a long list of technology descriptions (www.frtr.gov/scrntools.htm). The National Academies of Sciences, Engineering, and Medicine—National Research Council (NRC) publishes periodic reports on the state-of-the-art in the remediation of contaminated sites (http://www.nap.edu/topic). The Strategic Environmental Research and Development Program (SERDP) is an environmental science and technology program, planned and executed by the U.S. Department

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TABLE 9.1 Common and innovative contaminant remediation technologies.

Technology	Application	Development Status
Pump-and-Treat (P&T)	(Source Zone) / Plume / Containment	Established
Physical Containment	Source Zone / Plume	Established
Solidification/Stabilization	Source Zone	Established
Soil Vapor Extraction / Air Sparging	Unsaturated Zone; Source Zone / Plume	Established
Bioremediation and Monitored Natural Attenuation (MNA)	Source Zone / Plume	Innovative / Established
Permeable Reactive Barrier	Source Zone / Plume	Innovative / Established
Chemically Enhanced Flushing	Source Zone	Established
Thermal Treatment	Source Zone / Unsaturated Zone	Innovative / Established
In Situ Oxidation	Source Zone / Plume	Innovative / Established
Phytoremediation	Plume / Unsaturated Zone / Containment	Innovative / Established

Note: The boundary between what is a conventional and innovative technology is fluid.

Source: Modified after NRC 2013.

of Defense (DOD), Department of Energy, and the EPA and others. Together with another U.S. DOD program, the Environmental Security Technology Certification Program (ESTCP), these programs support the development and demonstration of the latest remediation technologies. They also provide access to documents describing innovative, cost-effective, and sustainable environmental cleanup solutions, including for the treatment of DNAPL source zones or groundwater plumes (www.serdp-estcp.org). Funded by the European Union, the EUGRIS (European Groundwater and Contaminated Land Remediation Information System) is an openly available information platform for contaminated land and groundwater information (www.eugris.info/index.asp). While there are many more resources available to students as well as practitioners, one of the largest depositories of information about contaminated site characterization and remediation technologies is maintained by the U.S. EPA (www.clu-in.org). Currently, the website includes information on several hundred field-scale remediation technology demonstration projects.

9.2 Source-Control Measures

9.2.1 Solid Waste

Solid waste may have been buried in an unsecure landfill, placed in an open excavation or old quarry, or simply spread on the land surface. If contaminants continue to be leached from these sources by infiltrating precipitation, or even groundwater if the solid wastes have been buried below the water table, then a source-control measure

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is necessary before groundwater remediation is attempted. If the source continues to leach contaminants, then groundwater remediation may be futile.

Source-control measures include physical removal of the waste and transportation to a secure landfill or incinerator, construction of impermeable covers or low-permeability caps to eliminate or minimize infiltration of precipitation, and construction of physical barriers around the waste source.

9.2.2 Removal and Disposal

If the source is removed, then wastes can no longer migrate from it. Solid waste that has been spread on the land surface can easily be removed by conventional earthmoving equipment. Waste that has been buried in a landfill can also be exhumed and transported to a secure landfill. A hazardous-waste landfill was operated near Wilsonville, Illinois, USA, from 1976 to 1981. Hazardous wastes, including liquids, were buried in drums that were placed in 26 trenches, each approximately 3.3 m to 6.5 m (10 to 20 ft) deep, 15 to 30 m (50 to 100 ft) wide, and 53 m to 122 m (175 to 400 ft) long. In 1981, it was found that hazardous wastes had migrated up to 16.7 m (50 ft) from the trenches over a 3-year period, a rate 100 to 1000 times greater than predicted prior to construction of the landfill. Following a court order, the site owner exhumed and removed all the drums and transported them to a more secure landfill. The process took 4 years and many millions of dollars (Herzog et al. 1989).

Excavation and removal of hazardous materials must be done in a manner that protects the health and safety of workers and the public. The materials may be hazardous if one comes into contact with them, they give off toxic or dangerous vapors, or if ingestion of these materials would be harmful. The risk of moving material as opposed to leaving it in place must always be evaluated prior to a removal action.

Furthermore, the final disposition must be environmentally sound. In at least one case, spent solvents were moved from an abandoned hazardous-waste site to a solvent-recycling facility. The latter facility eventually went bankrupt and became a hazardous-waste site itself. Under CERCLA, the courts have found that the generator of hazardous wastes is responsible for their cleanup and disposal costs if the disposal-site operator becomes bankrupt. In this case, the generator had to pay twice for the disposal of wastes. This policy is known as "cradle-to-grave" and is designed to ensure that hazardous waste is controlled from the time it is generated until its ultimate disposal. The EPA defines hazardous waste as "waste with properties that make it dangerous or potentially harmful to human health or the environment" (U.S. EPA 2016). In regulatory terms, an RCRA hazardous waste falls into two categories: (1) waste specifically listed by EPA and (2) characteristic waste which exhibits one or more of the following: ignitability, corrosivity, reactivity, or toxicity. These four waste characteristics are communicated in many different ways, including Material Safety Data Sheets (MSDS) or by hazard labels. For instance, the NFPA 704 chemical hazard label standard uses a diamond-shaped diagram of symbols and numbers to indicate the degree of hazard associated with a particular chemical or material (Figure 9.1). You probably have seen this or similar signs posted in laboratories or other places where potentially hazardous materials are being stored. In any given state, the EPA or the state hazardous waste regulatory agency enforces hazardous waste laws and most universities have hazardous waste offices to ensure compliance with those laws.

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FIGURE 9.1 The NFPA 704 chemical hazard label. Each quadrant is labeled with its respective color and hazard.



Soil contaminated with organic compounds may be remediated by excavation and incineration. This is a technique that has been proposed for highly refractory organic compounds, such as PCBs and some pesticides. The organic matter of the soil is incinerated while a supplemental fuel is burned in the incinerator. Incineration converts the waste into ash, flue gas, and heat. While the heat can be utilized for beneficial purposes, there is concern about toxic compounds that might accumulate in the ash and gaseous emissions of the incinerator plant. The appropriate disposal of the ash and the filtration of the flue gas add significant cost to the waste incineration and make this process expensive. Compounds with a high BTU (heat) value, such as hydrocarbons, can also be incinerated. This is less costly, since supplemental fuel is not needed. However, permits are needed for incineration, and these may be difficult to obtain from state and local authorities.

9.2.3 Containment

If the waste cannot economically or technically be excavated, then it may be possible to contain it. If the waste is below the water table, flowing groundwater can pass through it and create leachate as illustrated in Figure 9.2a. Such buried waste can be surrounded by a **groundwater cutoff wall**. The purpose of the groundwater cutoff wall is to divert groundwater flow from passing through the waste so that it cannot form leachate (Lynch et al. 1984; Need and Costello 1984). The cutoff wall needs to be deep enough to key into an impermeable layer so that groundwater cannot pass under the wall, which is referred to as encapsulation. Note that the term encapsulation is not only used to describe the isolation of an area of waste, but is used also to describe the different measure of surrounding an individual container with impermeable material.

There are several ways that cutoff walls can be used (U.S. EPA 1998). The wall can extend all around the waste (Figure 9.2b). If this is done, the groundwater will flow around the wall and be diverted from the waste. The water table will rise on the upgradient

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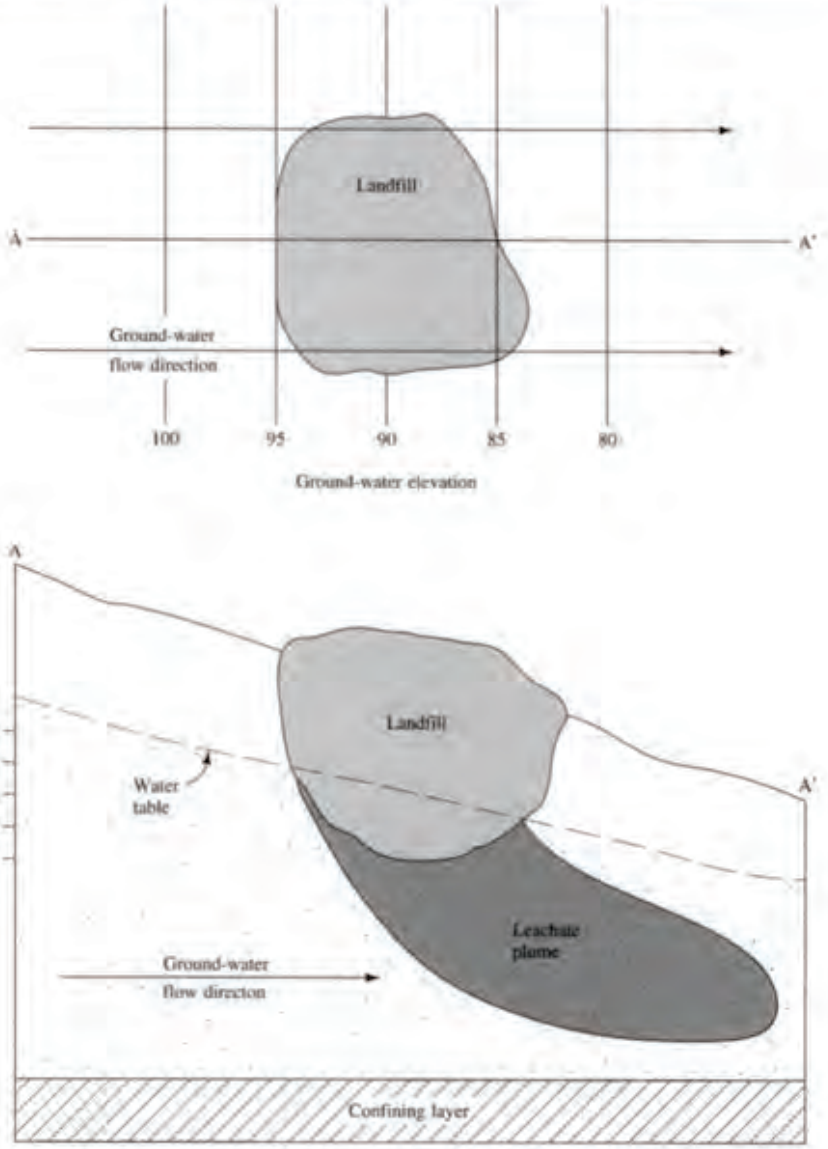
FIGURE 9.2a Top view and cross section of a landfill that was constructed with an excavation that extends below the water table. Groundwater can flow through the waste and create leachate.



wall and fall on the downgradient wall. If there is no recharge or flow through the cutoff walls, the water table within the cutoff walls will be flat. However, there is generally leakage through the cover or cutoff walls, so some extraction wells will be needed for added hydraulic control within the cutoff walls to prevent build-up of water within walls.

If the cutoff walls are extended far enough to surround both the waste body and the plume of contamination, then remediation may proceed without worry that it will spread further. One of the problems that have arisen with the remediation of groundwater is that the plume may spread rapidly, whereas legal action to assess blame for the plume proceeds through the courts with glacial speed. If a cutoff wall is installed as an emergency action, then the plume can wait until the courts have spoken.

Cutoff walls have also been used to stop the spread of a contaminant plume. At the Rocky Mountain Arsenal near Denver, Colorado, USA, a cutoff wall was constructed

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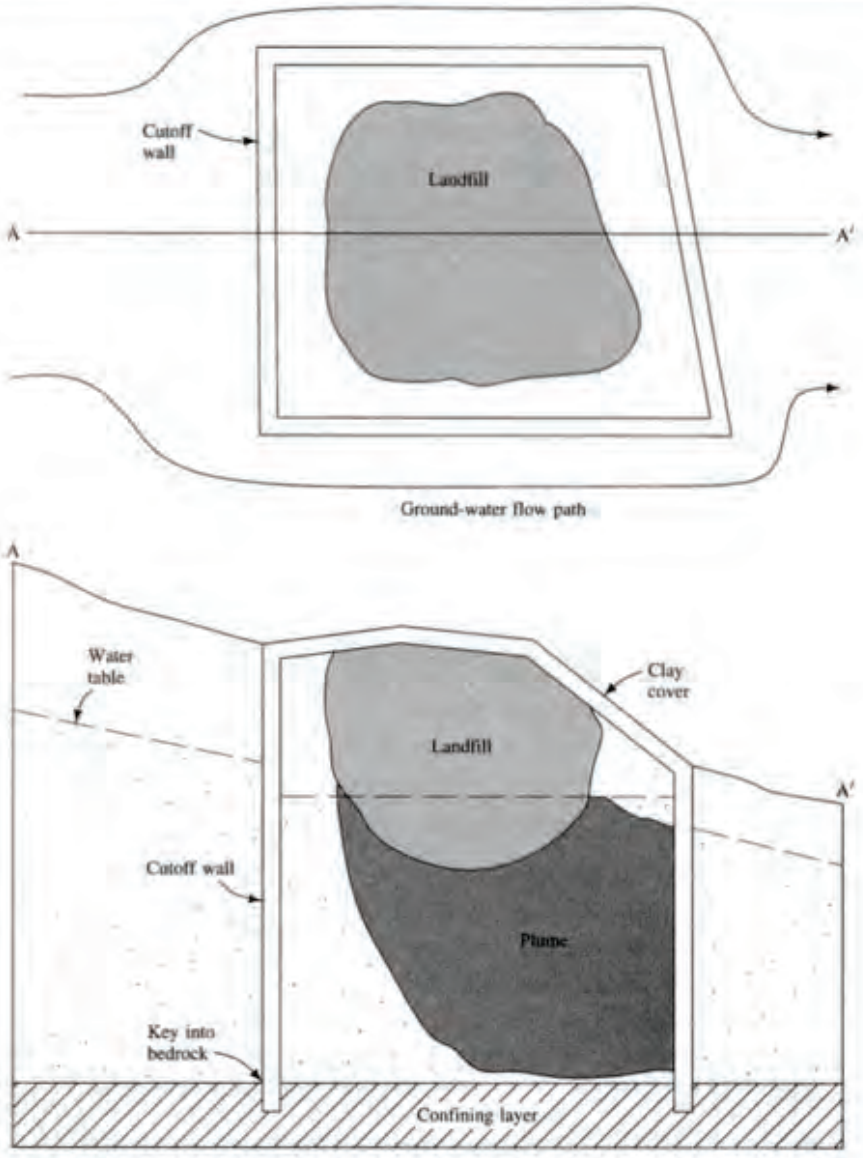
FIGURE 9.2b Top and side view of a cutoff wall that completely surrounds the landfill in (a), opposite page. Cutoff wall is keyed into underlying low-permeability formation.



across a bedrock valley containing higher-permeability, unconsolidated deposits that acted as a pathway for a contaminant plume. The contaminated water is pumped from the upgradient side of the cutoff wall, treated to remove the contamination, and injected into the aquifer on the downgradient side of the cutoff wall (U.S. EPA 1998). This system is illustrated in Figure 9.3.

A number of different types of materials have been suggested for use in cutoff walls (Pearlman 1999). Most are constructed of soil-bentonite slurries, but concrete and concrete/polymer mixtures are also used particularly in regions of topographic relief. A trench is excavated with an excavator or backhoe. The trench is held open by a slurry of bentonite and water. The slurry acts in the same manner as the drilling mud that holds open a borehole. The bentonite slurry penetrates into the more permeable formations and forms a low-permeability filter cake. As the working end of the trench

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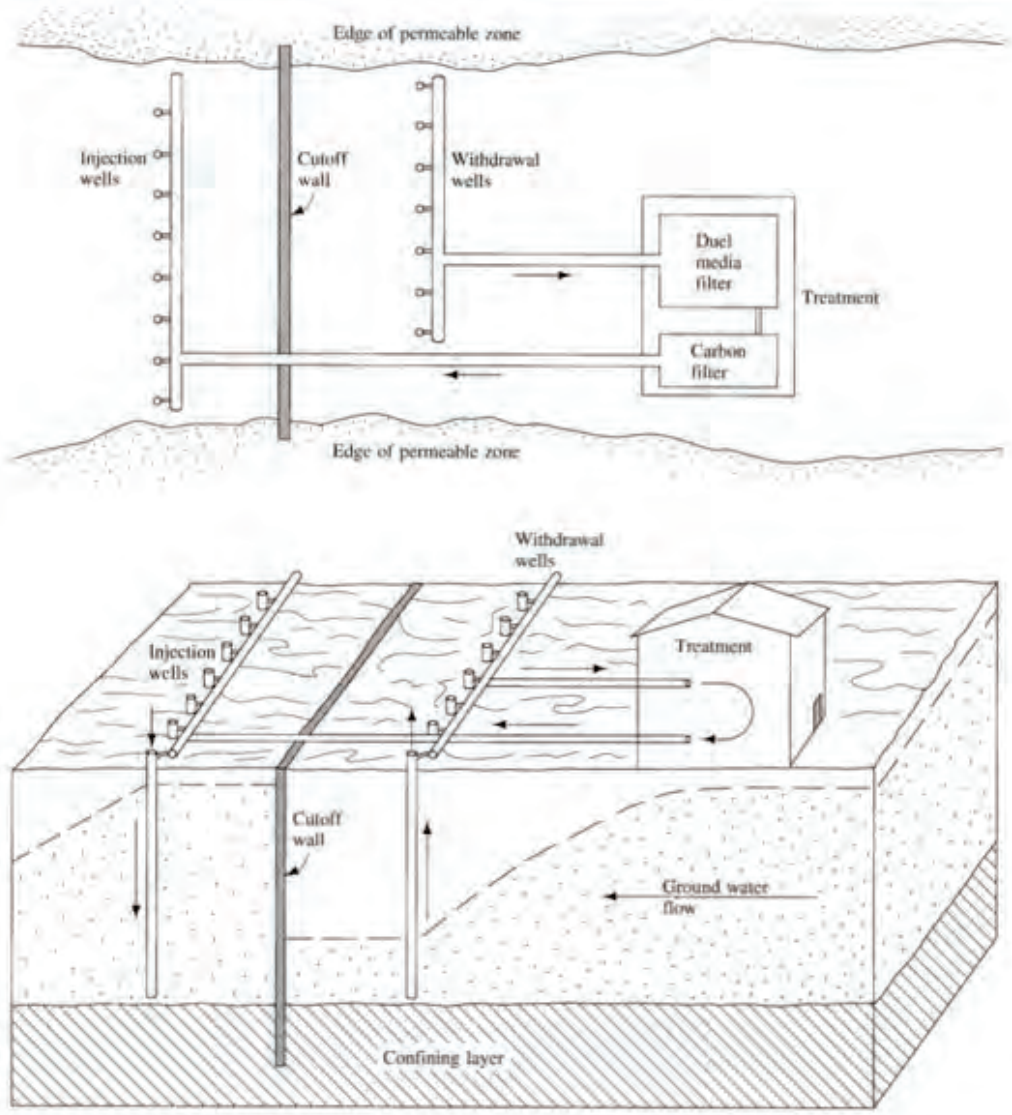
FIGURE 9.3 Cutoff wall used with extraction and injection wells at the Rocky Mountain Arsenal, Denver, Colorado, to isolate and treat a plume of contaminated groundwater.



is built around the site, the opposite end of the trench is back-filled with a soil-bentonite slurry. The soil-bentonite slurry has a very low permeability and minimizes the movement of most groundwater through it. The trench is typically 1 m (2 to 3 ft) wide and can be up to 18.3 m (60 ft) deep if excavated with a backhoe or up to 36.5 m (120 ft) deep if dug with a clamshell shovel (Need and Costello 1984). While expensive, technology to install cutoff walls as deep as 122 m (400 ft) is available (Valkenburg 1991). Preconstruction design studies are needed to determine if the waste that is to be contained is compatible with the bentonite-soil slurry.

A grout curtain may also be constructed as a cutoff barrier. Grout is injected into the earth through a borehole. The grout is liquid when injected but eventually hardens into an impermeable material. This approach was used to contain radioactive water at the Fukushima nuclear power plant disaster site in Japan, according to the company in charge for the site remediation (www.tepco.co.jp). Other construction methods include

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steel-sheet piling, bored pile walls and, as temporary solution, artificial ground freezing. The selection of a cut-off barrier construction method will depend on the desired depth of wall, ground conditions, and geometry of wall.

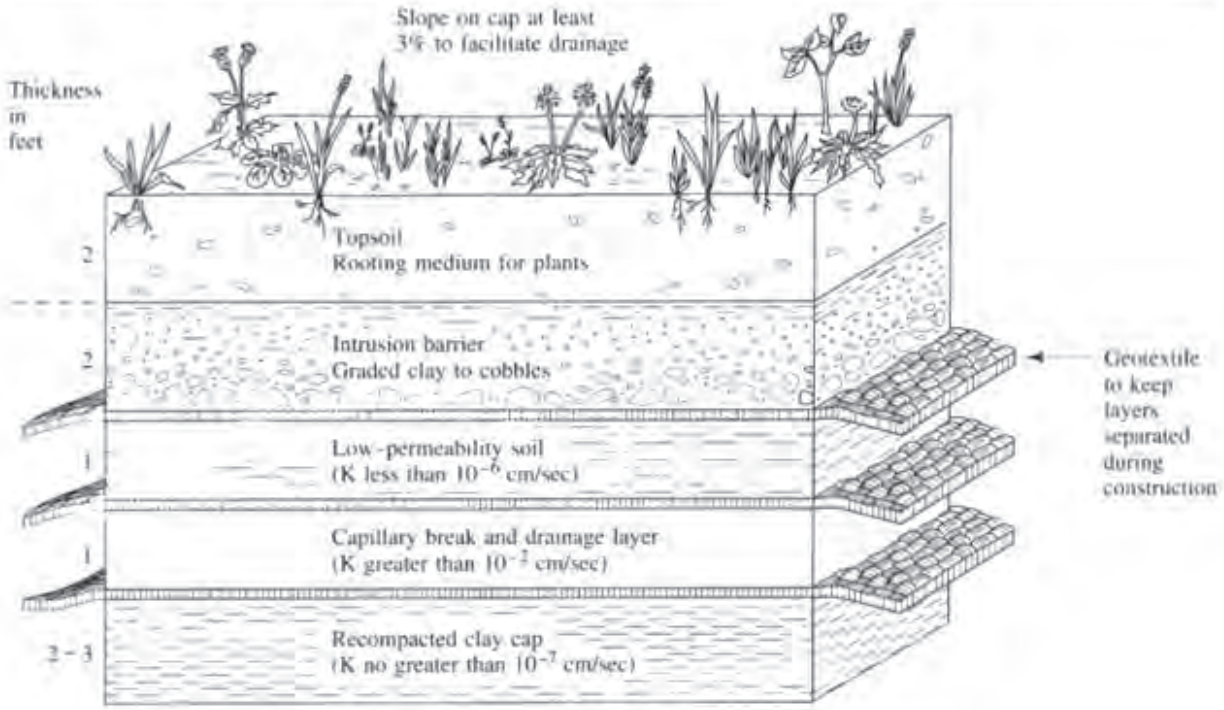
If contaminated material can be immobilized or its solubility reduced through a chemical reaction, this process is called stabilization. Similarly, if the contaminated material can be encapsulated to form a solid and to restrict its migration by decreasing the surface area exposed to leaching, that process is referred to as solidification. **Solidification/Stabilization** is an established technology that has been used for decades to address a variety of *in situ* and *ex situ* solid and liquid wastes. Typically, the contaminated material is treated with an inorganic or organic binder, such as cement, fly ash, lime, soluble silicates or asphalt, epoxide, polyesters, and polyethylene (U.S. EPA 2000).

In most cases it will also be necessary to construct a cover over the waste material to prevent the infiltration of precipitation. If the waste material is above the water table, a cover without a slurry wall might be all that is needed. For a waste material buried below the water table, a low-permeability cover is needed in association with a slurry wall. In the absence of a cover, the infiltrating water will fill the area within the slurry wall like a bathtub.

Covers may be constructed of native soils, synthetic membranes, or a combination of both. Covers are typically sloped in order to promote runoff of precipitation. It may even be necessary to bring in fill material to create the necessary elevation at the center of the cover to form the needed slope.

A multilayer cover constructed of natural materials might have the following elements, starting from the surface (Figure 9.4): (1) 0.6 m (2 ft) of topsoil as a rooting medium for vegetation with shallow roots, such as grass or crown vetch, which is

FIGURE 9.4 Typical design of a multilayer cap for a landfill that is constructed of natural soil materials.



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needed to prevent erosion; (2) a 0.6 m (2 ft) thick compacted layer of cobbles mixed with clay to stop burrowing animals from breaching the cap; (3) a 0.3 m (1 ft) thick low-permeability zone to separate the cobble layer from the next-lower zone; (4) a 0.3 m (1 ft) thick layer of very permeable sand, which acts as a capillary break to the movement of soil moisture and provides for lateral drainage of any infiltrating precipitation; and (5) a bottom layer that consists of 0.6 to 1 m (2 to 3 ft) of recompacted clay with a maximum permeability less than 10^{-7} cm/sec (8.5×10^{3} ft/d) to act as a final barrier to groundwater recharge. Geotextile fabric would be needed between several of the layers to keep the materials from mixing during construction and to distribute the stresses evenly. Figure 9.4 shows the details of this design. Erosion of the soil and penetration of the cover by tree roots are the main concerns for the long-term integrity of this design.

Synthetic geomembranes can also be used in cover designs as low-permeability layers. One advantage of using native soil materials is that their long-term performance is assured, whereas the long-term behavior of plastic membranes, and those made of other materials has not been tested for all types of soil, climatic, and contaminant mixture scenarios. However, for many applications, plastic membrane covers are suitable. They can easily be installed so that monitoring and extraction wells extend through the cap.

Infiltration of precipitation into the ground can also be reduced by paving the surface with a material such as asphalt. However, an asphalt seal is more permeable than a multilayer cover and would require extensive maintenance to seal cracks that form. Diversion ditches and drains might be used to prevent surface runoff from entering an area where it can infiltrate into the soil and come into contact with buried waste material.

There are alternative cover designs that are increasingly being used for waste disposal sites and hazardous waste landfills. For instance, the evapotranspiration (ET) cover system relies on the properties of one or more vegetated soil layers to store water until it is either transpired through vegetation or evaporated from the soil surface (e.g., Hauser et al. 2001). Compared to conventional land fill covers, ET cover systems are less costly to construct. However, ET cover systems are mostly limited to areas that have arid or semi-arid climates, such as the southwestern United States (U.S. EPA 2003; 2011).

9.2.4 Hydrodynamic Isolation

Hydraulic controls can also be used to isolate a zone where the groundwater has been contaminated. An extraction well positioned at the leading edge of a contaminant plume can be used to stabilize the position of the plume or contain it (Figure 9.5). The plume-stabilization well will pump contaminated water, which may require treatment before disposal. It will prevent the encroachment of the plume of contamination to uncontaminated parts of the aquifer. With the contamination thus isolated, work on source control and other remediation measures can progress at the most expedient pace.

The downgradient limit of the capture zone is called the stagnation point. Figure 9.6 shows a water table profile along the y-axis. It can be seen that the stagnation point forms a groundwater divide between flow toward the well and flow in the regional direction. The stagnation point and the capture zone are also shown for an LNAPL spill in Figure 9.7. Note that there is a maximum quantity of water that can be pumped from a single extraction well. If the plume is wider than the capture zone developed by the maximum pumping rate, then multiple extraction wells are needed. One concern with multiple extraction wells is that their capture zones must overlap,

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FIGURE 9.5 Plume-stabilization well used to isolate plume of contaminated groundwater.

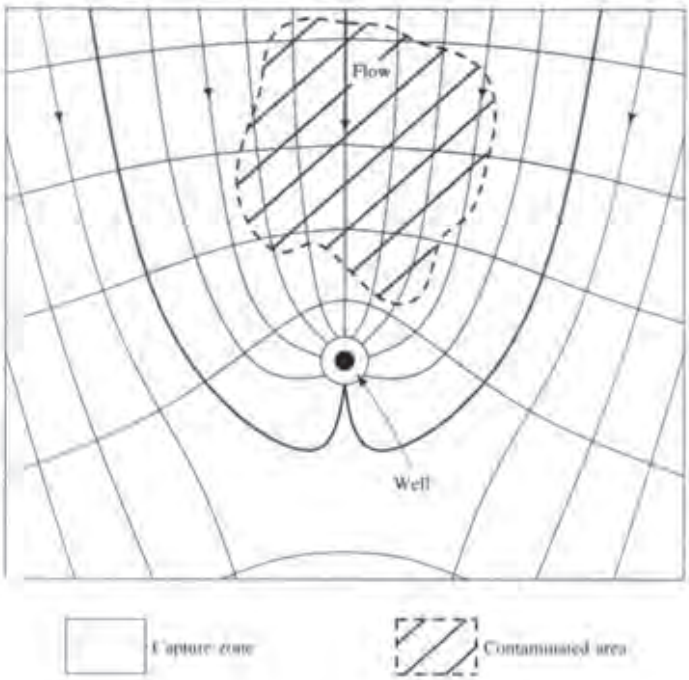
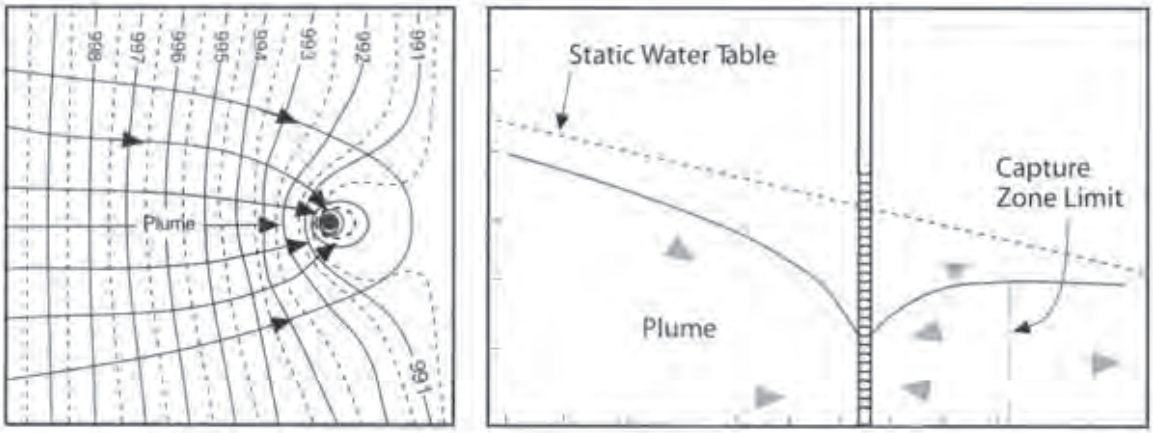


FIGURE 9.6 Example of plume stabilization by a well which is used to hydraulically contain a plume of contaminated groundwater. Shown are plan view and cross sections.



Source: After Cohen et al. 1993; as cited in U.S. EPA 1995, Report EPA/625/R-95/005.

or groundwater flow can pass between them. These considerations illustrate why contaminant hydrogeologists regularly rely on groundwater models as an important aide in designing remediation systems.

Wilson (1984) described the use of a pair of injection and withdrawal wells to create a hydraulic isolation zone around a plume of gasoline contamination. The withdrawal well draws contaminated water to it; the water is then reinjected into the ground upgradient of the position of the plume (Figure 9.8a). The withdrawn water may be treated prior to injection, or nutrients can be added to promote bioremediation. In addition, treatment systems may need periodic maintenance necessitating a shutdown.

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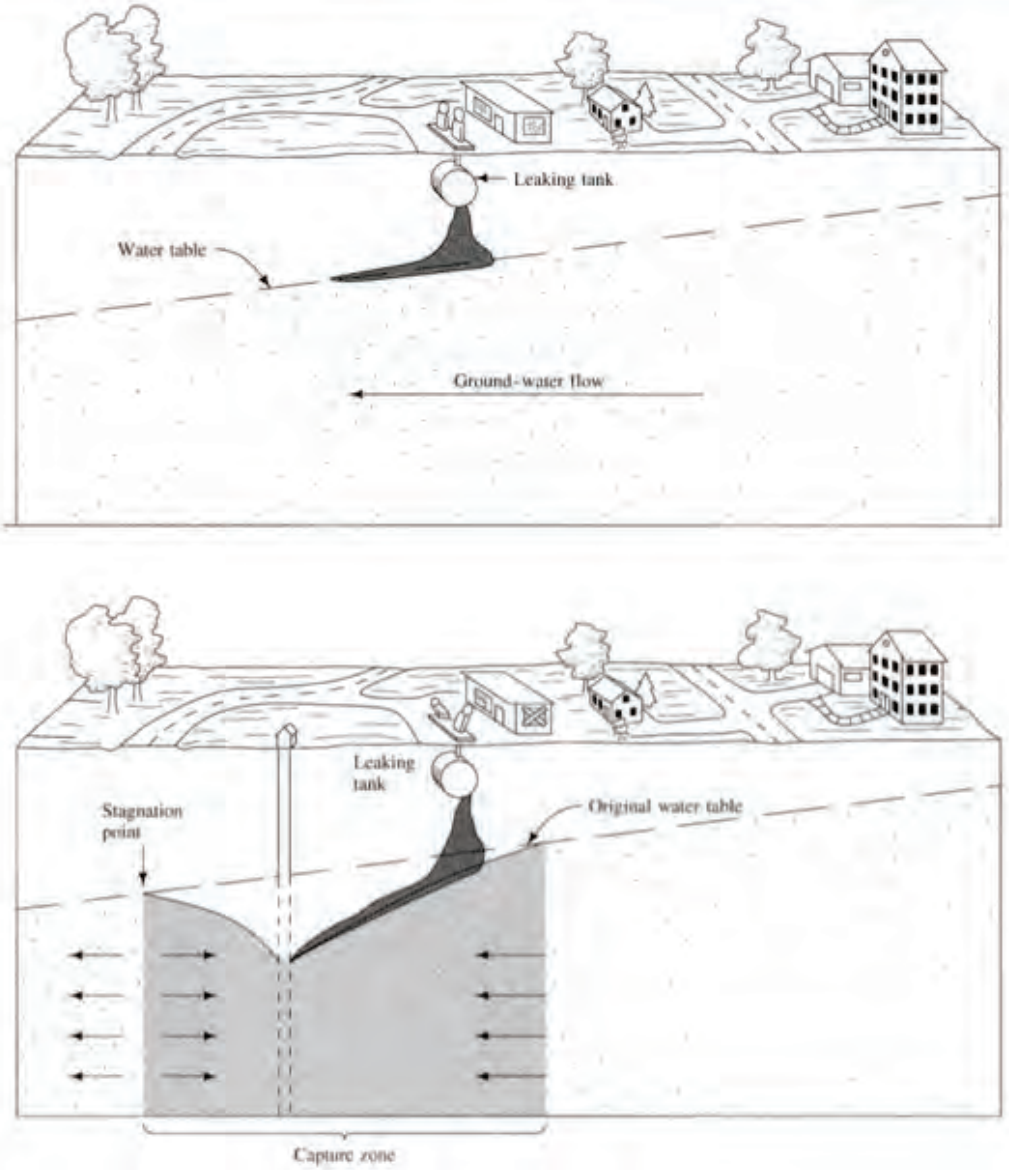
FIGURE 9.7 Cross section along the *x* axis showing the cone of depression for a single extraction well superimposed on the regional water table.



With a reinjection system the untreated water can still be injected and the downgradient plume-stabilization well can be kept pumping. Otherwise, if the plume-stabilization well is shut down, the plume might be able to spread beyond its hydraulic boundary. Care must be exercised to minimize smearing of LNAPLs by reducing rigorous pumping that results in great fluctuations of the water table. Wilson (1984) also described a double-cell hydraulic containment system with two pairs of injection and production wells, as shown in Figure 9.8b. This system provides further isolation of the plume and also creates a smaller inner cell so that the production well that is pumping contamination will pump a smaller volume of water, which will lower treatment costs. With two injection and pumping wells, there is a possibility of shutting down one well periodically for maintenance and still having the system operational.

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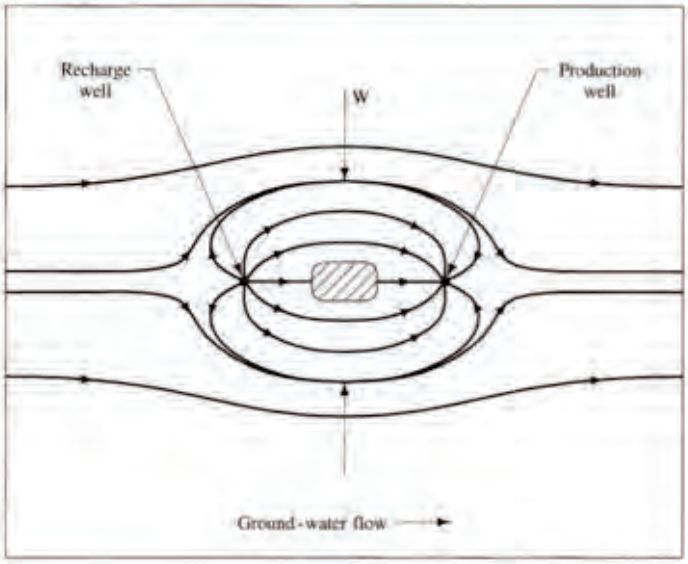
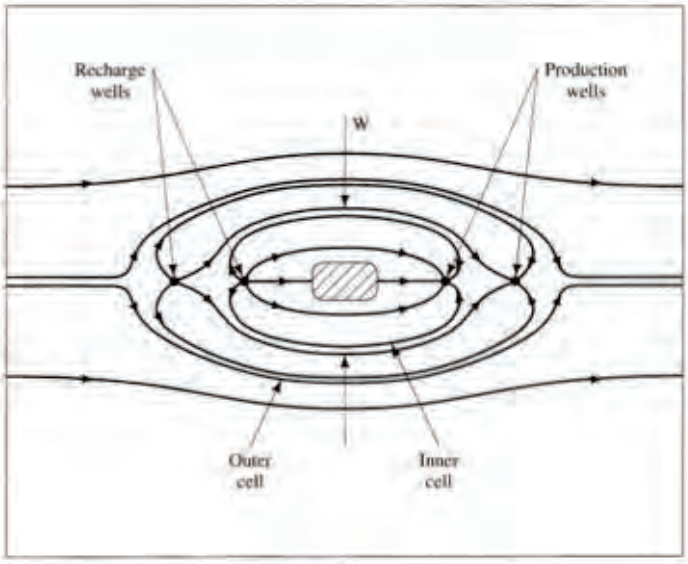
FIGURE 9.8 Plan view of (a) single-cell and (b) double-cell hydraulic containment of contaminated groundwater.



(a)



(b)

Source: J. L. Wilson. 1984. Proceedings of the Fourth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring, 65–70. National Water Well Association. Used with permission.

■ 9.3 Pump-and-Treat Systems

9.3.1 Overview

For a long time, almost all groundwater remediation was based on extraction wells or drains that were usually accompanied by treatment of the extracted water before discharge (Mackay and Cherry 1989). The extraction of groundwater that contains dissolved inorganic and organic chemicals removes the contaminants from the subsurface

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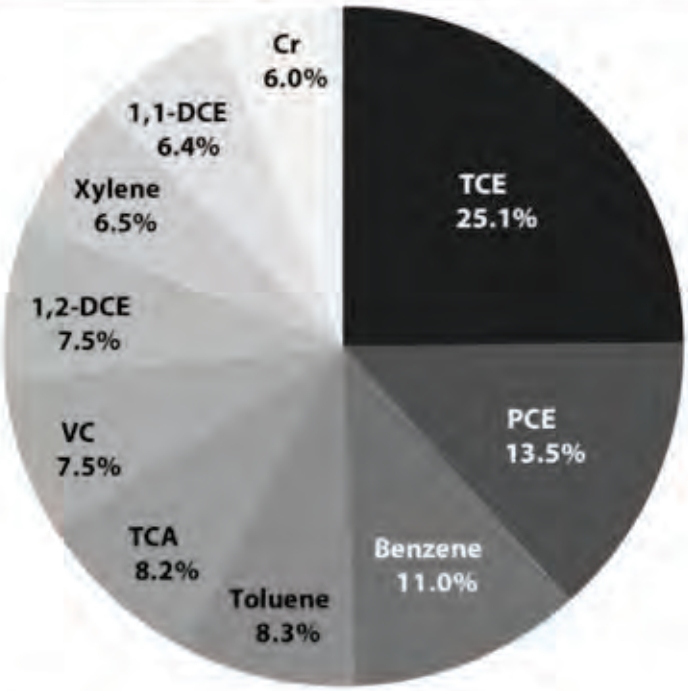
so that the contaminated groundwater can be treated at the surface. This remediation approach is known as Pump-and-Treat (P&T). The advantage of the P&T method is that conventional methods of wastewater treatment can be employed. Pump-and-treat was the sole remedy at 56% (485 of 877 sites) of National Priority List (NPL) sites in the United States between fiscal years 1982 and 2005, representing the most common groundwater remedial action during that period (U.S. EPA 2007). Figure 9.9 provides an overview of the 10 most frequently treated contaminants using P&T technology. P&T systems also are frequently used to treat metals and metalloids, including chromium (U.S. EPA 2007). There are, however, a number of disadvantages that limit the usefulness of this technology to emergency responses, plume containment in combination with source-control measures, or treatment of highly water soluble compounds. Since the early 1990s many highly efficient groundwater treatment technologies have been devised and tested so that contaminated site managers now have alternatives to the P&T technologies. Not surprisingly, by 2011 only 22% of groundwater remedies at NPL sites were P&T based (U.S. EPA 2013).

Depending on the efficacy of treatment and regulatory requirements, the treated water can be discharged to a receiving water body, passed to a publicly owned wastewater treatment plant for further treatment and dilution, or reinjected into the ground. Often the disposal of the treated wastewater requires state and local permits or regulatory approval. Discharge to a publicly owned wastewater-treatment plant may require local permits for industrial discharge and there might be pretreatment standards. Water

FIGURE 9.9 Contaminants treated most commonly by pump-and-treat systems: trichloroethene (TCE); tetrachloroethene (PCE); 1,1,1-trichloroethane (TCA); 1,2-dichloroethene (1,2-DCE); 1,1-dichloroethene (1,1-DCE), vinyl chloride (VC), and chromium (Cr).



Source: U.S. EPA 2007.

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discharged to a surface-water body in the United States requires state permits, including a National Pollutant Discharge Elimination System (NPDES) permit. Many states provinces, and regions require a permit to inject water into the ground and there may be concentration limits specified as a part of the permit. If there are NAPLs present, the situation is much more complex than if all contaminants are in a dissolved form. As long as an NAPL is present, it will partition between the NAPL phase and the dissolved phase. Thus, as contaminated water is withdrawn from the aquifer for treatment, the clean water that is drawn into the aquifer eventually becomes contaminated with pollutants partitioning from the remaining NAPL. If some of the NAPL is mobile, it may be captured by pumping. LNAPLs that are floating on the water table are relatively easy to locate and remove if the LNAPL has not been smeared vertically. However, DNAPLs that sink to the bottom of the aquifer are very difficult even to locate, much less recover (Mackay and Cherry 1989; Freeze and Cherry 1989). Because considerable amounts of residual NAPL will remain even if the mobile NAPL is removed, a great many years may be required for pump-and-treat systems to remove all the residual NAPL by partitioning into the recoverable dissolved phase. In the case of contamination by DNAPLs especially in fractured rock aquifers, it may be very difficult or impossible to remediate a contaminated aquifer (Mackay and Cherry 1989; Freeze and Cherry 1989; National Academies of Sciences, Engineering, and Medicine 2015).

If the dissolved phase sorbs onto the mineral matter of the soil, that phase may desorb as the contaminated water is flushed from the pores. The greater the distribution coefficient, the more slowly the sorbed phase will be released and the longer it will take to remediate the aquifer. The kinetics of desorption dictate that many pore volumes of uncontaminated water might be needed to remove completely the sorbed phase of both organic and inorganic contaminants. Whiffin and Bahr (1984) noted that the observed rate at which organic compounds desorbed from an aquifer was slower than the rate predicted by transport equations that assumed equilibrium conditions between the sorbed phase and the dissolved phase (Figure 9.10). The advection-dispersion equation results were initially fairly accurate; however, when the concentration dropped to about half the initial concentration, the actual rate of removal was slower than the predicted rate.

The discrepancy between the Whiffin and Bahr (1984) model and the observations in the field are related to contaminant residence time in the subsurface and diffusion transport processes. Hence, in heterogeneous media, some contaminants can be sequestered for long periods of time, despite active pumping. Contaminants that have been in the ground for a long period of time have been able to diffuse into the less permeable zones of porous media aquifers or into the bedrock matrix of fractured rock aquifers. Pump-and-treat systems are inefficient in removing these contaminants, because the majority of the water being removed by pumping will come from the most permeable zones of the aquifer. In alternating layers of sand and clay, the contaminated water will penetrate the fine clay, which has very limited permeability, from the highly permeable sands over time. Some of the contamination will remain in the dissolved phase, some will partition onto the surface of the clay lens and associated soil organic carbon and some will diffuse into the clay lens. The fine sediment will have a larger surface area per unit volume of the aquifer than the coarse sediment and thus will sorb more contamination.

These mass transport limitations have been illustrated by Mackay and Cherry (1989) (Figure 9.11). Figure 9.11a shows contamination residing in homogenous aquifer

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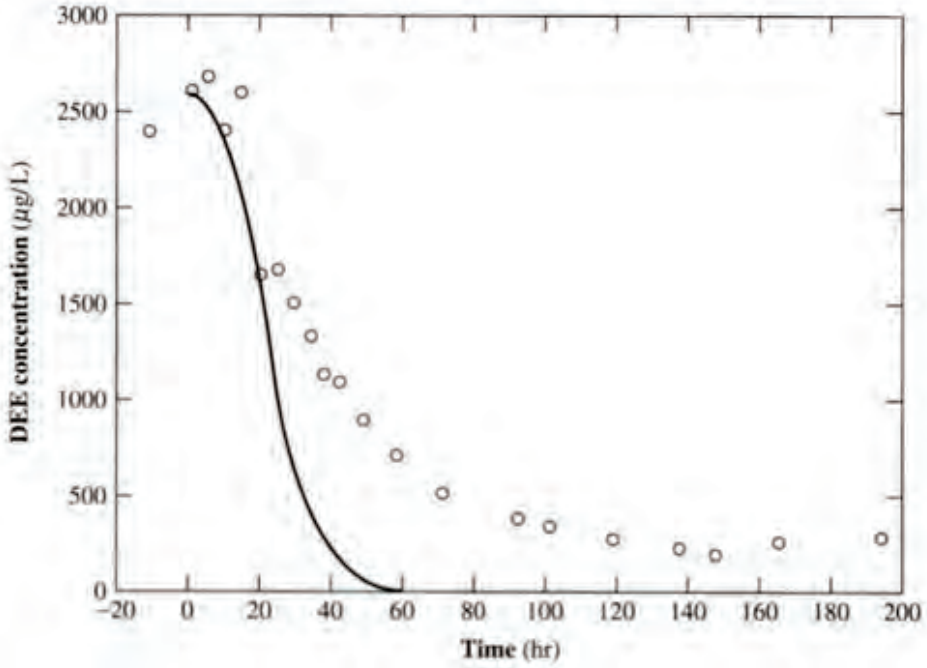
FIGURE 9.10 Measured desorption values for diethyl ether for water pumped from a purge well (open circles) versus calculated desorption curve based on advection-dispersion equation (solid line).



Source: R. B. Whiffin and J. M. Bahr. 1984. Proceedings of the Fourth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring, 75–81. National Water Well Association. Used with permission.

composed of uniform sand. During the time interval t_0 to t_1, the contamination is effectively flushed out. However, if the porous media is heterogeneous and the aquifer consists of sand with an interbedded clay lens, the concentration in the effluent from the extraction well is still elevated at t_1 (Figure 9.11b). Water removed by pumping will come primarily from the sandy material. The contaminated water in the pores of sand will be fairly quickly removed; perhaps only a few pore volumes of water will need to be flushed through to accomplish this. Contaminants sorbed onto the sand grains will be removed by partitioning into the clean water that then occupies the pores in the coarse sand layers.

Meanwhile, the contaminated water occupying the pores of the clay lens will be flushed from this layer very slowly. It will take the movement of many pore volumes of water through the sand to flush just a few pore volumes of water through the much less permeable clay layer. Hence, it will take much longer to remove the contaminants that are desorbing from the fine sediments after the contaminated pore water is removed from the sand.

There will be an initial rapid decline in the concentration of contaminants in the water being removed by a pump-and-treat system. This decline represents the removal of the contaminated water contained in the larger pores of the aquifer. Initially, when the larger pores in the sandy material are being flushed, the drop in concentration will be rapid. Flushing the much smaller pores in the clay will take much more time and, the rate at which the concentration declines will decrease. The concentration will eventually approach somewhat constant value, which represents a steady state condition where the rate at which the contaminants are being removed by the pump-and-treat

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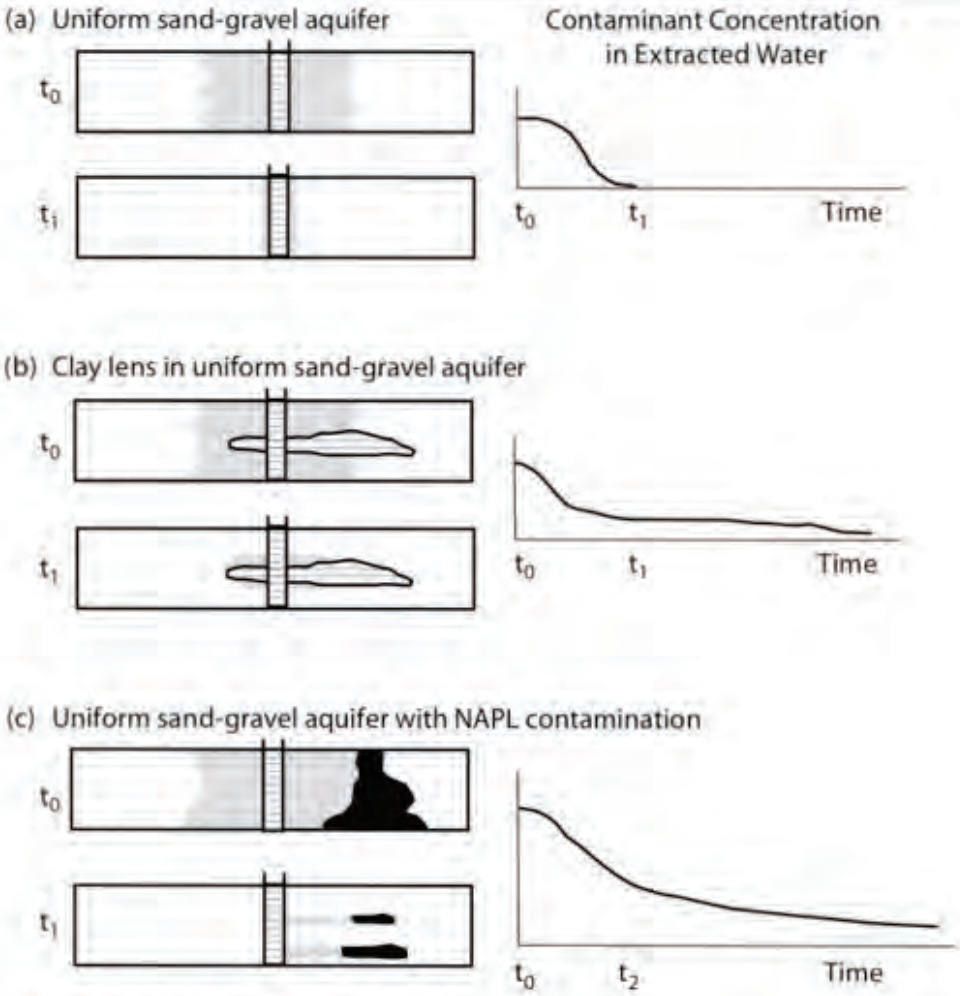
FIGURE 9.11 Hypothetical examples of contaminant removal during pump-and-treat treatment. Gray areas indicate sorbed and dissolved contaminants (uniform initial distribution). Lined shapes indicate clay lens. Black areas indicate NAPL.



Source: Modified after Mackay and Cherry 1989.

system is equal to the rate at which they are being released into the groundwater by diffusion desorption and/or partitioning from residual NAPLs (Figure 9.11c). The resulting long period of slow release of contaminants to the groundwater is called the **tailing** phase of the remediation.

During the tailing phase in the remediation process contaminant mass is still being removed from the aquifer, but the groundwater is not becoming any cleaner. The concentration at which this occurs may be higher than the cleanup goals for the remediation. It may take many years of pumping at this stage to reduce the amount of sorbed contaminants and/or the residual NAPLs sufficiently for the groundwater quality to improve to a point where it meets cleanup goals. Figure 9.12 depicts how the slow, diffusion-controlled release of contamination from material of low hydraulic permeability (clay) can determine the length of the remediation period. For instance, it would take about 10 years to reduce the TCE concentration by 90% if the clay lens is 0.3 m (1 ft) thick. The time increases to almost 40 years for a lens 0.6 m (2 ft) thick and to over

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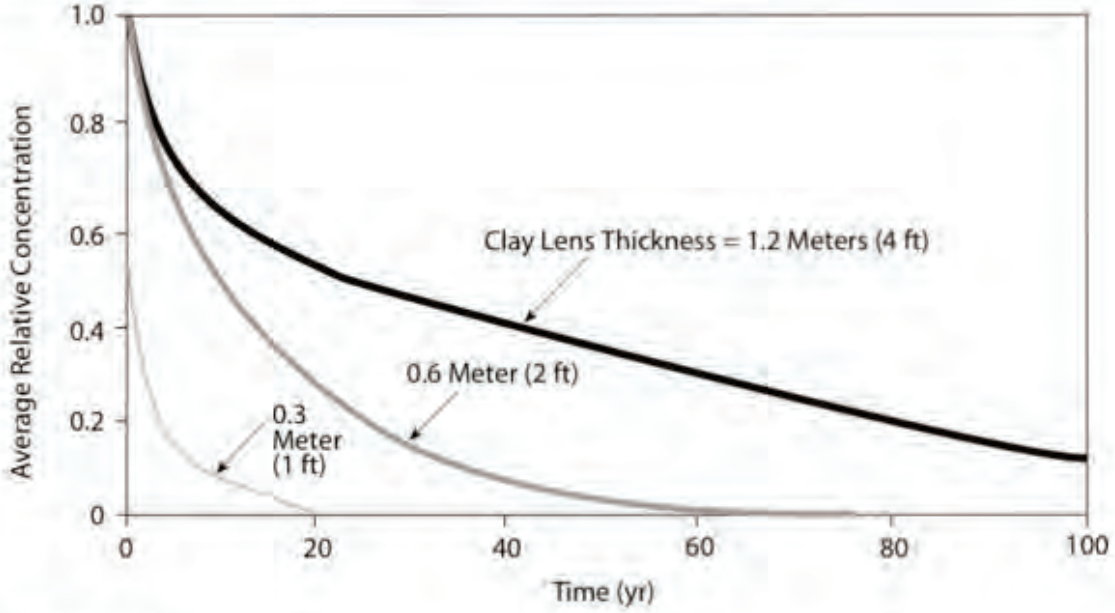
FIGURE 9.12 The effect of matrix diffusion on the average relative trichloroethene (TCE) concentrations in clay lenses of varying thickness as a function of time.



Source: U.S. EPA 1996.

100 years for a lens 1.2 m (4 ft) in thickness. These simulations show that it may take decades or longer to significantly lower the contaminant concentration in clay lenses.

A study of pump-and-treat cleanup at 16 sites in the United States where the groundwater was contaminated with organics revealed that if the initial concentration of contamination was high (>1000 μg/L), pumping could achieve reductions of contaminant concentrations of 90 to 99% before leveling occurred. At sites where the initial concentration was less than 1000 μg/L, leveling occurred before a 90% reduction was accomplished (Doty and Travis 1991). Moreover, if remediation is halted before the sorbed phase is completely removed, the dissolved concentration will eventually **rebound** and rise above the level detected at the end of the remedial period as additional material desorbs to come to equilibrium with the dissolved phase. Typically, the rebound of the dissolved contaminant concentration is quick, i.e., can occur within a few days after the pumping ceased.

The effects of rebound and tailing on the progress of P&T treatment are illustrated in Figure 9.13. It must be noted that these effects are not solely limited to P&T systems, but also affect other, more innovative groundwater treatment technologies that rely on chemically-enhanced flushing processes to remove contamination from low-permeability material.

Figure 9.13 illustrates the multiple stages in remediation of a contaminated aquifer or soil. Early during the treatment (Stage I), there is rapid removal of contaminant mass and concentrations drop quickly. Stage I transitions into Stage II which represents the diffusion-controlled period as the concentration graph attains an asymptotic shape. During the tailing stage (Stage III), the rate of mass removal slows because the site geology controls the rate at which the remaining contamination is released. The impact of matrix diffusion is illustrated by the dashed line curve, which shows the theoretical removal expected in

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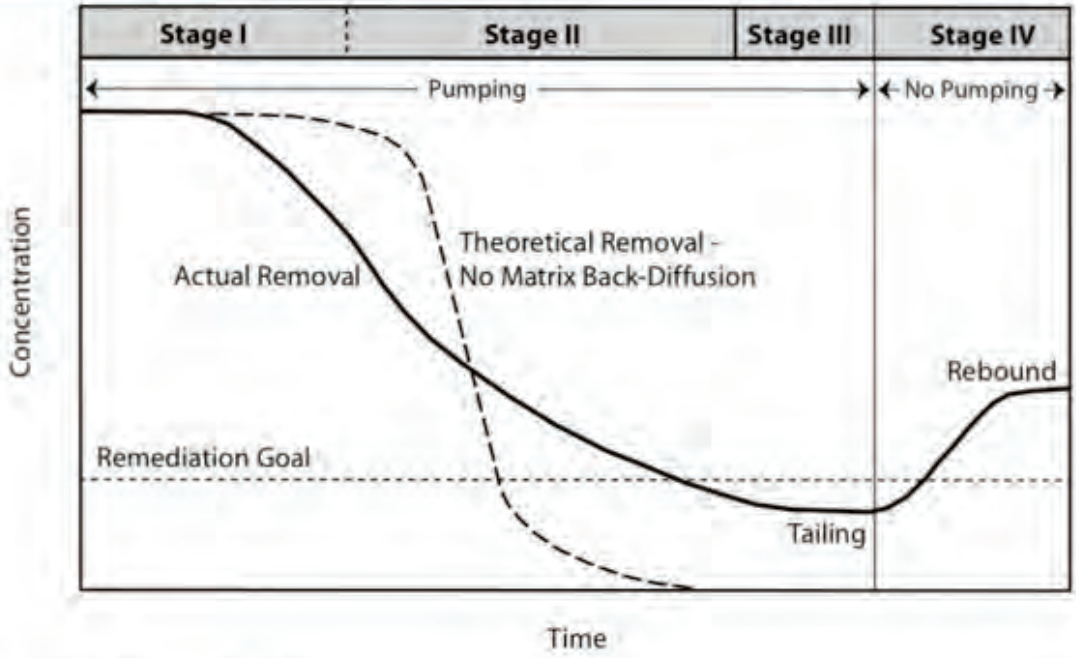
FIGURE 9.13 Stages in the remediation of a contaminated aquifer or soil.



Source: Modified after U.S. EPA 1996.

the absence of diffusion from low-permeability domains into higher permeable zones. Remediation efforts continue until a pre-determined clean up goal has been reached. In some cases, that remediation goal may be higher than the pollutant specific standard, like the maximum contaminant level (MCL) defined by the U.S. EPA. When at one point the pumping stops, it is likely that the slow, diffusion-controlled release of contaminants from low-permeability domains results in an increase in the dissolved phase concentration. This is Stage IV, the rebound stage. Should the rebound result in groundwater concentrations higher than the cleanup standard, remediation must continue. Under these circumstances, it may be necessary to periodically turn on the pump(s) until the residual concentration drops beneath the remediation goal again. Such a treatment scheme is known as **pulsed pumping** (U.S. EPA 1996). Another option is to vary the pumping rates or turn injection wells into extraction wells and vise-versa. This **adaptive pumping** approach limits the development of stagnation zones, which are parts of the aquifer that are not, or only minimally, flushed if the extraction/injection scheme was static.

Figure 9.13 illustrates an aquifer where the contaminant is in the dissolved phase or is sorbed onto soil particles. If there is an undissolved phase (DNAPL) present, then the release of contaminant into the flushing water will be controlled by the solubility of the DNAPL. More soluble DNAPLs, such as trichloroethylene, which has a solubility of 1100 mg/L, will become dissolved much more rapidly than low-solubility NAPLs, such as coal tar or creosote. However, as the DNAPL will tend to form pools on the top of low-permeability layers, the flushing liquid will only come in contact with the top of the DNAPL pool and little dissolution will actually occur (Johnson and Pankow 1992). As a result, pump-and-treat will be inefficient for mass removal in the case of DNAPLs. In spite of this inefficiency pumping still is viable as a means of plume containment.

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Pump-and-treat methods have been shown to be effective in removing a large amount of more soluble contaminant mass from the aquifer during the initial phase of pumping. They are also useful in halting the spread of a plume of contamination, i.e., plume containment. However, if the contaminant concentration in the aquifer is still above the cleanup goal once a pump-and-treat project reaches the stage where the contaminant release is diffusion controlled, decades of additional pumping might be required before the aquifer is "clean." This does not mean that the pump-and-treat approach failed, it only means that it was an unrealistic expectation to attain complete remediation of an aquifer with pump-and-treat as the only remedy. The shortcomings of conventional pump-and-treat schemes have led to the development of many innovative remediation technologies, which will be discussed in greater detail later in this chapter.

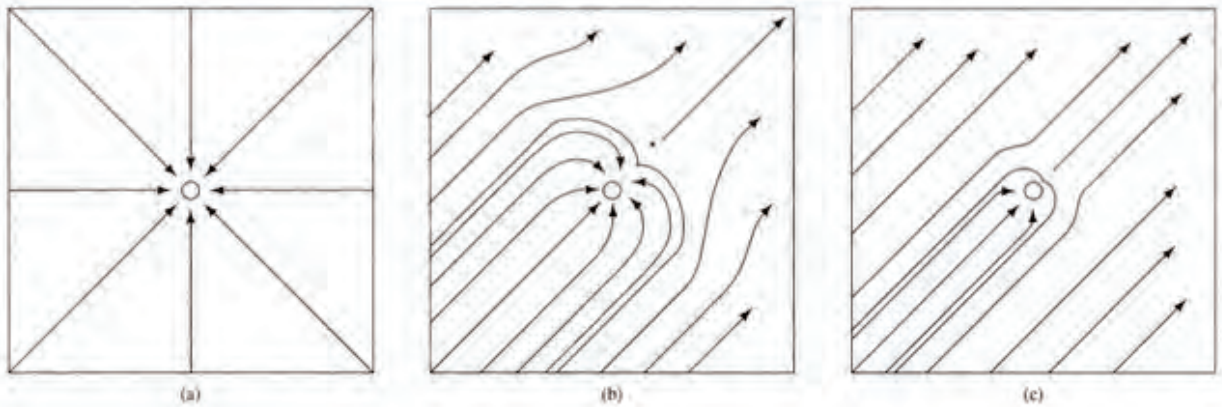
9.3.2 Capture Zones

In order to capture a plume of contaminated water, it is necessary to have one or more pumping wells located downgradient of the source area. Each well will have what is known as a **capture zone**, which is the area contributing flow to that particular well.

If the water table is flat, there is no regional flow. The capture zone of a well is radially symmetrical, centered on the well and extending as far as the edge of the cone of depression (see Figure 9.14a). If there is a slope to the water table, the groundwater flows and the capture zone are asymmetrical, with the greatest extent in the upgradient direction (Figure 9.14b). As the groundwater velocity increases, the width of the capture zone decreases for a given pumping rate (see Figure 9.14c).

The shape of the capture zone is a function of the average linear groundwater velocity, the quantity of the water being pumped from the aquifer, and the distribution of hydraulic conductivity. The upgradient extent of the capture zone depends upon the length of time over which the pumping occurs. The Wellhead Protection Area (WHPA) program was developed by the U.S. EPA that may be used to delineate capture zone. It is a semi-analytical groundwater flow simulation program that can account for multiple pumping and injection wells and delineates the area contributing flow to those wells.

FIGURE 9.14 (a) Flow lines toward a well in an aquifer with no water table gradient; (b) flow lines toward a well and the capture zone with uniform flow to the upper right of the figure; (c) flow lines toward a well and the capture zone with uniform flow to the upper right at a rate 10 times the rate of (b).



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WHPA is applicable to homogeneous aquifers exhibiting two-dimensional, steady groundwater flow in an areal plane and appropriate for evaluating multiple aquifer types (i.e., confined, leaky-confined, and unconfined) (U.S. EPA 1993).

If the hydrogeology is not homogeneous or if more complex geologic or contaminant transport problems have to be accounted for, there are a number of sophisticated models available today. For instance, FLOWPATH II is a 2-D finite difference, steady-state groundwater flow model for calculation of wellhead protection zones, hydraulic heads, groundwater velocities, time related path lines, capture zones, water balances, and steady state drawdown distributions. Another model is PATH3D, which can help delineating contaminant capture zones or wellhead protection zones or can be used to evaluate the effectiveness of groundwater remedial scenarios under complex hydrogeological conditions. There are a number of other noteworthy programs and the Integrated Groundwater Modeling Center (IGWMC) at the Colorado School of Mines in Golden, CO, USA, provides reviews and links to many of those models.

9.3.3 Computation of Capture Zones

The effect of aquifer heterogeneity was illustrated by Shafer (1987). Figure 9.15a shows the initial hydraulic head for a homogeneous, isotropic, unconfined aquifer. The hydraulic-head distribution after 20 years of pumping from a single well is shown in Figure 9.15b. During this time period, the cone of depression has not spread all the way to the upgradient end of the diagram. The extent of the capture zone is shown superimposed on the model grid in Figure 9.15c. Figure 9.16a shows the distribution of hydraulic conductivity in nonhomogeneous aquifer with the same initial head distribution as the one in Figure 9.15a. In contrast to the homogenous system, the hydraulic head distribution in the nonhomogeneous aquifer with one well pumping is not symmetric and the shape of the 20-year capture zone is irregular (Figures 9.16b and c). The nonsymmetric, irregularly shaped capture zone reflects the heterogeneous distribution of the hydraulic conductivity in the nonhomogeneous aquifer. This example illustrates that ignoring aquifer heterogeneity can lead to incomplete capture of a contaminant plume.

9.3.4 Optimizing Withdrawal-Injection Systems

The rate at which groundwater restoration can be accomplished by pump-and-treat systems depends in part on how many pore volumes of water can be withdrawn from the contaminated zone. If the entire plume falls within the capture zone of one or more withdrawal wells, then we know that the plume will not spread and eventually maximum feasible restoration will occur. However, by increasing the rate (number of pore volumes of water per year) at which contaminated water is pumped, the restoration time can be decreased. For optimal conditions we also want to minimize the volume of contaminated water that is pumped, because that also must be treated.

Satkin and Bedient (1988) used a contaminant-transport model to investigate the use of various pumping and injection patterns to remediate a plume of contamination. They examined the effectiveness of seven different well patterns for various combinations of hydraulic gradient, maximum drawdown, and aquifer dispersivity. The patterns are shown on Figure 9.17.

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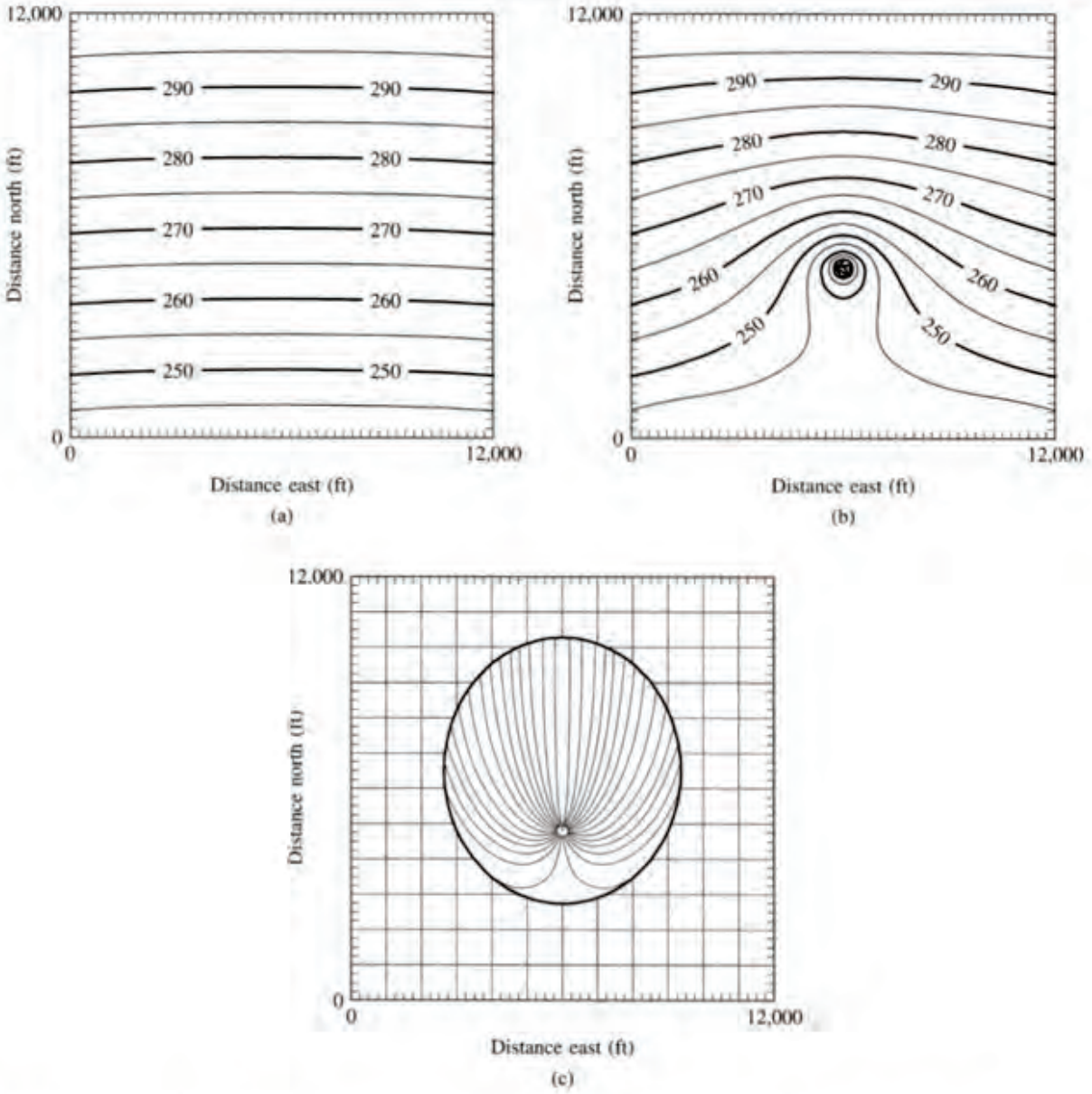
FIGURE 9.15 (a) Hydraulic head distribution with no wells pumping. (b) Hydraulic head distribution in a homogeneous, isotropic aquifer with one well pumping. (c) Shape of the 20-year capture zone based on hydraulic head distribution of Figure 9.15b.



Source: J. M. Shafer. 1987. Reverse pathline calculation of time-related capture zones in nonuniform flow. *Groundwater* 25:283–289. Used with permission.

If a single pumping well is used, it must be placed so that the capture zone encompasses the plume. The closer the well can be to the center of mass of the contaminant, the faster the contamination can be removed. If the plume can be captured by a single withdrawal well, then multiple pumping wells aligned along the axis of the plume will increase the rate of cleanup over a single well by pumping a greater volume of water. The use of pumping wells without injection wells may create a problem if there isn't a receiving body of water in which to dispose of treated groundwater.

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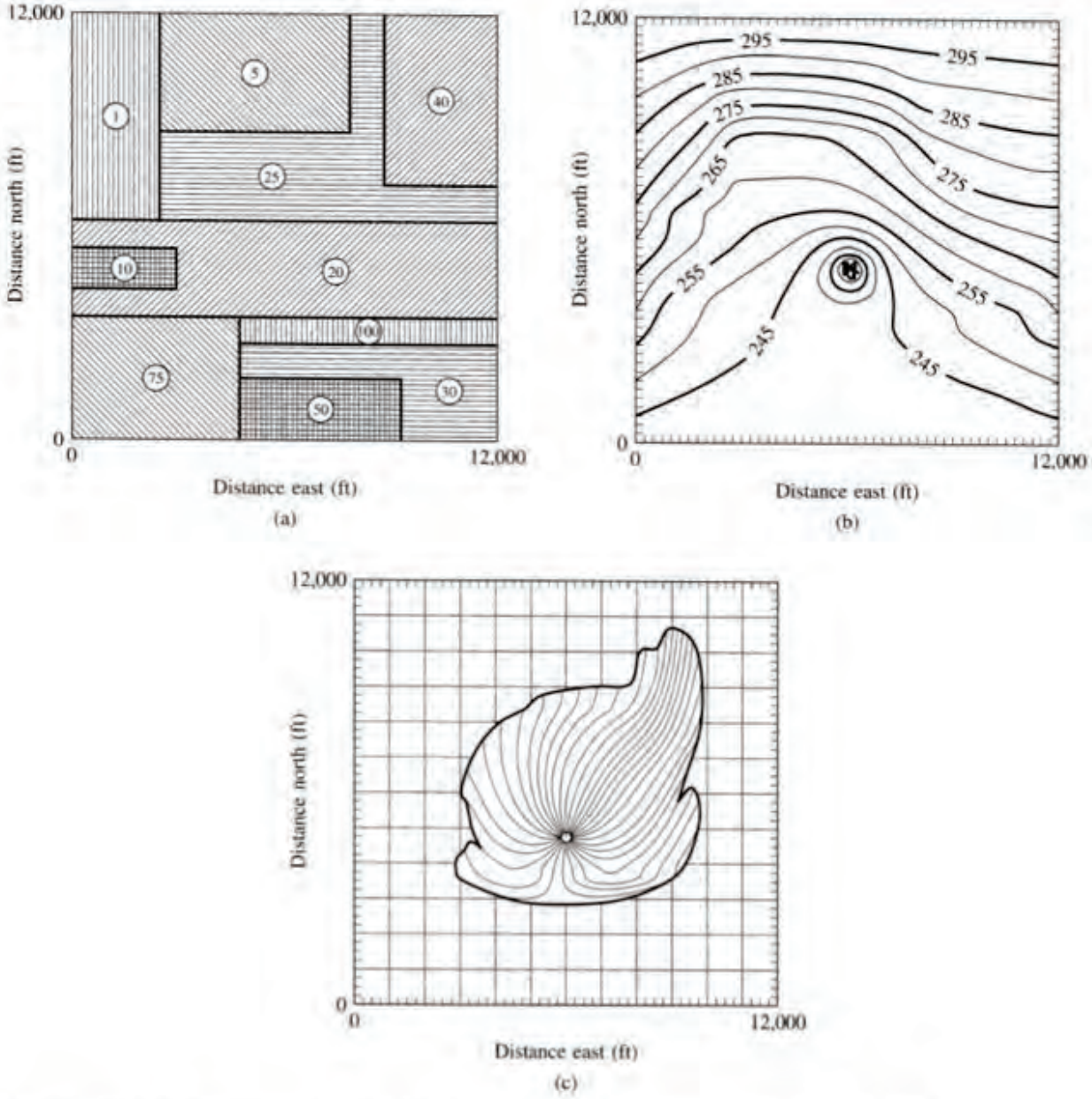
FIGURE 9.16 (a) Distribution of hydraulic conductivity in nonhomogeneous aquifer with the initial head distribution of Figure 9.15a. (b) Hydraulic head distribution in the nonhomogeneous aquifer with one well pumping. (c) Shape of the 20-year capture zone based on hydraulic head distribution of Figure 9.16b.



Source: J. M. Shafer, 1987. Reverse pathline calculation of time-related capture zones in nonuniform flow. *Groundwater* 25:283–289. Used with permission.

If injection wells are used in combination with withdrawal wells, cleanup time can be reduced, because steeper hydraulic gradients can be created. These steeper gradients will produce more water flowing to the withdrawal well(s) than occurs if extraction wells alone are used. We have already seen how a system of a downgradient withdrawal well in conjunction with an upgradient injection well can be used to create a circulation cell

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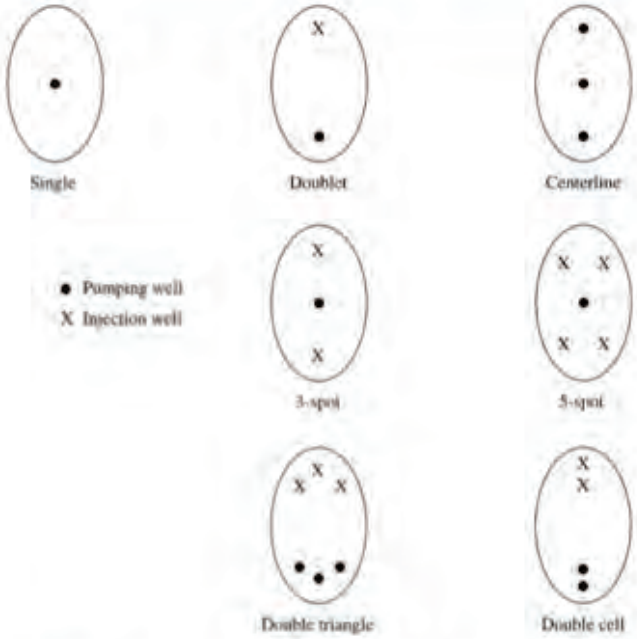
FIGURE 9.17 Possible patterns for extraction and extraction-injection well systems.



Source: R. L. Satkin and P. B. Bedient. 1988. Effectiveness of various aquifer restoration schemes under variable hydrogeologic conditions. *Groundwater* 26:488–498. Used with permission.

to isolate the plume. This is called a doublet on Figure 9.17. Other injection-withdrawal combinations tested included the double cell and double triangle, which are variations of the doublet. Two patterns tested were based on one extraction well and multiple injection wells: the three-spot and the five-spot. When injection wells are used in conjunction with extraction wells, the treated water is disposed via reinjection. However, groundwater injection wells are prone to clogging and may need periodic maintenance (Fetter 1994). Additionally, states, provinces, or regions may have water-quality standards for any water that is reinjected; many locales require a permit for injection wells.

Satkin and Bedient (1988) found that the best well pattern for cleanup was highly site-specific. They also found that even with the same well pattern, variation in the placement of the wells yielded different cleanup times. When the hydraulic gradient is low, the doublet, double cell, and three-spot patterns were very effective. Under conditions of high hydraulic gradient, the centerline was most effective. In this pattern the downgradient injection well, which must be located beyond the leading edge of the plume, creates a hydraulic barrier to further migration of the plume. The five-spot pattern was not found to be very effective under any conditions.

9.3.5 Permanent Plume Stabilization

Decades of experience with pump-and-treat technology showed that in most cases it is not feasible or even technically possible to fully remediate a badly contaminated aquifer by pump-and-treat technology. This is especially true if the source cannot be located and removed, for example, if there are nonbiodegradable residual DNAPLs present in a fractured rock aquifer. For such aquifers the only feasible technology might

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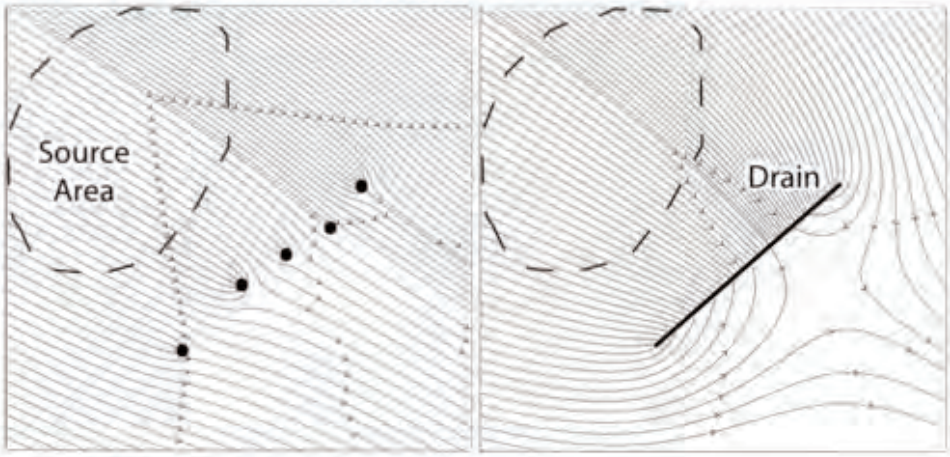
well is insufficient to prevent the plume from growing. Pumping at the source zone and downgradient improved the situation but some contaminated groundwater still escaped downgradient. Only the installation of a mid-gradient well prevented the escape of contaminated groundwater. The modeling results underline the importance of source control pumping and the establishment of sufficiently large downgradient capture zones to prevent continued offsite migration of contaminated groundwater.

A different approach to plume containment is to construct a **French drain** perpendicular to the direction of the plume migration. Such a drain system is typically constructed by excavating a ditch to the maximum depth of the plume and back filling it with gravel or other highly permeable material. Embedded at the base of the trench is a horizontal perforated pipe that connects to a vertical well. Contaminated water intercepted by the trench is collected by the pipe and then pumped to the surface for further treatment. As shown in Figure 9.19, a French drain may provide more effective plume containment than a series of extraction wells (Cohen et al. 1997). These drain systems are limited to comparably shallow plumes in unconsolidated material because digging deep trenches (>>30 m or >100 ft) is typically cost prohibitive and often not feasible, particularly if the sediment is unstable and prone to caving. Constructing French drains in bedrock is generally possible, but typically too expensive.

Figure 9.19 Compared to a line of conventional pump-and-treat wells (left), a plume emanating from an up gradient source zone can be effectively intercepted by a trench drain constructed perpendicular to the main axis of groundwater flow (right).



Source: Cohen et al. 1997.

■ 9.4 Treatment of Extracted Groundwater

9.4.1 Overview

It is often necessary to withdraw water during site remediation projects and that water must be treated *ex situ* according to the type of contamination. Different types of treatment are needed for water contaminated with heavy metals or that is contaminated by dissolved organic compounds. Similarly, the treatment approach will be different for compounds that are volatile versus those that are not, or those pollutants that can be chemically or physically destroyed or converted into non-toxic compounds versus

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those that cannot. Most of the treatment techniques that are used were developed for wastewater and have been adapted to contaminated groundwater. Generally, there are two types of treatment approaches (1) separation and (2) destruction technologies. Examples for the former include adsorption to granular activated carbon (GAC), or air stripping. Destruction technologies include, for instance, UV oxidation and other advanced oxidation processes or biological treatment methods. These and other *ex situ* treatment technologies for contaminated groundwater are described in detail on the Federal Remediation Technologies Roundtable (FRTR) or EUGRIS websites and other online information depositories introduced in Section 9.1. Some of these treatment technologies require the contaminated matrix, soil or groundwater, to be transported to the treatment facility; others can be easily set up on the contaminated site. The treatment methods for contaminated soil and sediment are not covered in this chapter.

The design of a treatment system must be cost effective. To this end the designer must consider the trade-off between capital costs and operating costs. Extraction systems can be designed by the hydrogeologist to withdraw the maximum volume of water in the shortest period of time. This yields the fastest, but not necessarily the most cost-effective cleanup of the aquifer. The size of the treatment plant is dictated by the maximum rate by which water will be pumped for treatment. The capital costs for the treatment plant include the treatment vessels, pumps, piping, and tanks. The greater the flow rate at which contaminated water is pumped through the treatment system, the larger these items must be and the greater the initial capital costs.

Operating costs include the electricity to run the plant, the cost of chemicals, the labor to operate the plant, and the cost of repairs. Some of the operating costs will be continuous no matter how long the project lasts (e.g., the cost of chemicals used to treat the water). If the same total volume of water is treated, the same amount of chemicals will be needed, no matter how long or short the treatment period. Other costs, such as labor, depend primarily upon the length of time of the operation. If the total volume of contaminated water is treated over a very short period of time, there will be high initial capital costs for the large-capacity plant and low operating costs because of the short time period. If the same volume of water is pumped over a longer period of time, the capital costs will be lower, since a smaller treatment plant is needed, but the operating costs will be higher. The smallest treatment plant possible is that needed to treat the quantity of water generated by the minimum pumping rate, which is just high enough to capture the plume. There will be some optimum treatment rate that minimizes the combined capital and operating costs.

9.4.2 Treatment of Inorganic Contaminants

The majority of inorganic contamination needing treatment consists of metals, which can be removed by precipitation or adsorption. Often the treatment involves mixing of reactive agent(s) into the extracted contaminated water. Many metal hydroxides precipitate at a specific alkaline pH value. For these metals, adjustment of pH by adding lime can cause precipitation of the metal hydroxide, which is removed via a clarifier followed by filtration. Ferrous iron can be removed by aeration to create ferric iron, which will precipitate at a slightly alkaline pH. Hexavalent chromium must first be reduced to the trivalent state by lowering the pH to 3 and then adding a reducing agent such as sulfur dioxide. The trivalent chromium can then be precipitated as a

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hydroxide by raising the pH above the neutral value. Arsenic can be coprecipitated with iron by adding dissolved iron at a pH of 5 to 6 and then raising the pH with lime to between 8 and 9. Arsenic also adsorbs to activated alumina.

Inorganic compounds can be removed by ion exchange. This process uses a resin to adsorb and retain anionic or cationic contaminants from groundwater. In place of the toxic ions, the resin releases benign anions or cations, such as chloride and calcium. When the resin becomes saturated after all of the resin's functional groups have been occupied, it needs to be recharged before reuse, or possibly disposed and replaced. This treatment approach is used commonly for nitrate, which cannot be removed by precipitation. Ion exchange has also been used for removing radiogenic isotopes, like uranium (Botha, Bester, and Hardwick 2009). Inorganic contaminants can also be removed by reverse osmosis and electro dialysis. In reverse osmosis, water is pressured to flow through a semi-porous membrane. While the water molecule passes through the membrane, many molecules and ions cannot and are retained on the membrane surface. In case of electro dialysis, flow through a membrane is induced by an electric potential and because the membranes are cation- or anion-selective, either positive ions or negative ions will flow through and can be exchanges for benign ions. This method has been used to remove radium, uranium, arsenic, nitrate, perchlorate, and hardness from drinking water (U.S. EPA 2015) or to remove cooper, chromium and arsenic from chromated copper arsenate (CCA) treated timber waste water (Ribeiro, Mateus, and Ottosen 2000).

9.4.3 Treatment of Dissolved Organic Contaminants

Many of the organic contaminants found in groundwater are volatile. They can be stripped from the water by exposing the water to a flow of air. This is accomplished in an air-stripping tower (Figure 9.20). The tower is a tall cylinder filled with an inert packing material, typically made of polypropylene. The packing material is designed to have a very high porosity and a large total surface area. The contaminated water is sprayed into the top of the tower onto the packing material. A blower attached to the bottom of the tower forces air up the tower at the same time that the water, which was broken up into droplets by the spray nozzles, trickles down the packing material. The volatile organic chemicals vaporize from the water into the air and are expelled out of the top of the tower. Care must be taken that emissions from the air-stripping tower do not create an air-pollution problem. For this reason, the exhaust from the air stripper is typically treated by sorption onto activated carbon or a thermal treatment unit, as can be the case for gasoline type vapors. For typical air stripping towers 4.6 to 6 m (15 to 20 ft) in height and containing conventional packing, removal efficiencies of VOC are around 99%. The removal efficiencies can be improved by adding a second air stripper in series with the first, heating the contaminated water, or changing the configuration of packing material (FTRC 2015). A potential problem with air stripping is biological fouling, which describes the buildup of biofilms growing on the inside of the air stripping tower. If not attended to, biofouling can lead to decreasing treatment and eventually clogging of the system. Another common problem with air strippers is precipitation of iron or other minerals. Typically, if the treated groundwater contains more than 5 mg/liter iron or its hardness is greater than 800 mg/liter (FRTR 2015), it becomes likely that mineral precipitates will build up inside the stripper tower. Mechanical filters, such as sand beds, might be needed to filter the precipitated iron from the wastewater stream

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An uncontaminated, confined sand aquifer that was 1.5 m (5 ft) thick was instrumented with a line of injection and extraction wells located 6 m apart. The direction of groundwater flow from the injection to the extraction wells was parallel to the regional hydraulic gradient. Intermediate sampling wells were placed at distances of 1, 2.2, and 4 m (3 to 12 ft) from the injection wells. Depending upon the injection and withdrawal rates, travel times from the injection wells to the withdrawal wells were from 20 to 42 hr. When oxygenated water was injected into the aquifer prior to the biostimulation experiments, the oxygen was transported to the extraction wells with little loss.

The compounds that were selected for study were vinyl chloride (VC), *trans*-1,2-dichloroethene (t-DCE), cis-1,2-Dichloroethene (c-DCE), and trichloroethene (TCE). When these were injected prior to biostimulation, they were retarded in the rank order of TCE > t-DCE > c-DCE > VC. It was found that with a long period of injection prior to biostimulation, the sorption capacity of the aquifer could be saturated with respect to TCE, t-DCE, and c-DCE. After 1000 hr. of injection, the concentration of these compounds in the monitoring well located 1 m (~3 ft) from the injection well was found to be 90 to 95% of the injected concentration.

After the aquifer reached steady-state concentrations of the organic halides, it was biostimulated by injecting alternating pulses of dissolved oxygen and methane, along with continuous injection of the organic halides. The methane acted as the primary substrate (electron donor) for the growth of indigenous methane-utilizing bacteria, while the oxygen was the electron acceptor. The organic halides were degraded by cometabolism, a process by which the methantrophic bacteria that are utilizing the methane produce enzymes that are able to degrade the chlorinated ethenes. During the biostimulation experiments, decreases in concentration of both methane and the organic halides were observed. Within 2 m (6 ft) of travel through the aquifer, VC was reduced by 90 to 95%, t-DCE by 80 to 90%, c-DCE by 45 to 55%, and TCE by 20 to 30%. Residence times in the aquifer were only 1 to 2 days for this amount of biodegradation. It took about three weeks for the biostimulation experiment to reach these steady-state rates of reduction. An intermediate degradation product, *trans*-dichloroethene epoxide, was detected. When the injection of methane was halted, the concentration of the epoxide quickly decreased and the concentration of the halogenated ethenes slowly increased. However, when the rate of methane addition was increased beyond a certain concentration, it was shown to reduce the rate of transformation of VC and tDCE. Thus, while methane was necessary for stimulating *in situ* aerobic biotransformation, there appears to be an optimal concentration beyond which it inhibits the process.

9.11 Conceptual Site Models

The bioremediation approach serves as an example for the complexity of the biochemical and hydrogeologic interactions and their dependency on aquifer characteristics and the physical/chemical properties of the contaminant(s). Failure to understanding these conditions can determine the success or failure of site cleanup activities. Therefore, the development of a conceptual model of the site is an essential part of the site remediation process. Such a model is referred to as a conceptual site model (CSM). A CSM develops during the course of a site investigation. Elements of a CSM include at minimum a conceptualization of the processes that determine contaminant releases, contaminant migration, and the relationship between contaminant sources and receptors. The CSM is used to integrate all site information and data and to determine whether data gaps exist and whether additional information needs to be collected at the site. The model is used furthermore to facilitate the selection of remedial

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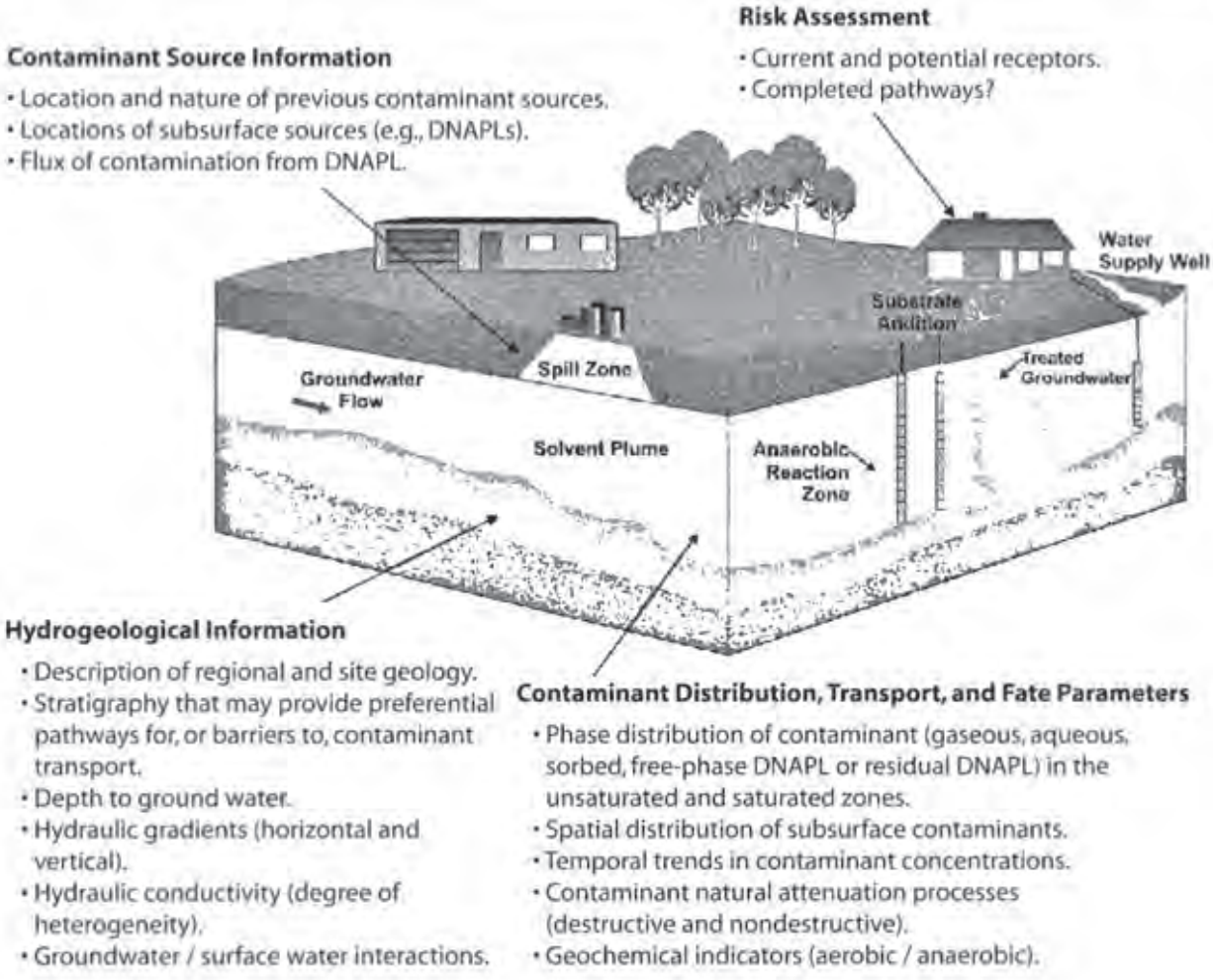
alternatives and to evaluate the effectiveness of remedial actions in reducing the exposure of environmental receptors to contaminants (ASTM 2014). The CSM should be maintained and refined as new information and data is collected from the initial assessment through site closeout. Different types of CSM are common, including text documents and pictorial and graphical depictions of current and future site conditions. Parsons Corporation (2004) provides an example of the elements of a graphical CSM (Figure 9.38). Typical CSM information needs and other elements of a CSM for sites contaminated with unexploded ordnance and/or other hazardous, toxic, and radioactive waste is provided by the U.S. Army Corp of Engineers (2012).

FIGURE 9.38 Elements of a Conceptual Site Model.



Source: Parsons Corporation 2004.

9.12 Permeable Reactive Barriers

A permeable reactive barrier (PRB) is a subsurface emplacement of reactive materials through which a dissolved contaminant plume must move as it flows, typically under natural gradient conditions. Treated water exits on the other side of the PRB. This *in*

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situ method for remediating dissolved-phase contaminants in groundwater combines a passive chemical or biological treatment zone with subsurface fluid flow management (U.S. EPA 2015d). The purpose of a PRB is to intercept a contaminant plume and prevent it from migrating to downgradient receptors, such as drinking water wells.

The concept of placing reactive materials in the path of a plume was developed based on observations by Reynolds et al. (1990). The authors noticed that at their field site concentration of dissolved chlorinated compounds were systematically lower in wells with galvanized iron casing compared to wells constructed from non-metallic pipe material. Laboratory experiments showed that metallic or zero valent iron (ZVI) reacted with the chlorinated compounds and degraded them to non-toxic products, such as ethane and ethane (Gillham and O'Hannesin 1994). The first field trial of a PRB was carried out by Gillham and O'Hannesin on the Canadian Air Force Base Borden, Ontario in 1991. A trench of up to 6 m (20 ft) in length and 2.5 m (8 ft) deep was excavated and backfilled with a mix of 22% of granular iron from a local foundry and 78% coarse sand. The total volume of the reactive matrix was 20 m^3. The groundwater flow velocity in the unconfined sandy aquifer at the site was 9 cm/day (0.3 ft/day). The groundwater concentration of TCE was 258 mg/L and 68 mg/L for PCE. After installation, approximately 90% of the TCE and 86% of the PCE were removed within this proto-type PRB system, with no measurable decrease in performance over the first five year duration of the test. All degradation intermediates, including *cis*-1,2-DCE, were degraded within the reactive barrier. Changes in water chemistry indicated that calcium carbonate was precipitating within the reactive material. However, the clogging caused by the precipitates was inconsequential for the performance of the system within the five year study period. The authors concluded that full removal would have been achieved by increasing the amount of ZVE (O'Hannesin and Gillham 1998). Since these early trials, more than 200 reactive barriers have been installed and PRB technology is now an accepted practice for groundwater remediation, particularly for the treatment of dissolved chlorinated VOC plumes (ITRC 2011).

In situ PRB systems are typically constructed by digging a continuous trench perpendicular to the flow direction of a groundwater plume (Figure 9.39). After excavation, the trench is backfilled with a mix of reactive material and coarse sand and gravel, which provides the mix with a hydraulic permeability and porosity that is greater than the surrounding natural sediments. The length and depth of the PRB is determined by the dimensions of the groundwater plume, i.e., the trench must be large enough to capture the entire plume in both horizontal and vertical direction. If possible, the trench is anchored in a less permeable stratum, such as a clay layer, to prevent the plume from diving under the treatment system. In some cases, funnel-and-gate PRB systems have been installed in which an impermeable barrier blocks the advancing plume and redirects (funnels) the flow of contaminated groundwater through an opening (gate) in the wall and into a PRB system (ITRC 2005a). A funnel-and-gate system is depicted in Figure 9.39. The length of PRB systems is limited by site conditions and typically ranges from a few meters to a few hundred meters. The depth, however, is limited by the equipment available to excavate the trench. Trenches excavated with conventional equipment, such a back hoes or chain trencher, are comparably shallow (10 to 15 m or 33 to ~50 ft). Depths of 20 m (66 ft) or more can be achieved by caisson installation or cofferdam/sheet pile methods. Alternatively, the reactive material can be mixed *in situ*

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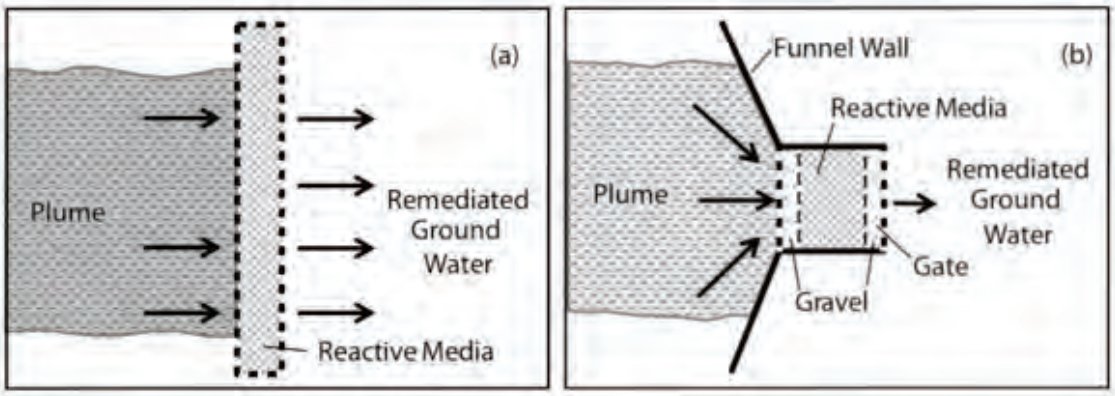
into the treatment zone or slurries of reactive materials can be directly injected into the subsurface. The cost of constructing the trench and backfilling it with reactive material is the major cost driver of this remediation technology.

FIGURE 9.39 Permeable reactive barrier (PRB) designs (map view). (a) Continuous trench and (b) Funnel-and-gate systems.



The thickness of the PRB wall is a critical design parameter. It depends on hydrogeologic factors, (such as groundwater flow velocities and flow directions which may change over the seasons), the strength and chemical make-up of the source zone including which contaminants are present and how much mass of dissolved contaminant must be treated, and the reactivity of the PRB material, including the geochemical conditions that can influence the reactive material, such as the pH of the groundwater. The reactivity of the material inside a PRB can be quantified in terms of a reaction rate constant or the half-life time of the contaminant coming in contact with the reactive material. Because some contaminants, including PCE and TCE, undergo sequential degradation, which involves the production of toxic intermediates, such as vinyl chloride, reaction rates for each compounds need to be taken into consideration. If the flow-through thickness and contaminant residence time inside the PRB is underestimated, still-contaminated water will emerge on the downgradient side of the wall. It is therefore not surprising that extensive laboratory and field tests are required to ensure the field performance of a PRB system. A lot of practical information about the proper installation of PRB systems has been accumulated over the past two decades and many PRB installations manuals and guidance documents are available on the internet, including Gavaskar et al. (2000) and ITRC (2011).

Zero-valent iron based PRBs are most commonly used for the *in situ* treatment of chlorinated aliphatic VOC, such as PCE and TCE. The reactions involved in the degradation of chlorinated VOC by metallic iron (Fe^0) within a PRB are abiotic in nature. Zero valent iron is a mild reductant and can react with dissolved oxygen (Eqn. 9.1) and to some extent with water (Eqn. 9.2):

$$2Fe^0_{(S)} + 4H^+_{(aq)} + O_{2(aq)} \rightarrow 2Fe^{2+}_{(aq)} + 2H_2O \quad \textbf{(9.1)}$$

$$Fe^0_{(S)} + 2H_2O \rightarrow Fe^{2+}_{(aq)} + H_{2(aq)} + 2OH^-_{(aq)} \quad \textbf{(9.2)}$$

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These two equations illustrate the corrosion (=oxidation) of iron when coming in contact with oxygen or water. The two electrons released during the oxidation of iron can be readily accepted by chlorinated hydrocarbons, which are degraded via reductive dehalogenation, as shown in Equation 9.3

$$\begin{array}{lll} Fe^0 \rightarrow Fe^{2+} + 2e^- & & \text{Oxidation} \\ RCl + 2e^- + H^+ \rightarrow RH + Cl^- & & \text{Reduction} \\ \hline Fe^0 + RCl + H^+ \rightarrow Fe^{2+} + RH + Cl^- & & \text{Net Reaction} \end{array} \quad \textbf{(9.3)}$$

The products of the reductive dechlorination reaction are chloride (Cl^-), ferrous iron (Fe^{2+}), less chlorinated hydrocarbons, and hydrogen. Dechlorination of chloroethenes and chloroethanes is complete with ethene and ethane as the final carbon-containing compounds, respectively (Orth and Gillham 1996; Fennelly and Roberts 1998). The corrosion of the iron can generate large amounts of iron oxides and (oxy)hydroxide precipitates, which may eventually decrease the porosity and permeability of the reactive material within the PRB; particularly at the upgradient side of the barrier. However, these iron precipitates can convert to magnetite, which does not passivate the reactive surface of the iron. Also, field experiences from many PRB sites indicate that the loss of permeability due to precipitation is a relatively slow process that takes decades to cause significant changes in the hydraulic performance of the system. If installed properly, it is therefore likely that the dechlorination reaction is sustainable for many years of PRB operation (EPA 1998).

The degradation of chlorinated hydrocarbons by ZVI is a stepwise process during which intermediates are produced, such as *cis*-1,2-dichloroethene, vinyl chloride or chloroacetylene in cases where the parent compound is TCE or PCE. The degradation reactions are typically described using pseudo first-order kinetics with respect to the halogenated hydrocarbon, with the rate constant relatively insensitive to the initial hydrocarbon concentration (IRTC 2011).

$$C = C_0^{-k't}$$

or:

$$\ln\left(\frac{C}{C_0}\right) = -k't$$

where C_0 and C are the concentrations of the chlorinated compound of the influent and at time t, respectively. The pseudo-first order rate constant is k, which equals the first order rate constant, k, when the concentration of the iron remains constant. Dehalogenation rates vary for the different halogenated contaminants. The primary determinant of degradation rate is the iron surface area, i.e., the surface area of iron per unit volume of pore water. For this reason, some PRB designs are based on nanoscale iron particles, which have larger surface areas and higher surface reactivity compared to conventional granular iron. Nanoscale iron particles range in size from approximately 10 to 100 nm and have a high iron content (>99.5% Fe) (Zhang 2003).

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The reaction rates can be enhanced further by coating the iron particles with metallic catalyst, such as palladium (Li and Farrel 2000). One advantage of nanoscale iron particles is that slurries of these particles can be injected directly into the treatment zone. This approach alleviates the need of excavating a trench and back-filling it with mixes of ZVI and highly permeable sand/gravel materials.

Dissolved chlorinated compounds were the first groundwater contaminants treated by *in situ* PRB systems using metallic iron as the reactive material. Since then, the list of ZVI treatable compounds has rapidly expanded and now includes many other organic and inorganic contaminants (Table 9.2). For instance, metallic iron can **transform** explosives, such as TNT (Johnson and Tratnyek 2008), and pesticides, e.g., Lindane (U.S. EPA 2002) or can **immobilize** inorganic ions, such as arsenic (VI) and chromium (VI). Particularly metals that occur as anions exhibit a high degree of mobility because anions do not readily sorbed to the predominantly negatively-charged aquifer materials. For example, chromium (VI) is usually speciated as chromate, CrO_4^{2-}, which is a known carcinogen. The anion is comparably soluble under typical near-neutral pH and only slightly negative Eh conditions in typical aquifers. However, when reduced to trivalent Cr(III), relatively non-toxic and little soluble precipitates are formed. The immobilization of Cr(VI) by iron is a two-step process: first, Cr(VI) is reduced to Cr(III) (Eqn. 9.4). Subsequently, the Cr(III) precipitates as Fe(III) oxyhydroxide (Eqn. 9.5) (U.S. EPA 1998):

$$CrO_4^{2-} + Fe^0 + 8H^+ \rightarrow Fe^{3+} + Cr^{3+} + 4H_2O \quad \textbf{(9.4)}$$

$$(1-x)Fe^{3+} + (x)Cr^{3+} + 2H_2O \rightarrow Fe_{(1-x)}Cr_xOOH_{(s)} + 3H^+ \quad \textbf{(9.5)}$$

The mechanisms of Cr(VI) reduction by Fe(0) and their effects on the pH and Eh conditions of the system have been described by Powell et al. (1995) and Powell and Puls (1997). At some sites, Cr(VI) occurs together with other contaminants, such as TCE. Research has shown that it is possible to simultaneously treat both chromium and TCE with ZVI (U.S. EPA 1998).

While ZVI remains the most widely used reactive material used in PRB systems, an increasing number of new reactive materials and variations of the PRB based treatment approach are being developed and tested. These advances are greatly expanding the number of treatable groundwater contaminants. They also make it possible to apply this technology to hydrogeologic environments other than the unconsolidated aquifers for which PRB was initially developed. For example, a fractured bedrock aquifer comprised of shale and siltstone is contaminated with PCE at a manufacturing plant in northern New Jersey, USA (U.S. EPA 2011b). The main source area is located in shallow bedrock to a depth of approximately 13 m (42.5 ft) below ground surface, with some contamination in deeper parts of the aquifer. The lateral extent of the PCE plume is approximately 25 m (80 ft) by 37 m (120 ft). The plume was approximately 1.2 km (4,000 ft) in length prior to treatment. A pump-and-treat system and later, an enhanced bioremediation system were installed for containment of the PCE plume. After observing some reduction of contaminant flux, a nanoscale zero-valent iron injection was proposed as a more aggressive strategy. Before the injection of the nanoscale particles into the bedrock, the hydraulic communication within the fracture network was improved by hydrofracturing. This technology involves applying

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TABLE 9.2 Common environmental contaminants that can be transformed by ZVI, including bimetallic and nanoscale iron particles.

Chlorinated methanes	Chlorinated ethenes/ethanes	Chlorinated benzenes	Trihalomethanes
Carbon tetrachloride (CCl_4)	Tetrachloroethene (C_2Cl_4)	Hexachlorobenzene (C_6Cl_6)	Bromoform ($CHBr_3$)
Chloroform ($CHCl_3$)	Trichloroethene (C_2HCl_3)	Pentachlorobenzene (C_6HCl_5)	Dibromochloromethane ($CHBr_2Cl$)
Dichloromethane (CH_2Cl_2)	*cis*-Dichloroethene ($C_2H_2Cl_2$)	Tetrachlorobenzenes ($C_6H_2Cl_4$)	Dichlorobromomethane ($CHBrCl_2$)
Chloromethane (CH_3Cl)	*trans*-Dichloroethene ($C_2H_2Cl_2$)	Trichlorobenzenes ($C_6H_3Cl_3$)	
	1,1-Dichloroethene ($C_2H_2Cl_2$)	Dichlorobenzenes ($C_6H_4Cl_2$)	
	Vinyl chloride (C_2H_3Cl)	Chlorobenzene (C_6H_5Cl)	
	1,1,1-trichloroethane ($C_2H_3Cl_3$)		
	1,1,2-trichloroethane ($C_2H_3Cl_3$)		
	1,1-dichloroethane ($C_2H_4Cl_2$)		
Other polychlorinated hydrocarbons	Pesticides	Organic dyes	Other organic contaminants
Dioxins	DDT ($C_{14}H_9Cl_5$)	Orange II ($C_{16}H_{11}N_2NaO_4S$)	TNT ($C_7H_5N_3O_6$)
Pentachlorophenol (C_6HCl_5O)	Lindane ($C_6H_6Cl_6$)	Chrysoidine ($C_{12}H_{13}ClN_4$)	RDX ($C_3H_6N_6O_6$)
PCBs		Tropaeolin O ($C_{12}H_9N_2NaO_5S$)	N-nitrosodimethylamine (NDMA) ($C_4H_{10}N_2O$)
		Acid Orange	
		Acid Red Arsenic (AsO_3^{-4})	
Heavy metal ions	Radiogenic ions	Inorganic ions	
Mercury (Hg^{2+})	Uranium (U VI)	Perchlorate (ClO^{-4})	
Nickel (Ni^{2+})	Technetium (Tc VII)	Nitrate (NO^{-3})	
Silver (Ag^{+})		Dichromate ($Cr_2O_2^{-7}$)	
Cadmium (Cd^{2+})		Selenium (Se IV)	
		Arsenic (As VI)	

Source: Modified after Zhang 2003 and U.S. EPA 1998.

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high hydrostatic pressures to the well wall until the solid bedrock fractures. The newly opened fractures permit enhanced injection and farther reach of the nanoparticle slurry into the bedrock. Following hydrofracturing, approximately 800 pounds of nanoscale iron particles was delivered through four injection wells. Performance monitoring of the ZVI injection indicated significant impacts on source area geochemistry, including increased pH levels (~9) and low ORP values (-500 mV). Although it is likely that the iron particles did not reach all contaminated areas of the bedrock aquifer, it appears that amount of injected iron was sufficient to control both the primary PCE source and any back diffusion from the shale and siltstone matrix.

Innovative reactive materials for PRB include surfactant-modified zeolites, metal hydroxides or carbonates, organoclays, peat moss, mulch, compost and agricultural waste products (Thiruvenkatachari et at. 2008). Zeolites are clay minerals that have an elevated permeability (for a clay) and a high capacity for cation exchange. When coated with non-ionic surfactants, the surface of the zeolites becomes more hydrophobic, which makes it attractive to non-polar organic compounds. When modified with cationic surfactants, the zeolite surface has a positive charge and hence a greater affinity for anions, such as dissolved chromate (Bowman 2003; Misaelides 2011). Surfactant modified zeolites retain some of their cation ion exchange capacity. Peat moss has an affinity for both heavy metal ions, such as nickel or uranium and anions, e.g., chromate. Compounds like mulch or agricultural waste products used in PRBs are intended to be long-term sources of organic carbon or, in case of compost, serve as a source of nutrients (IRTC 2011). For instance, Lu et al. (2008) investigated the performance of pilot-scale permeable reactive barrier filled with plant mulch that was installed at Altus Air Force Base in Oklahoma, USA in 2002. The barrier was 139 m long (~450 ft), 7 m deep (~2 m), and 0.5 m (1.6 ft) wide and was constructed to treat trichloroethylene (TCE) contamination in groundwater emanating from a landfill. Data from over four years' monitoring indicated that the PRB stimulated TCE degradation to cis-DCE and vinyl chloride. Ongoing biodegradation reactions were corroborated by the detection of TCE degrading bacteria DNA (*Dehalococcoides*) and the detection of vinyl chloride within and downgradient of the PRB.

Systems like the one described by Lu et al. (2008) are also called **biowalls** or **bio barriers**. These *in situ* biowalls use solid low-cost organic materials, such as mulch or compost, to stimulate anaerobic degradation of chlorinated solvents, energetic (e.g., perchlorate) and explosive compounds (e.g., TNT, anions (nitrate and sulfate), and heavy metals (e.g., chromium and cadmium). Biowall materials can be amendment with, for example, emulsified vegetable oil, to stimulate both biotic and abiotic degradation processes. This permits to optimize biowall performance based on the type of contaminant(s) present and the desired degradation pathway(s) to be stimulated (Air Force Center for Engineering and the Environment 2008). Typically, biowalls stimulate anaerobic degradation processes, including reductive dechlorination and biotic anaerobic oxidation, and therefore are most often used for treating dissolved chlorinated compounds like PCE and TCE and their degradation products (DCE isomers and vinyl chloride). According to the ITRC (2011), an advantage of biological PRB systems over purely abiotic systems, such a ZVI, is that the treatment processes may extend downgradient of the constructed treatment zone due to migration of soluble organic carbon, enabling the effects of anaerobic degradation beyond the biowall. In addition,

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the biowall system can be amended with specific bacteria (bioaugmentation) to target one or multiple contaminants and accelerate their degradation. A drawback is that the longevity of biowalls is anticipated to be shorter than that of ZVI walls and replenishment of organic substrate may be required.

The geochemistry of the solution inside a PRB system and downgradient can be adjusted by materials to buffer pH (e.g., limestone gravel) or to adjust the redox potential and further stimulate abiotic biogeochemical transformation processes (e.g., addition of reactive iron sulfite minerals, such as pyrite or mackinawite). The redox conditions in the treatment zone can also be manipulated by injecting sodium dithionite solution. The dithionate reduces ferric iron (Fe III) that is naturally present in the aquifer material to ferrous iron (Fe II). The presence of Fe(II) in the treatment zone can reduce, for example, soluble Cr(VI) to Cr(III) precipitates (Naftz et al. 2002). Also, the injection of oxidants, like hydrogen peroxide (H_2O_2) or potassium permanganate ($KMnO_4$) into the PRB can create strongly oxidizing conditions that are suitable for the *in situ* chemical oxidation and destruction of many organic contaminants, including BETX and other petroleum hydrocarbons (Thiruvenkatachari et at. 2008). Finally, sorbing barriers systems have been developed which use granular activated carbon or ion exchange materials. However, these systems have a limited live time and need to be replacement when the capacity of the sorbent is exhausted.

There now are a great variety of the reactive materials and amendments that permit tailoring the PRB treatment to specific contaminants, including once that cannot be treated with the original ZVI approach, e.g., BTEX compounds. Barriers of different chemistries may also be placed sequentially which further increases the treatment options for contaminated site managers. It is likely that future research into PRB system will further enhance the applicability of this remediation approach.

■ 9.13 Chemically-Enhanced *In Situ* Flushing

Some chemicals, such as surface active agents (surfactants), complexing agents (cyclodextrins) or cosolvents (alcohols), can increase the solubility of otherwise slightly soluble hydrophobic organic contaminants, such as petroleum hydrocarbons or chlorinated solvents. In case of some metals or ionic organic contaminants, a similar solubility enhancing effect can be achieved by injecting acidic, basic, or reducing solutions. When injected into the aquifer and flushed through the contaminated source zone, these solubility enhancing agents increase the aqueous phase concentration of the contaminants, sometimes by orders of magnitude. After its passage through the treatment zone, the flushing solution is extracted and treated at the surface. Therefore, in its most basic form, chemically-enhanced flushing technology can be considered an enhancement of pump-and-treat in which water is the flushing solution. Compared to P&T, chemically-enhanced flushing is a much more aggressive and relatively rapid treatment approach with treatment durations often an order or two magnitudes shorter than P&T (ITRC 2009a).

In situ flushing is considered a mature remediation technology. The chemically-enhanced flushing approach is used predominantly to remediate source zones, particularly residual NAPL compounds. It is less well suited for the treatment of dissolved plumes or contaminants residing in the unsaturated zone. Flushing is most efficient in relatively homogeneous and permeable (hydraulic conductivity $>10^{-3}$ cm/sec) soil

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the biowall system can be amended with specific bacteria (bioaugmentation) to target one or multiple contaminants and accelerate their degradation. A drawback is that the longevity of biowalls is anticipated to be shorter than that of ZVI walls and replenishment of organic substrate may be required.

The geochemistry of the solution inside a PRB system and downgradient can be adjusted by materials to buffer pH (e.g., limestone gravel) or to adjust the redox potential and further stimulate abiotic biogeochemical transformation processes (e.g., addition of reactive iron sulfite minerals, such as pyrite or mackinawite). The redox conditions in the treatment zone can also be manipulated by injecting sodium dithionite solution. The dithionate reduces ferric iron (Fe III) that is naturally present in the aquifer material to ferrous iron (Fe II). The presence of Fe(II) in the treatment zone can reduce, for example, soluble Cr(VI) to Cr(III) precipitates (Naftz et al. 2002). Also, the injection of oxidants, like hydrogen peroxide (H_2O_2) or potassium permanganate ($KMnO_4$) into the PRB can create strongly oxidizing conditions that are suitable for the *in situ* chemical oxidation and destruction of many organic contaminants, including BETX and other petroleum hydrocarbons (Thiruvenkatachari et at. 2008). Finally, sorbing barriers systems have been developed which use granular activated carbon or ion exchange materials. However, these systems have a limited live time and need to be replacement when the capacity of the sorbent is exhausted.

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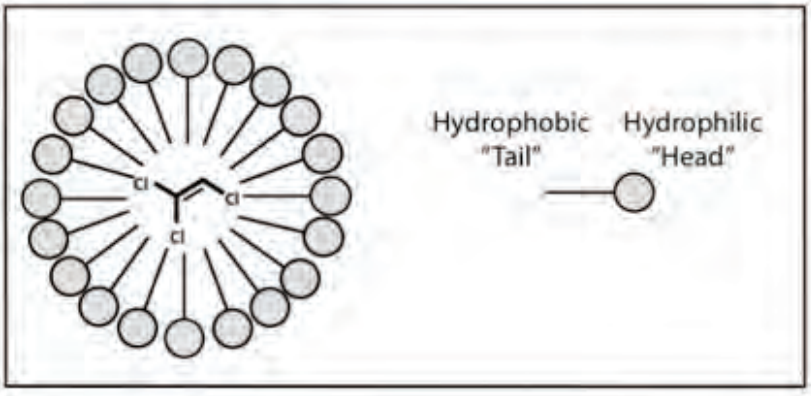
(Naval Facilities Engineering Command 2002). Heterogeneous aquifer conditions, including fractured bedrock aquifers, typically stand in the way of effectively flooding the treatment zone because lower permeable zones may be by-passed. Chemically-enhanced flushing is sometimes used in combination with other *in situ* remediation technologies, such as bioremediation or *in situ* oxidation (e.g., Dugan et al. 2010). Although their effect on the solubility of contaminants is similar, there are major differences between surfactant, cosolvent, or complexing agents. The following sections provide a brief overview of these agents. One disadvantage is that field applications typically have limited areal extent. For further readings, there have been a great number of papers, books, and manuals written about these flushing agents (e.g., Keuper et al. 1997; Lowe et al. 1999; Ward et al. 2000; Boving and Brusseau 2000; Naval Facilities Engineering Command 2002; 2003; ITRC 2003; Pennel et al. 2014).

9.13.1 Surfactant Enhanced *In Situ* Flushing

Surfactants are amphiphilic organic molecules that have both hydrophobic and hydrophilic moieties. When dissolved in water, surfactant molecules tend to cluster together and form **micelles** (Figure 9.40). These micelles aggregate when a specific threshold, known as critical micellar concentration (CMC), is exceeded. In water, the hydrophilic "heads" of the dissolved surfactant molecules point towards the aqueous phase, assuring that surfactants are highly water soluble. The hydrophobic "tails" of the surfactant molecule project inside the micelle. The "heads" and "tails" of surfactant molecules are typically separated by hydrocarbon chains. The non-polar core of these micelles attracts equally non-polar compounds, like TCE or other chlorinated solvents. This partitioning of hydrophobic contaminants into the micelle structure is the basis of the surfactant enhanced flushing technology, which is also referred to as Surfactant Enhanced Aquifer Remediation (SEAR). The enhancement of contaminant solubility is directly proportional to the concentration of the surfactant above the CMC.

Surfactants also reduce the interfacial tension between the aqueous and NAPL phases. At very low interfacial tensions, larger globules of NAPL spontaneously break

FIGURE 9.40 Surfactants are amphiphilic compounds; they have both hydrophobic and hydrophilic moieties. Above the critical micelle concentration, surfactant molecules aggregate into micelles. Hydrophobic contaminants (TCE shown here) can partition into the hydrophobic interior of the micelle.



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up into tiny droplets of about 5 to 50 nm in radius. At that point, the system consists of water, NAPL droplets and surfactants and is called a **microemulsion**. The reduction in interfacial tension and formation of microemulsions can be exploited to **mobilize** NAPL. Relative to surfactant enhanced solubilization, NAPL mobilization can remove more contaminant mass in less time. But, in case of DNAPL, there is greater risk of uncontrolled downward movement, as DNAPL is being physically displaced by the surfactant solution. When injecting surfactant solution with the primary purpose of inducing mobilization, it is therefore necessary to prevent vertical DNAPL migration. This can either be achieved by having competent bedrock or a capillary barrier underlying the treatment zone or by manipulating the density the DNAPL, for example, by co-injection of cosolvents. Because of the risk of vertical displacement, mobilization flooding should only be considered when there is a high degree of certainty that the flushing solution can be recovered. In general, a surfactant flushing system can be tailored to remove contaminants either primarily by solubilization or primarily by mobilization (Pope 2015). Under appropriate site conditions, removal rates as high as 98.5% of the original DNAPL mass have been reported (Londergan et al. 1997). A number of very well documented field tests have demonstrated that *in situ* flushing can achieve these high removal percentages in months, and sometimes even days (EPA 2000).

Surfactants are produced at industrial scales and are one of the most widely used chemicals. Many different kinds of surfactants have been developed for a large number of applications, including detergents, fire-fighting agents (see Chap. 5) or pharmaceuticals and cosmetics. Depending on the charge of their polar heads, surfactant can be non-ionic., cationic or anionic. For most remediation applications, non-ionic or anionic surfactants are preferred because they do not sorb as strongly to the charged surfaces of natural minerals (i.e., clays) as cationic surfactants. Also, they are generally less toxic than cationic surfactants.

Case Study: Hill Air Force Base, Utah.

The Hill Air Force Base is located near Ogden, Utah, USA. The test site was used continuously from 1967 until 1975 for base-wide disposal of spent degreasing fluids and other solvents. At the site, DNAPL pooled within the topographic lows of a clay aquitard approximately 15 to 17 m (50 to 56 ft) below ground surface. The DNAPL was composed of approximately 70% TCE, 10% PCE, 5% TCA with other minor volatile organic constituents. In addition, there was a significant oil and grease fraction entrained in the DNAPL. The groundwater contaminants included PCE, TCE, TCA, DCE and trace heavy metals. The depth to groundwater was 8.3 m (27 ft). The unconfined aquifer consists of alluvial sands and gravel. The deposits are highly heterogeneous and are underlain by a thick uniform and continuous clay layer. The effective porosity of the aquifer is 20% and its hydraulic conductivity is 6×10^{-3} to 5×10^{-2} cm/sec (17 ft/day to 146 ft/day).

Prior to the surfactant flooding, a DNAPL source-recovery system was installed. Partitioning interwell tracer tests (PITT) were conducted pre- and post- surfactant flooding to characterize the DNAPL distribution and to demonstrate the removal efficiency of the surfactant treatment. The flushing solution injected into the treatment zone consisted of 8% an anionic surfactant (Aerosol MA-801) and 4% isopropyl alcohol. About 0.7% of sodium chloride was added to adjust the ionic strength of the mixture. The solution decreased the interfacial tension between the surfactant solution and the DNAPL to 0.02 dynes/cm. About 2.4 pore volumes of the flushing solution were injected during a 3 day period, followed by 5.5 days

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compounds by self-sustaining smoldering processes (Switzer et al. 2009; Pironi et al. 2009). This approach is commercialized as self-sustaining treatment for active remediation (STAR) technology.

ISTT field applications are growing in number, partially because clean up goals can be achieved quickly, often within days or weeks. ESTCP (2010) provides a critical evaluation of 182 ISTT applications conducted between 1988 and 2007. Of those 182 applications, 87 used electrical resistance heating, 46 steam-based heating, 26 conductive heating, and 23 other heating technology applications. Measured in terms of reducing contaminant concentration and mass flux from the treatment zone, improvements ranged from less than 10 to over 1000 times. Overall, the electrical resistance heating and thermal conductive heating variants of ISTT are less affected by heterogeneous and low-permeability lithologies (EPA 2014a), which is why *in situ* thermal technology performance appears less hindered by the geologic stratification and mass-transfer resistances that limit other *in situ* remediation technologies (Triplett Kingston, Dahlen, and Johnson 2010).

■ 9.15 *In situ* Chemical Oxidation (ISCO)

In situ chemical oxidation (ISCO) refers to a groundwater remediation technology that relies on the chemical oxidation of a wide variety of dissolved contaminants by strong oxidants, such as permanganate (MnO_4^-), hydrogen peroxide (H_2O_2), ozone (O_3), catalyzed hydrogen peroxide (Fenton oxidation), persulfate ($S_2O_8^{2-}$), peroxone (H_2O_2 and O_3), or percarbonate. The reactive species and other properties of common oxidants are summarized in Table 9.4. Relative to each other, ozone and persulfate are stronger oxidants than permanganate and hydrogen peroxide. Fenton's reagent produces a variety of oxidizing species of different strengths.

An ISCO treatment system is similar to *in situ* enhanced flushing systems, except that generally no extraction well(s) is required. A solution of the oxidant in water is prepared on the site and then injected into the subsurface. Vertical injection wells and direct push probes are the most common delivery methods. As the oxidant solution moves through the treatment zone it comes into contact with the contaminant and degrades it into benign compounds, including carbon dioxide and water. The oxidant concentration and the amount of oxidant mass injected into the treatment zone must be determined beforehand based on the initial soil and groundwater contaminant concentrations. Also, natural organic matter (NOM) or reduced minerals, carbonate, and other free radical scavengers in the subsurface can reduce the amount of oxidant available to degrade the target compounds. Thus, the amount of ISCO reagent that can be potentially wasted on oxidant consuming compounds must be included into the oxidant dose calculations. This **natural oxidant demand** is an important ISCO design parameter and failure to consider it will influence the treatment performance and cost of the ISCO system. However, there is little advantage in an "over injection of oxidant" approach because there is the potential to enhance the release and migration of the target contaminants, generate excessive heat, and form undesired by-products, including precipitates (NRC 2005b; IRTC 2005; Siegrist et al. 2011).

Oxidizing agents like sodium or potassium permanganate, persulfate and percarbonate are solids, whereas hydrogen peroxide is a liquid and ozone is a gas. Because

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TABLE 9.4 Common oxidants and their most important oxidant reactions, including persistence and electrode potentials of the reactive species involved. Reduction potential is negative.

Oxidant	Reactive Species	Reactions	Persistence*	Electrode Potential (Eh)
Permanganate	Permanganate ion (MnO_4^-)	$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_{2(solid)} + 2H_2O$ ($3.5 < pH < 12$)	>3 months	1.7 V
Hydrogen peroxide	Hydrogen peroxide (H_2O_2)	$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$	min.-hrs	1.8 V
Ozone	Ozone (O_3)	$O_3 + 2H^+ + 2e^- \rightarrow O_2 + 2H_2O$	min.-hrs	2.1 V
	Hydroxyl radical (•OH)	$2O_3 + 3H_2O \rightarrow 4O_2 + 2 \cdot OH + 2H_2O$		2.8 V
Fenton's (catalyzed hydrogen peroxide)		$Fe_2^+ + H_2O_2 \rightarrow Fe^{3+} + \cdot OH + OH^-$ (initiation rxn)		
	Hydroxyl radical (•OH)	$2 \cdot OH + 2H^+ + 2e^- \rightarrow 2H_2O$		2.8
	Perhydroxyl radical ($\cdot OH_2$)	$\cdot OH_2 + 2H^+ + 2e^- \rightarrow 2H_2O$		1.7
	Superoxide radical ($\cdot O_2$)	$\cdot O_2 + 4H^+ + 3e^- \rightarrow 2H_2O$		–2.4 V
	Hydroperoxide anion (HO_2^-)	$HO_2^- + H_2O + 2e^- \rightarrow 3OH^-$		–0.9 V
Persulfate ($S_2O_8^{2-}$)	Persulfate ($S_2O_8^{2-}$)	$S_2O_8^{2-} + 2e^- \rightarrow 2 \cdot SO_4^{2-}$ (initiation rxn)	hrs-weeks	2.1 V
	Sulfate radical ($\cdot SO_4^-$)	$\cdot SO_4^- + e^- \rightarrow SO_4^{2-}$		2.6 V
Activated Persulfate ($S_2O_8^{2-}$)		$S_2O_8^{2-} + Heat^* \rightarrow 2 \cdot SO_4^-$ (initiation rxn)	min-weeks	2.1 V
	Sulfate radical ($\cdot SO_4^-$)	$2 \cdot SO_4^- + 2H_2O \rightarrow 2HSO_4^- + 2 \cdot OH$		2.6 V
	Hydroxyl radical (•OH)	$2 \cdot OH + 2H^+ + 2e^- \rightarrow 2H_2O$		2.8 V

* Literature values and estimates.

* Other persulfate activators: Fe^{2+}, elevated pH >10.5 and peroxone (H_2O_2 and O_3).

Source: Huling and Pivetz (2006); ITRC 2005b.

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ozone is inherently unstable, it must be produced at the site immediately before injection into subsurface. Permanganate salts might be delivered to the site in form of an aqueous solution. Most oxidants are hazardous chemicals that must be handled properly by trained field personnel.

ISCO treatment is applicable to variety of contaminants; however, chlorinated solvents are by far the most commonly treated ones. In an analysis of ISCO field applications and performance data, Krembs et al. (2010) found that of 223 sites analyzed, 70% treated chloroethenes and 8% chloroethanes. Other commonly treated contaminants include chlorobenzenes, BTEX and other petroleum hydrocarbons, incl. PAH and gasoline additives (MTBE). About 54% of sites contained NAPL. In general, fuel-related compounds, particularly MTBE, can be treated more effectively relative to chlorinated compounds. However, a number of organic compounds (e.g., PCB or perfluorinated flame retardants) are resistant or even impossible to treat with currently existing ISCO methods. Therefore, the development of advanced oxidation processes is an area of ongoing research.

ISCO is a comparably aggressive contaminant mass-reduction technology and primarily applied to NAPL source zones and groundwater plumes with high dissolved contaminant concentrations. ISCO has been implemented at sites with varied subsurface conditions, ranging from unconsolidated permeable and homogeneous materials to fractured bedrock environments. Generally, ISCO is a relative rapid treatment process that can achieve treatment goals within weeks or months. However, a comparably small percentage of ISCO treatments met pre-defined remediation goals, such as maximum contaminant levels (MCL) (Krembs et al. 2010). This may signify that remediation practitioners overestimated the performance of ISCO or underestimated the impact of site conditions on this technology.

Of the ISCO projects reviewed by Krembs et al. (2010), 89% combined the use of ISCO with other *in situ* remediation technologies. For instance, ISCO has been coupled with surfactants/cosolvents enhanced DNAPL removal, either in sequence or simultaneously (Dugan et al. 2010). Similarly, Eberle et al. (2017) reports on a pilot-scale field project where activated persulfate oxidant was used in combination with cyclodextrin, an enhanced solubilization agent discussed in Section 9.12. The advantage of combining the two treatment approaches is that the enhanced solubilization agent increases the mass of contaminant in solution and thereby makes it available for destruction by the oxidizing agent. This *in situ* "treatment train" approach, when performed as designed, can eliminate the need for extracting and *ex situ* treatment of contaminated liquids. Also, there is ample field site evidence that microbial populations are not permanently reduced by ISCO. In fact, it appears that microbial populations even flourish after ISCO treatment, which permits coupling ISCO with enhanced bioremediation or monitored natural attenuation (MNA) technologies (NRC 2005).

■ 9.16 Phytoremediation

Phytoremediation is a set of technologies that rely on plants and their associated microorganisms to sequester, extract, or degrade toxic compounds in groundwater, soils, sediment and surface water. Because it is a natural process, phytoremediation can be an effective remediation method for a variety of sites and contaminants,

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at a reduced rate. A large number of plants have been evaluated for potential use in phytoremediation applications. The selection of one or more plant species is based on factors such as ability to extract or degrade the contaminants of concern, adaptation to local climates, high biomass, depth root structure, compatibility with soils, growth rate, ease of planting and maintenance, and ability to take up large quantities of water through the roots (U.S. EPA 2012c). Recent developments in transgenic plant research may lead to a greater selection of plant varieties or the treatment of contaminants currently not possible (Lee 2013). The duration of the treatment generally depends on the type and initial contaminant concentration, its distribution within the treatment zone, plant selection and their growth rate, hydrogeologic and climatologic conditions, and other site characteristics.

Phytoremediation has become an alternative to other, more aggressive cleanup technologies because of relatively low capital costs and the inherently aesthetic nature of planted sites. However, this treatment technology is not a "Do something quick and cheap in the field and then walk away" approach. Like any remediation system, phytoremediation requires significant operation, maintenance, and monitoring for several years after planting. For instance, plants may require irrigation, fertilization, weed and pest control or replanting (ITRC 2009).

■ 9.17 Summary

There is great interest in developing effective and efficient methods of remediating contaminated soils and groundwater in order to meet the mandates of public concern and federal legislation such as RCRA and CERCLA in the United States.

In order to have a successful remediation, it is necessary to first isolate or remove the source of the contamination. Sources can include hazardous wastes spread on the land or improperly buried in the earth, leaking landfills, leaking underground storage tanks, or soils that have become contaminated by accidental spills and leaks. If it is not possible to remove sources, they can be isolated by physical barriers, such as slurry walls and impermeable covers or by hydrodynamic barriers created by pumping and injection wells.

While not very effective, contaminated groundwater can be pumped from the ground and treated. Pump-and-treat technologies can be effectively used to hydraulically control plumes. Before initiating a pump-and-treat program, any mobile NAPL present should be removed. Floating NAPLs can be removed by multi-phase extraction pumps located in wells. Residual NAPL and contaminants sorbed onto mineral surfaces and soil organic carbon will slowly partition into the clean groundwater that replaces the contaminated groundwater removed by pumping. This will greatly prolong the period of time that it takes to remediate the aquifer. If all the residual contamination is not removed from the aquifer, the concentration of contaminants will increase after the termination of a pump-and-treat operation. It may be impossible to remediate sites contaminated with DNAPLs by conventional pump-and-treat methods. Such aquifers might require permanent plume-stabilization wells to prevent the spread of the plume, or need to be remediated with more advanced technologies.

Water that is extracted from the aquifer can be treated to remove both organic and inorganic contaminants. Methods of treatment of dissolved organics include

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air stripping and carbon absorption. Underground tanks that are leaking should be removed and replaced. Soil and groundwater remediation is frequently necessary after a leaking tank has been removed.

Vadose zone soil contaminated by residual volatile organic compounds (VOC) can be remediated by soilvapor extraction systems. Air, containing organic vapors, is drawn from the soil pores via SVE wells in the vadose zone and replaced with fresh air. Some methods exist that combine pumping water for treatment with soil vapor extraction to treat contaminated soil and groundwater simultaneously.

Soil and groundwater contaminated by organic compounds may be amenable to bioremediation by both aerobic and anaerobic microbes. Electron acceptors and/or donor may be added to the soil or aquifer to encourage microbial activity. *In situ* bioremediation and related monitored natural attenuation (MNA) processes have the advantage of treating the contaminants dissolved in soil and groundwater at the same time as residual contaminants in the soil.

Permeable Reactive Barriers (PRB) are linear structures placed in the path of an advancing groundwater plume. Reactive materials inside the PRB, such as metallic iron, interact with the dissolved contaminants and degrade or immobilize them. PRBs are passive treatment systems because no pumping is required.

Chemically-enhanced *in situ* flushing technology relies on chemicals that enhance the solubility and, in some case, mobility of NAPL compounds in the subsurface. The primary objective of this remediation technology is to remove the maximum amount of contaminant with a minimum amount of chemicals and in minimal time while maintaining hydraulic control over the injected chemicals and contaminant. This approach requires injection and extraction wells with above ground treatment of the extracted liquids.

During thermal *in situ* treatment, heat is delivered to the treatment zone to volatize, displace, or destroy amendable contaminants in the subsurface. Convection and conduction heat sources have been tested and found effective for remediating a variety of contaminants, including some that are not treatable with other methods. However, high temperature necessary to destroy those compounds can also affect the soil properties. Thermal treatment is typically combined with SVE systems to capture volatilized compounds. New approaches include subsurface controlled, contaminant burning, or smoldering techniques.

In situ oxidation relies on strong oxidants that, when injected into the treatment zone, degrade organic contaminants. This aggressive remediation approach typically does not require the extraction of contaminated liquids from the subsurface and is applicable to a large number of organic compounds.

Phytoremediation takes advantage of green plants and their ability to take up, transform or volatilize a number of metal and organic contaminants. While limited to relatively low soil and groundwater contaminant concentrations, and typically requiring many growing seasons to achieve clean up goals, phytoremediation is a green technology.

While great advances have been made in the field of remediation over the past decades, many contaminants and site-settings, particularly fractured bedrock aquifers, remain difficult or impossible to treat with current methods. Hence, this topic will remain an area of active research for many years.

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Chapter Notation

B	Uniform thickness of a confined aquifer	d	Distance between extraction wells
Bgs	Below ground surface	k	Pseudo-first order rate contestant
C	Concentration	x	Distance along the x axis
Co	Initial concentration	y	Distance along the y axis
U	Regional specific discharge (Darcy velocity)	h_0—h	Drawdown
		T	Aquifer transmissivity
Q	Pumping rate of plume-capture well	S	Aquifer storativity
		R	Radius of a pumping well
		t	Time since pumping began

References

ADAC. 2015. Entwicklung der Tankstellenanzahl seit 1965 in Deutschland. Accessed September 3, 2015 from https://www.adac.de/infotestrat/tanken-kraftstoffe-und-antrieb/probleme-tankstelle/anzahl-tankstellen-markenverteilung/default.aspx

Air Force Center for Engineering and the Environment (AFCEE). 2008. Technical Protocol for Enhanced Anaerobic Bioremediation Using Permeable Mulch Biowalls and Bioreactors. Available from https://clu-in.org/download/techfocus/prb/Final-Biowall-Protocol-05-08.pdf

American Petroleum Institute (API). 2007. API 2007. Technical Protocol for Evaluating the Natural Attenuation of MtBE. API Publication 4761. 186 pp.

Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process. Accessed September 13, 2015 at http://www.astm.org/Standards/E1527.htm

ASTM. 2014. ASTM E1689—95 Standard Guide for Developing Conceptual Site Models for Contaminated Sites. Available from http://www.astm.org/Standards/ E1689.htm

Ardito, C. P., and J. F. Billings. 1990. "Alternative remediation strategies: The subsurface volatilization and ventilation system." In *Proceedings of Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection and Restoration*, 281–96. Dublin, Ohio: National Water Well Association.

Bainchi-Mosquera, G. C., R. M. Allen-King, and D. M. Mackay. 1994. Enhancing degradation of dissolved benzene and toluene using a solid oxygen-releasing compound. *Ground Water Monitoring and Remediation* 14:120–128.

Belochini, F., A. Dell'Anno, L. DeProrpis, S. Ubaldini, F. Cerrone, and R. Danovaro. 2009. Auto- and heterotrophic acidophilic bacteria enhance the bioremediation efficiency of sediments contaminated by heavy metals. *Chemosphere* 74:1321–1326.

Blake, S. B., and R. W. Lewis. 1982. "Underground oil recovery." *Proceedings of the Second National Symposium on Aquifer Restoration and Ground Water Monitoring* 69–76. Dublin, OH: National Water Well Association.

Borden, R. C., R. T. Goin, and C.-M. Kao. 1997. Control of BTEX migration using a biologically enhanced permeable barrier. *Ground Water Monitoring and Review* 17:70–80.

Botha, M., L. Bester, and E. Hardwick. 2009. Removal of uranium from mine water using ion exchange at Driefontein Mine. In *Abstracts of the International Mine Water Conference 19th–23rd October 2009*, Pretoria, South Africa.

Bowman, R. S. 2003. Applications of surfactant-modified zeolites to environmental remediation. *Microporous and Mesoporous Materials* 61:43–56.

Boving, T. B., and J. E. McCray. 2000. Cyclodextrin-enhanced remediation of organic and metal contaminants in porous media and groundwater. *Remediation Journal* 10:59–83.

Boving, T. B., and M. L. Brusseau. 2000. Solubilization and removal of residual trichloroethene from porous media: Comparison of several solubilization agents. *Journal of Contaminant Hydrology* 42:51–67.

Boving, T. B., J. E. McCray, W. J. Blanford, and M. L. Brusseau. 2004. "Cyclodextrin enhanced remediation at NAB Little Creek, Virginia Beach, VA: Cost and performance assessment."

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TITLE 35: ENVIRONMENTAL PROTECTION
SUBTITLE G: WASTE DISPOSAL
CHAPTER I: POLLUTION CONTROL BOARD
SUBCHAPTER j: COAL COMBUSTION WASTE SURFACE IMPOUNDMENTS

PART 845
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AUTHORITY: Implementing Sections 12, 22, and 22.59 of the Environmental Protection Act [415 ILCS 5/12, 22, and 22.59] and authorized by Sections 22.59, 27, and 28 of the Environmental Protection Act [415 ILCS 5/22.59, 27, and 28].

SOURCE: Adopted in R20-19 at 45 Ill. Reg. 5884, effective April 21, 2021.

SUBPART A: GENERAL PROVISIONS

Section 845.100 Scope and Purpose

a) This Part establishes criteria for determining which CCR surface impoundments do not pose a reasonable probability of adverse effects on health or the environment. CCR surface impoundments failing to satisfy any of the requirements of this Part are considered open dumps, which are prohibited under Section 21(a) of the Act.

b) This Part applies to owners and operators of new and existing CCR surface impoundments, including any lateral expansions of CCR surface impoundments that dispose of or otherwise engage in solid waste management of CCR generated from the combustion of coal at electric utilities and independent power producers. Unless otherwise provided in this Part, these requirements also apply to CCR surface impoundments located off-site of the electric utility or independent power producer.

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c) This Part also applies to inactive CCR surface impoundments at active and inactive electric utilities or independent power producers, regardless of the fuel currently used at the facility to produce electricity.

d) Except as provided in Section 845.170, inactive CCR surface impoundments are subject to all the requirements of this Part applicable to existing CCR surface impoundments.

e) This Part does not apply to wastes, including fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated at facilities that are not part of an electric utility or independent power producer, such as manufacturing facilities, universities, and hospitals. This Part also does not apply to fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated primarily from the combustion of fuels (including other fossil fuels) other than coal, for the purpose of generating electricity unless the fuel burned consists of more than 50% coal on a total heat input or mass input basis, whichever results in the greater mass feed rate of coal.

f) This Part does not apply to the beneficial use of CCR.

g) This Part does not apply to CCR placement at active or abandoned underground or surface coal mines.

h) This Part does not apply to landfills that receive CCR.

i) If a CCR surface impoundment has completed an Agency-approved closure before April 21, 2021, this Part does not require the owner or operator of the CCR surface impoundment to resubmit to the Agency any closure plan, closure report, or closure certification for that completed closure.

j) Upon completion of an Agency-approved closure, the CCR surface impoundment is considered a CCR surface impoundment that has completed closure for purposes of fee applicability under Section 22.59(j) of the Act.

Section 845.110 Applicability of Other Regulations

a) Compliance with the requirements of this Part does not affect the need for the owner or operator of a CCR surface impoundment, or lateral expansion of a CCR surface impoundment, to comply with all other applicable federal, state, tribal, or local laws or other requirements.

b) Any CCR surface impoundment or lateral expansion of a CCR surface impoundment is subject to the following requirements:

1) Illinois Endangered Species Protection Act [520 ILCS 10] and 40 CFR 257.3-2.

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2) Surface Water

A) A facility must not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act.

B) A facility must not cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under section 404 of the Clean Water Act, as amended.

C) A facility or practice must not cause non-point source pollution of waters of the United States that violates applicable legal requirements implementing an areawide or statewide water quality management plan that has been approved by USEPA under section 208 of the Clean Water Act, as amended.

D) Definitions of the terms "discharge of dredged material", "point source", "pollutant", and "waters of the United States" can be found in the Clean Water Act, as amended (33 USC 1251 et seq.) and implementing regulations, specifically 33 CFR 323 (42 FR 37122, July 19, 1977).

E) Except as in compliance with the provisions of the Act, Board regulations, and the CWA, and the provisions and conditions of the NPDES permit issued to the discharger, the discharge of any contaminant or pollutant by any facility into the waters of the State from a point source or into a well will be unlawful.

3) Rivers, Lakes and Streams Act [615 ILCS 5/23 and 23(a)] and 17 Ill. Adm. Code 3702.

Section 845.120 Definitions

Except as stated in this Section, or unless a different meaning of a word or term is clear from the context, the definition of words or terms in this Part will be the same as that applied to the same words or terms in the Environmental Protection Act:

"1000-year flood" means a flood of magnitude (or greater) of 1 in 1000 probability of occurring in any given year.

"Act" means the Illinois Environmental Protection Act [415 ILCS 5].

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"Active facility" or "active electric utility" or "independent power producer" means any facility, subject to the requirements of this Part, that is in operation on or after October 19, 2015. An electric utility or independent power producer is in operation if it is generating electricity that is provided to electric power transmission systems or to electric power distribution systems on or after October 19, 2015. An off-site CCR surface impoundment is in operation if it is accepting or managing CCR on or after October 19, 2015.

"Active life" or "in operation" means the period of operation beginning with the initial placement of CCR in the CCR surface impoundment and ending at completion of closure activities in accordance with Subpart G.

"Agency" means the Illinois Environmental Protection Agency.
"Aquifer" means a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.

"Area-capacity curves" means graphic curves that readily show the reservoir water surface area, in acres, at different elevations from the bottom of the reservoir to the maximum water surface, and the capacity or volume, in acre-feet, of the water contained in the reservoir at various elevations.

"Areas susceptible to mass movement" means those areas of influence (i.e., areas characterized as having an active or substantial possibility of mass movement) where, because of natural or human-induced events, the movement of earthen material at, beneath, or adjacent to the CCR surface impoundment may result in the downslope transport of soil and rock material by means of gravitational influence. Areas of mass movement include, but are not limited to, landslides, avalanches, debris slides and flows, soil fluctuation, block sliding, and rock fall.

"Beneficial use of CCR" means CCR that meets the definition of "coal combustion by-product" in Section 3.135 of the Act [415 ILCS 5/3.135] and the definition of "beneficial use of CCR" in 40 CFR 257.53, incorporated by reference in Section 845.150.

"Board" means Illinois Pollution Control Board.

"Certified laboratory" means any laboratory certified under Section 4(o) of the Act or certified by USEPA for the specific constituents to be examined.

"Closed" for purposes of this Part means placement of CCR in a CCR surface impoundment has stopped, and the owner or operator has completed closure of the CCR surface impoundment and has initiated post-closure care in accordance with Subpart G.

"*Coal combustion residuals*" or "*CCR*" *means fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers*. [415 ILCS 5/3.142]

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"CCR fugitive dust" means solid airborne particulate matter that contains or is derived from CCR, emitted from any source other than a stack or chimney.

"CCR storage pile" means any temporary accumulation of solid, non-flowing CCR placed on the land that is designed and managed to control releases of CCR to the environment. CCR contained in an enclosed structure is not a CCR storage pile. Examples of control measures to control releases from CCR storage piles include: periodic wetting, application of surfactants, tarps, or wind barriers to suppress dust; tarps or berms for preventing contact with precipitation and controlling run-on/run-off; and impervious storage pads or geomembrane liners for soil and groundwater protection.

"*CCR surface impoundment*" or "*impoundment*" *means a natural topographic depression, man-made excavation, or diked area, which is designed to hold an accumulation of CCR and liquids, and the surface impoundment treats, stores, or disposes of CCR.* [415 ILCS 5/3.143]

"Dike" means an embankment, berm, or ridge of either natural or man-made materials used to prevent the movement of liquids, sludges, solids, or other materials.

"Displacement" means the relative movement of any two sides of a fault measured in any direction.

"Disposal" means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste as defined in section 1004(27) of the Resource Conservation and Recovery Act into or on any land or water or into any well so that the solid waste, or constituent thereof, may enter the environment or be emitted into the air or discharged into any waters, including groundwater. For purposes of this Part, disposal does not include the beneficial use of CCR.

"Downstream toe" means the junction of the downstream slope or face of the CCR surface impoundment with the ground surface.

"Enclosed structure" means:

> A completely enclosed, self-supporting structure that is designed and constructed of manmade materials of sufficient strength and thickness to support itself, the CCR, and any personnel and heavy equipment that operate within the structure, and to prevent failure due to settlement, compression, or uplift; climatic conditions; and the stresses of daily operation, including the movement of heavy equipment within the structure and contact of that equipment with containment walls;
>
> The structure has containment walls that are designed to be sufficiently durable to withstand any movement of personnel, CCR, and handling equipment within the structure;

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The structure is designed and operated to ensure containment and prevent fugitive dust emissions from openings, such as doors, windows and vents, and the tracking of CCR from the structure by personnel or equipment.

"Exceedance of the groundwater protection standard" means:

For existing CCR surface impoundments and inactive CCR surface impoundments:

an analytical result with a concentration greater than the numerical value of the constituents listed in Section 845.600(a), in a down gradient well; or

when the up gradient background concentration of a constituent exceeds the numerical value listed in Section 845.600(a), an analytical result with a concentration at a statistically significant level above the up gradient background concentration, in a down gradient well.

For new CCR surface impoundments and lateral expansions of existing CCR surface impoundments, an analytical result with a constituent concentration at a statistically significant level above the up gradient background concentration, in a down gradient well.

"Existing CCR surface impoundment" means a CCR surface impoundment in which CCR is placed both before and after October 19, 2015, or for which construction started before October 19, 2015 and in which CCR is placed on or after October 19, 2015. A CCR surface impoundment has started construction if the owner or operator has obtained the federal, State, and local approvals or permits necessary to begin physical construction and a continuous on-site, physical construction program had begun before October 19, 2015.

"Facility" means all contiguous land, and structures, other appurtenances, and improvements on the land, used for treating, storing, disposing of, or otherwise conducting solid waste management of CCR. A facility may consist of several treatment, storage, or disposal operational units (e.g., one or more landfills, surface impoundments, or combinations of them).

"Factor of safety" or "safety factor" means the ratio of the forces tending to resist the failure of a structure to the forces tending to cause that failure, as determined by accepted engineering practice.

"Fault" means a fracture or a zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side.

"Flood hydrograph" means a graph showing, for a given point on a stream, the discharge, height, or other characteristic of a flood as a function of time.

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"Free liquids" means liquids that readily separate from the solid portion of a waste under ambient temperature and pressure.

"Groundwater" means water below the land surface in a zone of saturation.

"Hazard potential classification" means the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the diked CCR surface impoundment or mis-operation of the diked CCR surface impoundment or its appurtenances. The hazardous potential classifications include Class 1 and Class 2, defined as follows:

> Class 1 CCR surface impoundment means a diked surface impoundment where failure or mis-operation will probably cause loss of human life.
>
> Class 2 CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

"Height" means the vertical measurement from the downstream toe of the CCR surface impoundment at its lowest point to the lowest elevation of the crest of the CCR surface impoundment, not including spillways.

"Holocene" means the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch, at 11,700 years before present, to present.

"Hydraulic conductivity" means the rate at which water can move through a permeable medium (i.e., the coefficient of permeability).

"Inactive CCR surface impoundment" means a CCR surface impoundment in which CCR was placed before but not after October 19, 2015 and still contains CCR on or after October 19, 2015. Inactive CCR surface impoundments may be located at an active facility or inactive facility.

"Inactive Closed CCR surface impoundment" means an inactive CCR surface impoundment that completed closure before October 19, 2015 with an Agency-approved closure plan.

"Inactive facility" or "inactive electric utilities or independent power producers" means any facility that is not in operation on or after October 19, 2015.

"Incised CCR surface impoundment" means a CCR surface impoundment that is constructed by excavating entirely below the natural ground surface, holds an accumulation of CCR entirely below the adjacent natural ground surface, and does not consist of any constructed diked portion.

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"Inflow design flood" means the flood hydrograph that is used in the design or modification of the CCR surface impoundment and its appurtenant works.

"In operation" means the same as "active life".

"Karst terrain" means an area where karst topography, with its characteristic erosional surface and subterranean features, is developed as the result of dissolution of limestone, dolomite, or other soluble rock. Characteristic physiographic features present in karst terrains include, but are not limited to, dolines, collapsed shafts (sinkholes), sinking streams, caves, seeps, large springs, and blind valleys.

"Lateral expansion" means a horizontal or vertical expansion of the waste boundaries of an existing CCR surface impoundment made after October 19, 2015.

"Liquefaction factor of safety" means the factor of safety (safety factor) determined using analysis under liquefaction conditions.

"Lithified earth material" means all rock, including all naturally occurring and naturally formed aggregates or masses of minerals or small particles of older rock that formed by crystallization of magma or by induration of loose sediments. This term does not include man-made materials, such as fill, concrete, and asphalt, or unconsolidated earth materials, soil, or regolith lying at or near the earth surface.

"Maximum horizontal acceleration in lithified earth material" means the maximum expected horizontal acceleration at the ground surface as depicted on a seismic hazard map, with a 98% or greater probability that the acceleration will not be exceeded in 50 years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

"New CCR surface impoundment" means a CCR surface impoundment or lateral expansion of an existing or new CCR surface impoundment that first receives CCR or starts construction after October 19, 2015. A new CCR surface impoundment has started construction if the owner or operator has obtained the federal, State, and local approvals or permits necessary to begin physical construction and a continuous on-site, physical construction program had begun after October 19, 2015.

"Operator" means the person or persons responsible for the overall operation of a CCR surface impoundment.

"Outermost damage zone of a fault" means the volume of deformed wall rocks around a fault surface that results from the initiation, propagation, interaction and build-up of slip along faults.

"Owner" means the person or persons who own a CCR surface impoundment or part of a CCR surface impoundment.

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"Poor foundation conditions" means those areas where features exist which indicate that a natural or human-induced event may result in inadequate foundation support for the structural components of an existing or new CCR surface impoundment. For example, failure to maintain static and seismic factors of safety, as required in Section 845.460, would cause a poor foundation condition.

"Probable maximum flood" means the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the drainage basin.

"Qualified person" means a person or persons trained to recognize specific appearances of structural weakness and other conditions that are disrupting, or have the potential to disrupt, the operation or safety of the CCR surface impoundment by visual observation and, if applicable, to monitor instrumentation.

"Qualified professional engineer" means an individual who is licensed under the Professional Engineering Practice Act of 1989 [225 ILCS 325] to practice one or more disciplines of engineering and who is qualified by education, technical knowledge and experience to complete the engineering analyses and make the specific technical certifications required under this Part.

"Recognized and generally accepted engineering practices" means engineering maintenance or operation activities based on established codes, widely accepted standards, published technical reports, or a practice widely recommended throughout the industry. These practices generally detail approved ways to perform specific engineering, inspection, or mechanical integrity activities.

"Retrofit" means to remove all CCR and contaminated soils and sediments from the CCR surface impoundment, and to ensure the surface impoundment complies with the requirements in Section 845.410.

"Run-off" means any rainwater, leachate, or other liquid that drains over land from any part of a CCR surface impoundment or lateral expansion of a CCR surface impoundment.

"Run-on" means any rainwater, leachate, or other liquid that drains over land onto any part of a CCR surface impoundment or lateral expansion of a CCR surface impoundment.

"Sand and gravel pit" or "quarry" means an excavation for the extraction of aggregate, minerals or metals. The term sand and gravel pit and/or quarry does not include subsurface or surface coal mines.

"Seismic factor of safety" means the factor of safety (safety factor) determined using analysis under earthquake conditions using the peak ground acceleration for a seismic event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the U.S. Geological Survey (USGS) seismic hazard

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maps for seismic events with this return period for the region where the CCR surface impoundment is located.

"Seismic impact zone" means an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 50 years.

"Slope protection" means engineered or non-engineered measures installed on the upstream or downstream slope of the CCR surface impoundment to protect the slope against wave action or erosion, including rock riprap, wooden pile, concrete revetments, vegetated wave berms, concrete facing, gabions, geotextiles, or fascines.

"Solid waste management" or "management" means the systematic administration of the activities that provide for the collection, source separation, storage, transportation, processing, treatment, or disposal of solid waste.

"Static factor of safety" means the factor of safety (safety factor) determined using analysis under the long-term, maximum storage pool loading condition, the maximum surcharge pool loading condition, and the end-of-construction loading condition.

"Structural components" means liners, leachate collection and removal systems, final covers, run-on and run-off systems, inflow design flood control systems, and any other component used in the construction and operation of the CCR surface impoundment that is necessary to ensure the integrity of the surface impoundment and ensure that the contents of the surface impoundment are not released into the environment.

"Temporary accumulation" means an accumulation on the land that is neither permanent nor indefinite. To demonstrate that the accumulation on the land is temporary, all CCR must be removed from the pile at the site. The entity engaged in the activity must have a record in place, such as a contract, purchase order, facility operation and maintenance, or fugitive dust control plan, documenting that all the CCR in the pile will be completely removed according to a specific timeline.

"Unstable area" means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of that area, including structural components of some or all the CCR surface impoundment that are responsible for preventing releases from the surface impoundment. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains.

"Uppermost aquifer" means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.

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"Waste boundary" means a vertical surface located at the hydraulically downgradient limit of the CCR surface impoundment. The vertical surface extends down into the uppermost aquifer.

"Wetlands" means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Section 845.130 Surface Impoundment Identification

The owner or operator of a CCR surface impoundment must place on, or immediately adjacent to, the CCR surface impoundment a permanent identification marker at least six feet high showing the identification number of the CCR surface impoundment assigned by the Agency, the name associated with the CCR surface impoundment and the name of the owner or operator of the CCR surface impoundment. The owner or operator must maintain the marker at all times an operating permit is required under this Part.

Section 845.140 Right of Inspection

The owner or operator of a CCR surface impoundment must allow the Agency and its duly authorized representatives to perform inspections in accordance with the Agency's authority under the Act, including:

a) Entering, at reasonable times, the facility where CCR surface impoundments are located or where any activity is to be conducted under a permit issued under this Part;

b) Having access to and copying at reasonable times any records required to be kept under the terms and conditions of a permit of this Part;

c) Inspecting at reasonable times, including during any hours of operation:

1) Equipment constructed or operated under a permit issued under this Part;

2) Equipment or monitoring methodology; or

3) Equipment required to be kept, used, operated, calibrated and maintained under a permit issued under this Part;

d) Obtaining and removing, at reasonable times, samples of any raw or finished water, discharge or emission of pollutants;

e) Entering, at reasonable times, to use any photographic, recording, testing, monitoring or other equipment for the purpose of preserving, testing, monitoring

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or recording any raw or finished water, activity, discharge or emission authorized by a permit.

Section 845.150 Incorporations by Reference

a) For purposes of this Part, the Board incorporates the following material by reference:

1) Non-Regulatory Government Publications and Publications of Recognized Organizations and Associations:

Association for the Advancement of Cost Engineering (AACE), 726 East Park Avenue #180, Fairmont, WV 26554, (304) 296-8444, web.aacei.org.

"Cost Estimate Classification System — As Applied in Engineering, Procurement, and Construction for the Process Industries", TCM Framework: 7.3 – Cost Estimating and Budgeting. March 6, 2009, AACE International Recommended Practice No. 18R-97.

NTIS. National Technical Information Service, 5285 Port Royal Road, Springfield VA 22161, (703) 605-6000, www.ntis.gov.

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", USEPA Publication No. SW-846, as amended by Updates I, II, IIA, IIB, III, IIIA, and IIIB (Doc. No. 955-001-00000-1) (available online at https://www.epa.gov/hw-sw846/sw-846-compendium).

2) Code of Federal Regulations, Available from the Superintendent of Documents, U.S. Government Publishing Office, Washington, DC 20401, (202) 783-3238, https://www.ecfr.gov, https:/www.govinfo.gov/app/collection/cfr, or https://www.federalregister.gov:

40 CFR 257.53 (2019) (Definition of "beneficial use of CCR")

40 CFR 257.103(f)(1)(x) (85 Fed. Reg. 53563-64 (Aug. 28, 2020)) (Preparation of Semi-Annual Progress Reports)

b) This Section incorporates no later editions or amendments.

Section 845.160 Severability

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If any provision of this Part or its application to any person or under any circumstances is adjudged invalid, that adjudication must not affect the validity of this Part as a whole or of any portion not adjudged invalid.

Section 845.170 Inactive Closed CCR Surface Impoundments

a) Among the provisions of this Part, only the following apply to inactive closed CCR surface impoundments:

1) All of Subpart A: General Provisions;

2) The following Sections of Subpart B (Permitting):

A) Section 845.200;

B) Section 845.210;

C) Section 845.220(a), (c), and (f)(1);

D) Section 845.230(c) and (d)(4);

E) Section 845.250;

F) Section 845.270;

G) Section 845.280;

H) Section 845.290;

3) The following Section of Subpart G (Closure and Post-Closure Care): Section 845.780(b), (d), and (e); and

4) All of Subpart I (Financial Assurance).

b) When a prior release from an inactive closed CCR surface impoundment has caused an exceedance of the groundwater quality standards in 35 Ill. Adm. Code 620, and the owner or operator has not completed remediation of the release before completing closure, the owner or operator must initiate or continue corrective action under an operating permit issued under this Part.

c) When a release from an inactive closed CCR surface impoundment causes an exceedance of the groundwater quality standards in 35 Ill. Adm. Code 620, and the Agency has not concurred with an alternative source demonstration, the owner or operator of an inactive closed CCR surface impoundment must initiate an assessment of corrective measures that prevents further releases, remediates any releases, and restores the affected area. The owner or operator of the inactive

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closed CCR surface impoundment must develop a corrective action plan and obtain a construction permit consistent with subsection (a)(2) before performing any corrective action to remediate any releases and to restore the affected area, including the final cover system, groundwater monitoring system, groundwater collection trench, extraction wells, slurry walls, or any construction related to corrective action.

SUBPART B: PERMITTING

Section 845.200 Permit Requirements and Standards of Issuance

a) Permit Requirements

1) No person may construct, install, or modify a CCR surface impoundment or related treatment or mitigation facilities, including corrective action measures under Subpart F, without a construction permit issued by the Agency under this Part.

2) Except as provided in Section 845.230(d), no person may operate a CCR surface impoundment without an operating permit issued by the Agency under this Part. For purposes of this Part, a CCR surface impoundment starts operation upon initial receipt of CCR.

3) No person may perform corrective action at a CCR surface impoundment without obtaining a construction permit for corrective action and modifying the facility's operating permit, or modifying the facility's operating permit when the approved corrective action does not require the modification of the CCR surface impoundment or the installation or modification of related treatment or mitigation facilities.

4) Except as provided in Section 22.59(e) of the Act, no person may close a CCR surface impoundment without obtaining a construction permit for closure issued by the Agency under this Part.

5) A CCR surface impoundment must maintain an operating permit until:

A) The completion of post-closure care when the CCR surface impoundment is closed with a final cover system; or

B) The completion of groundwater monitoring under Section 845.740(b) when the CCR surface impoundment is closed by removal.

6) The Agency may issue a joint construction and operating permit.

b) Standards for Issuance

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1) Except as provided in subsection (b)(2), the Agency may not issue any construction or operating permit required by this Part unless the applicant submits adequate proof that the CCR surface impoundment will be constructed, modified or operated so as not to cause a violation of the Act or Board rules.

2) The existence of a violation of the Act, Board regulation, or Agency regulation will not prevent the issuance of a construction or operating permit under this Part if:

A) The applicant has been granted a variance or an adjusted standard from the regulation by the Board;

B) The permit application is for construction, installation, or operation of equipment to alleviate or correct a violation; or

C) The permit application is for construction, installation, or operation of equipment necessary to restore, protect or enhance the environment.

3) *In granting permits, the Agency may impose reasonable conditions specifically related to the applicant's past compliance history with the Act as necessary to correct, detect, or prevent noncompliance. The Agency may impose such other conditions as may be necessary to accomplish the purpose of the Act and as are not inconsistent with this Part.* [415 ILCS 5/39(a)]

4) *In making its determinations on permit applications under this* Part*, the Agency may consider prior adjudications of noncompliance with the Act by the applicant that involved a release of a contaminant into the environment*. [415 ILCS 5/39(a)]

Section 845.210 General Provisions

a) All permit applications must be made on the forms prescribed by the Agency and must be mailed or delivered to the address designated by the Agency on the forms. The Agency must provide a dated, signed receipt upon request. The Agency's record of the date of filing must be deemed conclusive unless a contrary date is proved by a dated, signed receipt.

b) Required Signatures of Owners or Operators

1) All permit applications must contain the name, address, email address and telephone number of the operator, or duly authorized agent, and the

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property owner to whom all inquiries and correspondence must be addressed.

2) All permit applications must be signed by the owner, operator or a duly authorized agent of the operator.

3) An application submitted by a corporation must be signed by a principal executive officer of at least the level of vice president, or his or her duly authorized representative, if that representative is responsible for the overall operation of the facility described in the application form. In the case of a partnership or a sole proprietorship, the application must be signed by a general partner or the proprietor, respectively. In the case of a publicly owned facility, the application must be signed by either the principal executive officer, ranking elected official, or other duly authorized employee.

c) Legal Description. All permit applications must contain a legal description of the facility boundary and a description of the boundaries of all units included in the facility.

d) Previous Assessments, Investigations, Plans and Programs

1) The Agency may approve the use of any hydrogeologic site investigation or characterization, groundwater monitoring well or system, or groundwater monitoring plan, bearing the seal and signature of an Illinois Licensed Professional Geologist or Licensed Professional Engineer, completed before April 21, 2021 to satisfy the requirements of this Part.

2) For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas) provided that the previously completed assessments meet the applicable requirements of those Sections.

3) For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed assessment to serve as the initial assessment required by Section 845.440 (Hazard Potential Classification Assessment), Section 845.450 (Structural Stability Assessment) and Section 845.460 (Safety Factor Assessment) provided that the previously completed assessment:

A) Was not completed more than five years ago; and

B) Meets the applicable requirements of those Sections.

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4) For inactive closed CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a post-closure care plan previously approved by the Agency.

e) The Agency must mail all notices of final action by certified mail, postmarked with a date stamp and with return receipt requested. Final action must be deemed to have taken place on the postmarked date that the notice is mailed.

f) Violation of any permit condition or failure to comply with the Act or regulations promulgated under the Act must be grounds for enforcement action as provided in the Act, including revocation of a permit.

g) Issuance of a permit under this Part does not relieve the applicant of the obligation to obtain other permits required by law.

h) The owner or operator must place in the facility's operating record all permit applications submitted to the Agency and all permits issued under this Part (see Section 845.800(d)(1)).

i) Agency Listserv

1) For each facility subject to this Part, the Agency must create and maintain a listserv. Each listserv must include the email addresses of all interested persons who notify the Agency in writing—either directly under subsection (i)(2) or through the facility owner or operator under Section 845.220(a)(9) or 845.240(f)(4)—of their respective email addresses and that they would like to receive emails of notices concerning the facility.

2) The Agency's webpage must specify how interested persons may notify the Agency in writing of their respective email addresses and that they would like to be added to the Agency's listserv for a facility subject to this Part.

3) When this Part requires that the Agency email a notice to the listserv for a facility, the Agency must do so within the timeframe specified, concurrently with other required means of disseminating the notice, or otherwise in a timely manner. When this Part requires an owner or operator to request that the Agency email a notice to the listserv for the facility, the Agency must do so within two business days after receiving the request from the owner or operator.

Section 845.220 Construction Permits

a) All construction permit applications must contain the following information and documents.

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1) Design and Construction Plans (Construction History)

A) Identifying Information

i) The name and address of the person or persons owning or operating the CCR surface impoundment;

ii) The name associated with the CCR surface impoundment; and

iii) The identification number of the CCR surface impoundment if one has been assigned by the Agency.

B) A statement of the purpose for which the CCR surface impoundment is being used, how long the CCR surface impoundment has been in operation, and the types of CCR that have been placed in the CCR surface impoundment.

C) The name and size in acres of the watershed within which the CCR surface impoundment is located.

D) A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.

E) A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR surface impoundment; the method of site preparation and construction of each zone of the CCR surface impoundment; and the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.

F) At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR surface impoundment, detailed dimensional drawings of the CCR surface impoundment, including a plan view and cross-sections of the length and width of the CCR surface impoundment, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely

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affect operation of the CCR surface impoundment due to malfunction or mis-operation.

G) A description of the type, purpose, and location of existing instrumentation.

H) Area-capacity curves for the CCR surface impoundment.

I) A description of each spillway and diversion design features and capacities and calculations used in their determination.

J) The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.

K) Any record or knowledge of structural instability of the CCR surface impoundment.

2) Narrative Description of the Facility. The permit application must contain a written description of the facility with supporting documentation describing the procedures and plans that will be used at the facility to comply with the requirements of this Part. The descriptions must include, but are not limited to, the following information:

A) The types of CCR expected in the CCR surface impoundment, including a chemical analysis of each type of expected CCR;

B) An estimate of the maximum capacity of each surface impoundment in gallons or cubic yards;

C) The rate at which CCR and non-CCR waste streams currently enter the CCR surface impoundment in gallons per day and dry tons;

D) The estimated length of time the CCR surface impoundment will receive CCR and non-CCR waste streams; and

E) An on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment.

3) Site Location Map. All permit applications must contain a site location map on the most recent United States Geological Survey (USGS) quadrangle of the area from the 7 ½ minute series (topographic), or on another map whose scale clearly shows the following information:

A) The facility boundaries and all adjacent property, extending at least 1000 meters (3280 feet) beyond the boundary of the facility;

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B) All surface waters;

C) The prevailing wind direction;

D) The limits of all 100-year floodplains;

E) All-natural areas designated as a Dedicated Illinois Nature Preserve under the Illinois Natural Areas Preservation Act [525 ILCS 30];

F) All historic and archaeological sites designated by the National Historic Preservation Act (16 USC 470 et seq.) and the Illinois Historic Sites Advisory Council Act [20 ILCS 3410]; and

G) All areas identified as critical habitat under the Endangered Species Act of 1973 (16 USC 1531 et seq.) and the Illinois Endangered Species Protection Act [520 ILCS 10].

4) Site Plan Map. The application must contain maps, including cross-sectional maps of the site boundaries, showing the location of the facility. The following information must be shown:

A) The entire facility, including any proposed and all existing CCR surface impoundment locations;

B) The boundaries, both above and below ground level, of the facility and all CCR surface impoundments or landfills containing CCR included in the facility;

C) All existing and proposed groundwater monitoring wells; and

D) All main service corridors, transportation routes, and access roads to the facility.

5) A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.

6) Plans and specifications fully describing the design, nature, function and interrelationship of each individual component of the facility.

7) A new groundwater monitoring program or any modification to an existing groundwater monitoring program that includes but is not limited to the following information:

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A) A hydrogeologic site investigation meeting the requirements of Section 845.620, if applicable;

B) Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630; and

C) A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data (see Sections 845.640 and 845.650).

8) The signature and seal of a qualified professional engineer.

9) Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under Section 845.240, a summary of the issues raised by the public, a summary of any revisions, determinations, or other considerations made in response to those issues, and a list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.

b) New Construction. In addition to the requirements in subsection (a), all construction permit applications to build a new CCR surface impoundment, lateral expansion of a CCR surface impoundment, or retrofit an existing CCR surface impoundment must also contain the following information and documents:

1) Plans and specifications that demonstrate the proposed CCR surface impoundment will meet the location standards in the following Sections:

A) Section 845.300 (Placement Above the Uppermost Aquifer);

B) Section 845.310 (Wetlands);

C) Section 845.320 (Fault Areas);

D) Section 845.330 (Seismic Impact Zones); and

E) Section 845.340 (Unstable Areas and Floodplains).

2) Plans and specifications that demonstrate the proposed CCR surface impoundment will meet the following design criteria:

A) The CCR surface impoundment will have a liner meeting the liner requirements of Section 845.400(b) or (c);

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B) The CCR surface impoundment will have a leachate collection system meeting the requirements of Section 845.420; and

C) The CCR surface impoundment, if not incised, will be constructed with slope protection, as required by Section 845.430.

3) CCR fugitive dust control plan (see Section 845.500(b)).

4) Preliminary written closure plan (see Section 845.720(a)).

5) Initial written post-closure care plan, if applicable (see Section 845.780(d)).

c) Corrective Action Construction. In addition to the requirements in subsection (a), all construction permit applications that include any corrective action performed under Subpart F must also contain the following information and documents:

1) Corrective action plan (see Section 845.670);

2) Groundwater modeling, including:

A) The results of groundwater contaminant transport modeling and calculations showing how the corrective action will achieve compliance with the applicable groundwater standards;

B) All modeling inputs and assumptions;

C) Description of the fate and transport of contaminants with the selected corrective action over time; and

D) Capture zone modeling, if applicable;

3) Any necessary licenses and software needed to review and access both the models and the data contained within the models required by subsection (c)(2);

4) Corrective action groundwater monitoring program, including identification of revisions to the groundwater monitoring system for corrective action; and

5) Any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors, including an analysis of the factors specified in Section 845.680(a)(3).

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d) Closure Construction. In addition to the requirements in subsection (a), all construction permit applications for closure of the CCR surface impoundment under Subpart G must contain the following information and documents:

1) Closure prioritization category , if applicable (see Section 845.700(g));

2) Final closure plan (see Section 845.720(b)), including the closure alternatives analysis required by Section 845.710;

3) Groundwater modeling, including:

A) The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards;

B) All modeling inputs and assumptions;

C) Description of the fate and transport of contaminants, with the selected closure over time;

D) Capture zone modeling, if applicable; and

E) Any necessary licenses and software needed to review and access both the model and the data contained within the model.

4) Proposed schedule to complete closure; and

5) Post-closure care plan specified in Section 845.780(d), if applicable.

e) *Owners or operators of CCR surface impoundments who submitted a closure plan to the Agency before May 1, 2019, and who complete closure before July 30, 2021, shall not be required to obtain a construction permit for closure under subsection (d)*. [415 ILCS 5/22.59(e)]

f) A single construction permit application may be submitted for new construction, corrective action, and closure if the construction is related to the same multi-phased project. The permit application for a project with multiple phases must contain all information required by subsections (a), (b), (c), and (d), as applicable.

g) Duration of Construction Permits

1) For any construction permit that is not for the closure or retrofit of the CCR surface impoundment, the construction permit must be issued for fixed terms not to exceed 3 years.

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2) For any construction permit for the closure or retrofit of a CCR surface impoundment, the construction permit must be issued for an initial fixed term expiring within the timeframe approved by the Agency in the construction permit or five years, whichever is less. The Agency may renew a construction permit for closure or retrofit in two-year increments under Section 845.760(b).

Section 845.230 Operating Permits

The operating permit applications must contain the following information and documents:

a) Initial operating permit for a new CCR surface impoundment and any lateral expansion of a CCR surface impoundment.

1) A demonstration that the CCR surface impoundment, as built, meets the location standards in the following Sections:

A) Section 845.300 (Placement Above the Uppermost Aquifer);

B) Section 845.310 (Wetlands);

C) Section 845.320 (Fault Areas);

D) Section 845.330 (Seismic Impact Zones); and

E) Section 845.340 (Unstable Areas and Floodplains);

2) Certification from a qualified professional engineer that the composite liner, or if applicable, the alternative composite liner, has been constructed in accordance with the requirements of Section 845.400(b) or (c);

3) Certification from a qualified professional engineer that the leachate collection system has been constructed in accordance with the requirements of Section 845.420, if applicable;

4) Evidence that the permanent markers required by Section 845.130 have been installed;

5) Documentation that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in Section 845.430;

6) Initial hazard potential classification assessment and accompanying certification (see Section 845.440(a)(2));

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7) Initial Emergency Action Plan and accompanying certification (see Section 845.520(e));

8) Initial structural stability assessment and accompanying certification (see Section 845.450(c));

9) Initial safety factor assessment and accompanying certification (see Section 845.460(b));

10) Fugitive dust control plan and accompanying certification (see Section 845.500(b)(7));

11) Initial inflow design flood control system plan and accompanying certification (see Section 845.510(c)(3));

12) Proposed groundwater monitoring program, including a minimum of eight independent samples for each background and downgradient well (see Section 840.650(b));

13) Preliminary written closure plan (see Section 845.720(a));

14) Initial written post-closure care plan, if applicable (see Section 845.780(d));

15) An analysis of the chemical constituents found within the CCR to be placed in the CCR surface impoundment;

16) An analysis of the chemical constituents of all waste streams, chemical additives, and sorbent materials entering or contained in the CCR surface impoundment; and

17) A certification that the owner or operator meets the financial assurance requirements of Subpart I.

b) Renewal Operating Permit

1) Documentation that the CCR surface impoundment, if not incised, is being operated and maintained with one of the forms of slope protection specified in Section 845.430;

2) Emergency Action Plan certification if the plan was amended (see Section 845.520);

3) Fugitive dust control plan certification if the plan was amended (see Section 845.500(b)(7));

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4) Any significant changes to the design and construction plans compiled under subsection (d)(2)(A) or Section 845.220(a)(1);

5) A statement that the groundwater monitoring has been conducted under an Agency approved groundwater monitoring program;

6) Written preliminary closure plan, if amended (see Section 845.720(a)); and

7) Written post-closure care plan, if amended (see Section 845.780(d)).

c) Post-Closure Care Operating Permit

The owner or operator of a CCR surface impoundment conducting post-closure care under Section 845.780 must maintain an operating permit until the completion of post-closure care. Any changes to the post-closure care plan, groundwater monitoring system, groundwater sampling and analysis program, and groundwater monitoring program must be submitted to the Agency in an operating permit application.

d) Initial Operating Permit for Existing, Inactive and Inactive Closed CCR Surface Impoundments

1) The owner or operator of an existing, inactive or inactive closed CCR surface impoundment who has not completed post-closure care must submit an initial operating permit application to the Agency by October 31, 2021;

2) The initial operating permit application for existing or inactive CCR surface impoundments that have not completed an Agency approved closure before July 30, 2021, must contain the following information and documents on forms prescribed by the Agency:

A) The history of construction specified in Section 845.220(a)(1);

B) An analysis of the chemical constituents found within the CCR to be placed in the CCR surface impoundment;

C) An analysis of the chemical constituents of all waste streams, chemical additives and sorbent materials entering or contained in the CCR surface impoundment;

D) A demonstration that the CCR surface impoundment, as built, meets, or an explanation of how the CCR surface impoundments fails to meet, the location standards in the following Sections:

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i) Section 845.300 (Placement Above the Uppermost Aquifer);

ii) Section 845.310 (Wetlands);

iii) Section 845.320 (Fault Areas);

iv) Section 845.330 (Seismic Impact Zones); and

v) Section 845.340 (Unstable Areas);

E) Evidence that the permanent markers required by Section 845.130 have been installed;

F) Documentation that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in Section 845.430;

G) Initial Emergency Action Plan and accompanying certification (see Section 845.520(e));

H) Fugitive dust control plan and accompanying certification (see Section 845.500(b)(7));

I) Groundwater Monitoring Information:

i) A hydrogeologic site characterization (see Section 845.620);

ii) Design and construction plans of a groundwater monitoring system (see Section 845.630);

iii) A groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data (see Section 845.640); and

iv) Proposed groundwater monitoring program that includes a minimum of eight independent samples for each background and downgradient well (see Section 845.650(b));

J) Preliminary written closure plan (see Section 845.720(a));

K) Initial written post-closure care plan, if applicable (see Section 845.780(d));

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L) The certification required by Section 845.400(h), or a statement that the CCR surface impoundment does not have a liner that meets the requirements of Section 845.400(b) or (c);

M) History of known exceedances of the groundwater protection standards in Section 845.600, and any corrective action taken to remediate the groundwater;

N) A certification that the owner or operator meets the financial assurance requirements of Subpart I;

O) Hazard potential classification assessment and accompanying certification (see Section 845.440(a)(2));

P) Structural stability assessment and accompanying certification (see Section 845.450(c));

Q) Safety factor assessment and accompanying certification (see Section 845.460(b));

R) Inflow design flood control system plan and accompanying certification (see Section 845.510(c)(3));

S) Safety and health plan (see Section 845.530); and

T) For CCR surface impoundments required to close under 845.700, the proposed closure priority categorization required by Section 845.700(g).

3) The initial operating permit application for an existing or inactive CCR surface impoundment where an Agency approved closure has been completed before July 30, 2021, and where the impoundment is not an inactive closed CCR surface impoundment, must contain the following information and documents on forms prescribed by the Agency:

A) The history of construction specified in Section 845.220(a)(1);

B) Evidence that the permanent markers required by Section 845.130 have been installed;

C) Documentation that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in Section 845.430;

D) Emergency Action Plan certification (see Section 845.520(e));

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E) Groundwater monitoring information:

i) A hydrogeologic site characterization meeting the requirements of Section 845.620;

ii) Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630;

iii) A groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data (see Section 845.640); and

iv) Proposed groundwater monitoring program that includes a minimum of eight independent samples for each background and downgradient well (see Section 845.650(b));

F) Written post-closure care plan, if applicable (see Section 845.780(d));

G) History of known exceedances of the groundwater protection standards in Section 845.600, and any corrective action plan taken to remediate the groundwater.

4) The initial operating permit application for inactive closed CCR surface impoundments must contain the following information:

A) Evidence that the permanent markers required by Section 845.130 have been installed;

B) Groundwater monitoring program;

C) Written post-closure care plan (see Section 845.780(d)); and

D) History of known exceedances of the groundwater quality standards in 35 Ill. Adm. Code 620, whether the owner or operator has obtained a groundwater management zone, and any corrective action taken to remediate the groundwater.

e) Operating permits must be issued for fixed terms not to exceed five years.

Section 845.240 Pre-Application Public Notification and Public Meeting

a) At least 30 days before the submission of a construction permit application, the owner or operator of the CCR surface impoundment must hold at least two public

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meetings to discuss the proposed construction, with at least one meeting to be held after 5:00 p.m. in the evening. Any public meeting held under this Section must be located at a venue that is accessible to persons with disabilities, and the owner or operator must provide reasonable accommodations upon request.

b) The owner or operator must prepare and circulate a notice explaining the proposed construction project and any related activities and the time and place of the public meeting. At least 30 days before the public meeting, the owner or operator of the CCR surface impoundment must:

1) Mail or hand-deliver the notice to the Agency and all residents within a one-mile radius from the facility boundary;

2) Post the notice to the owner's or operator's publicly accessible Internet site under Section 845.810;

3) Post the notice in conspicuous locations throughout villages, towns, or cities within 10 miles of the facility, or use appropriate broadcast media (such as radio or television);

4) Request that the Agency email the notice to the Agency's listserv for the facility; and

5) Include in the notice the owner's and operator's contact information, the internet address where the information in Section 845.240(e) will be posted, and the date on which the information will be posted to the site.

c) When a proposed construction project or any related activity is located in an area with a significant proportion of non-English speaking residents, the notification must be circulated, or broadcast, in both English and the appropriate non-English language, and the owner or operator must provide translation services during the public meetings required by Section 845.240(a), if requested by non-English speaking members of the public.

d) The owner or operator of the CCR surface impoundment must prepare documentation recording the public meeting and place the documentation in the facility's operating record as required by Section 845.800(d)(2).

e) At least 30 days before a public meeting, the owner or operator of the CCR surface impoundment must post on the owner's or operator's publicly accessible internet site all documentation relied upon in making a tentative construction permit application.

f) At the public meeting, the owner or operator of the CCR surface impoundment must:

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1) Present its decision-making process for the construction permit application, including, when applicable, the corrective action alternatives and the closure alternatives considered. The presentation must include a comparison of projected groundwater impacts for each alternative considered and an objective comparison of the pros and cons of each alternative considered;

2) Include a question/answer portion of the meeting to allow the public to ask questions. There must be representatives from the owner or operator present who are qualified and knowledgeable enough to answer the questions posed by the public.

3) If there are questions posed by the public at the hearing that cannot be answered in person or if there are subsequent questions posed by the public following the meeting, the owner or operator of the facility must respond to those questions in writing within a reasonable timeframe and post the response on the facility's CCR website required by Section 845.810; and

4) Explain that the Agency is creating a listserv for the facility, compile a list of interested persons in attendance—and their respective email addresses—who would like to be added to the listserv, and transmit that list to the Agency with the permit application.

g) Within 14 days after the public meetings required by Section 845.240, the owner or operator must distribute a general summary of the issues raised by the public, as well as a response to those issues or comments raised by the public. If these comments resulted in a revision, change in a decision, or other considerations or determination, a summary of these revisions, changes and considerations must be included in the summary. The summary must be distributed to any attendee who requests a copy at the public meeting.

h) This Section does not apply to applications for minor modifications as described in Section 845.280(d).

Section 845.250 Tentative Determination and Draft Permit

Following the receipt of a complete application for a construction permit, operating permit, or joint construction and operating permit, the Agency must prepare a tentative determination.

a) The tentative determination must include at least the following:

1) A statement regarding whether the permit is to be issued or denied; and

2) If the determination is to issue the permit, a draft permit and a brief description of any conditions contained in the permit.

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b) Upon tentative determination to issue or deny the permit:

1) If the determination is to issue the permit, the Agency must notify the applicant in writing of the content of the tentative determination and draft permit and of its intent to circulate public notice of issuance in accordance with Section 845.260;

2) If the determination is to deny the permit, the Agency must notify the applicant in writing of the tentative determination and of its intent to circulate public notice of denial, in accordance with Section 845.260. In the case of denial, notice to the applicant must include a statement of the reasons for denial, as required by Section 39(a) of the Act.

c) The documents supporting the Agency's tentative decision to issue or deny a permit must be made part of the Agency's record.

Section 845.260 Draft Permit Public Notice and Participation

a) The Agency must post a notification that it has received a permit application on the Agency's webpage and must email the notice to the Agency's listserv for the applicant's facility.

b) Public Notice of Draft Permit

1) Not earlier than 15 days following the Agency's notification to the applicant of its tentative decision under Section 845.250 to issue or deny the permit application, the Agency must circulate public notice of the completed application for the permit in a manner designed to inform interested and potentially interested persons of the construction, modification, operation or closure of a CCR surface impoundment and of the proposed determination to issue or deny the permit.

2) The contents of public notice of completed applications for permits must include at least the following:

A) Name, address, and telephone number of the Agency;

B) Name and address of the applicant;

C) Brief description of the applicant's activities or operations that result in the construction, operation, modification or closure of a CCR surface impoundment;

D) A statement of the tentative determination to issue or deny the permit;

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E) A brief description of the procedures for the formulation of final determinations, including the procedures for submitting comments and the expiration date of the comment period;

F) Address and telephone number of Agency premises at which interested persons may obtain further information and request a copy of the permit application and related documents;

G) A translation of the public notice into the appropriate language or languages will be made if the Agency determines that a project is located within one mile of a significant population of non-English speaking residents;

H) A brief description of how members of the public can request a public hearing under Section 845.260(d); and

I) A brief description of how members of the public can request being added to the Agency's listserv for the facility.

3) Procedures for the circulation of public notice required under this Section must include at least the following concurrent actions:

A) Posting on the Agency's webpage and all the Agency's social media outlets;

B) Mailing the notice to the clerk of the nearest city, town or village requesting further posting in conspicuous locations throughout the city, town or village;

C) Requiring the applicant to post the notice near the entrance to the applicant's premises; and

D) Emailing the notice to the Agency's listserv for the facility.

c) Public Comment Period

1) The Agency must accept written comments from interested persons on the draft permit determination for 45 days following the circulation of the public notice under subsection (b).

2) All comments must be submitted to the Agency and to the applicant.

3) The Agency must keep all timely submitted comments and consider them in the formulation of its final determination with respect to the permit application.

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4) The period for comment may be extended at the discretion of the Agency.

d) Public Hearing

1) The Agency must hold a public hearing on the issuance or denial of a draft permit whenever the Agency determines that there exists a significant degree of public interest in the proposed permit.

2) Within the 45-day public comment period, any person, including the applicant, may submit to the Agency a request for a public hearing, which must include the reasons why a hearing is warranted.

3) Hearings held under this Section must be held in the geographical area in which the CCR surface impoundment is located. When determining the hearing location, consideration must be given to facilitating attendance of interested or affected persons and organizations and to accessibility of hearing sites to public transportation.

e) Notice of Public Hearing

1) The Agency must issue notice of a public hearing not less than 30 days before the date of the hearing, under the procedures for the circulation of public notice in subsection (b)(3).

2) The contents of the public notice for the public hearing must include at least the following:

A) Name, address, and telephone number of the Agency;

B) Name and address of each applicant whose application will be considered at the hearing;

C) Brief description of the applicant's activities or operations that result in the construction, operation, modification or closure of a CCR surface impoundment;

D) Information regarding the time and location of the hearing;

E) The purpose of the hearing;

F) A concise statement of the issues to be considered at the hearing;

G) Address and telephone number of premises at which interested persons may obtain further information and request a copy of the draft permit and related documents; and

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H) A statement that the hearing will be conducted in accordance with this Section.

I) A translation of the public notice into the appropriate language or languages will be made if the Agency determines that a project is located within one mile of a significant population of non-English speaking residents.

f) When the Agency receives written comments or holds a public hearing under this Section, the Agency must prepare a responsiveness summary that includes:

1) An identification of the public participation activity conducted;

2) Description of the matter on which the public was consulted;

3) An estimate of the number of persons present at the hearing;

4) A summary of all significant comments, criticisms, and suggestions, whether written or oral, submitted during the public comment period, at the hearing, or during the time the hearing record was open;

5) The Agency's response to all significant comments, criticisms, and suggestions; and

6) A statement of Agency action, including, when applicable, the issuance or denial of the permit.

Section 845.270 Final Permit Determination and Appeal

a) The Agency must not make a final permit determination until the public participation process in Section 845.260 has concluded.

b) After the consideration of any comments that may have been received, the Agency may either issue or deny the permit.

c) The Agency must provide a notice of the issuance or denial of the permit to the applicant, to any person who provides comments or an email address to the Agency during the public notice period or a public hearing, and to any person on the Agency's listserv for the facility. The Agency must post its final permit determination and, if a public hearing was held, the responsiveness summary, to the Agency's website. The notice must briefly indicate any significant changes that were made from the terms and conditions of the draft permit.

d) In the case of denial, the Agency must inform the applicant of the reasons for denial, as required by Section 39(a) of the Act.

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e) Appeal

1) If the Agency refuses to grant, or grants with conditions, a permit under this Part, the applicant may petition the Board to appeal the Agency's final decision under Section 40 of the Act.

2) *If the Agency grants or denies a permit under this Part, a third party, other than the permit applicant or Agency, may appeal the Agency's decision as provided under federal law for CCR surface impoundment permits.* [415 ILCS 5/40(g)]

3) All appeals must be filed with the Board within 35 days after the final action is served on the applicant.

Section 845.280 Transfer, Modification and Renewal

a) No permit is transferable from one person to another except as approved by the Agency. Approval must be granted only if a new owner or operator seeking transfer of a permit can demonstrate the ability to comply with all applicable financial requirements of Subpart I.

b) Agency Initiated Modification. The Agency may modify a permit under the following conditions:

1) Discovery of a typographical or calculation error;

2) Discovery that a determination or condition was based upon false or misleading information;

3) An order of the Board issued in an action brought under Title VII, VIII, IX or X of the Act; or

4) Promulgation of new statutes or regulations affecting the permit.

c) The owner or operator of a CCR surface impoundment may initiate modification to its permit by application submittal to the Agency at any time after the permit is approved and before the permit expires.

d) The Agency may make minor modifications to a permit without following the public notice procedures of Section 845.260. Minor modifications may only:

1) Correct typographical errors;

2) Require more frequent monitoring or reporting by the permittee, including the installation of additional groundwater monitoring wells;

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3) Allow for a change in ownership or operational control of a facility when the Agency determines that no other change in the permit is necessary, provided that a written agreement containing a specific date for transfer of permit responsibility, coverage, and liability between the current and new permittees has been submitted to the Agency;

4) Change the construction schedule, which does not impact the scheduled date of completion; or

5) Require electronic reporting requirements.

e) An application for renewal of a permit must be filed with the Agency at least 180 days before the expiration date of the existing permit unless the Agency grants a waiver of this requirement. The Agency may grant a waiver of the 180-day requirement only if:

1) The permittee submits a written request to the Agency at least 60 days before the expiration of the permit;

2) The permittee's written request includes the reasonably justifiable causes for not meeting the 180-day requirement; and

3) The permittee's written request includes a date by which the permittee will submit the renewal application.

f) Any Agency decision to deny a waiver request must be made within 21 days after receipt of the waiver request (see subsection (e)(1)).

g) The terms and conditions of an expiring permit remain effective and enforceable against the permittee until the Agency takes final action on the pending permit renewal application, only if the permittee has submitted a timely application under subsection (e) and the Agency, through no fault of the permittee, does not issue a new permit by the expiration date of the previous permit.

Section 845.290 Construction Quality Assurance Program

a) The following must be constructed according to a Construction Quality Assurance (CQA) program:

1) The construction of a new CCR surface impoundment, or the lateral expansion of an existing CCR surface impoundment;

2) The retrofit of an existing CCR surface impoundment;

3) Installation of a groundwater collection system and discharge system;

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4) Installation of the groundwater monitoring system; and

5) Installation of the final cover system.

b) The CQA program must meet the following requirements:

1) The owner or operator of the CCR surface impoundment must designate a CQA officer who is a qualified professional engineer.

2) At the end of each week of construction, until construction is complete, a summary report must be prepared either by the CQA officer or under the supervision of the CQA officer. The report must include descriptions of the weather, locations where construction occurred during the previous week, materials used, results of testing, inspection reports, and procedures used to perform the inspections. The CQA officer must review and approve the report. The owner or operator of the CCR surface impoundment must place the weekly reports in the facility's operating record (see Section 845.800(d)(3)).

3) The CQA officer must certify the following, when applicable:

A) The bedding material contains no undesirable objects;

B) The final closure plan or corrective action plan approved by the construction permit has been followed;

C) The anchor trench and backfill are constructed to prevent damage to a geosynthetic membrane;

D) All tears, rips, punctures, and other damage are repaired;

E) All geosynthetic membrane seams are properly constructed and tested in accordance with the manufacturer's specifications;

F) Any groundwater collection system is constructed to intersect the water table;

G) Any groundwater collection system is properly constructed to slope toward extraction points, and the extraction equipment is properly designed and installed;

H) Appropriate operation and maintenance plans for the groundwater collection system and extraction and discharge equipment are provided;

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I) Proper filter material consisting of uniform granular fill, to avoid clogging, is used in construction;

J) The filter material, as placed, possesses structural strength adequate to support the maximum loads imposed by the overlying materials and equipment used at the facility;

K) CCR stabilization; and

L) Site restoration, if any.

4) The CQA officer must supervise and be responsible for all inspections, testing and other activities required to be implemented as part of the CQA program under this Section.

5) The CQA officer must be present to provide supervision and assume responsibility for performing all inspections of the following activities, when applicable:

A) Compaction of the subgrade and foundation to design parameters;

B) Application of final cover, including installation of the geomembrane; and

C) Installation of the groundwater collection system and discharge system.

6) If the CQA officer is unable to be present as required by subsection (b)(5), the CQA officer must provide the following in writing:

A) The reasons for his or her absence;

B) A designation of a person who must exercise professional judgment in carrying out the duties of the CQA officer-in-absentia; and

C) A signed statement that the CQA officer assumes full responsibility for all inspections performed and reports prepared by the designated CQA officer-in-absentia during the absence of the CQA officer.

7) The CQA program must ensure, at a minimum, that construction materials and operations meet design specifications.

SUBPART C: LOCATION RESTRICTIONS

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Section 845.300 Placement Above the Uppermost Aquifer

a) Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments, must be constructed with a base that is located at least 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR surface impoundment and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table).

b) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).

c) The owner or operator of an existing CCR surface impoundment must complete the demonstration required by subsection (a) and submit the completed demonstration, along with a qualified professional engineer's certification, to the Agency in the facility's initial operating permit application.

d) The owner or operator of a new CCR surface impoundment or a lateral expansion of a CCR surface impoundment must submit plans and specifications in a construction permit application that demonstrate the CCR surface impoundment will be constructed under subsection (a). Upon completion of construction, the owner or operator must obtain a certification from a qualified professional engineer that the CCR surface impoundment or lateral expansion was constructed in accordance with the requirements in subsection (a) and submit the certification to the Agency in the facility's initial operating permit application.

Section 845.310 Wetlands

a) Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments, must not be located in wetlands unless the owner or operator demonstrates the following:

1) When applicable under section 404 of the Clean Water Act, Interagency Wetlands Policy Act of 1989 [20 ILCS 830] and Rivers, Lakes, and Streams Act [615 ILCS 5], or other applicable State wetlands laws, a clear and objective rebuttal of the presumption that an alternative to the CCR surface impoundment is reasonably available that does not involve wetlands.

2) The construction and operation of the CCR surface impoundment will not cause or contribute to any of the following:

A) A violation of any applicable State or federal water quality standard;

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B) A violation of any applicable toxic effluent standard or prohibition under section 307 of the Clean Water Act;

C) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973 (16 USC 1531 et seq.) and the Illinois Endangered Species Protection Act [520 ILCS 10]; and

D) A violation of any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 (16 USC 1431 and 33 USC 1401) for the protection of a marine sanctuary.

3) The CCR surface impoundment will not cause or contribute to significant degradation of wetlands by addressing all the following factors:

A) Erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the CCR surface impoundment;

B) Erosion, stability, and migration potential of dredged and fill materials used to support the CCR surface impoundment;

C) The volume and chemical nature of the CCR;

D) Impacts on fish, wildlife, and other aquatic resources and their habitat from release of CCR;

E) The potential effects of catastrophic release of CCR to the wetland and the resulting impacts on the environment; and

F) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected.

4) To the extent required under section 404 of the Clean Water Act or applicable State wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent reasonable as required by subsections (a)(1) through (3), then minimizing unavoidable impacts to the maximum extent reasonable, and, finally, offsetting remaining unavoidable wetland impacts through all appropriate and reasonable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and

5) Sufficient information is available to make a reasoned determination with respect to the demonstrations in subsections (a)(1) through (4).

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b) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).

c) The owner or operator of an existing CCR surface impoundment must complete the demonstration required by subsection (a) and submit the completed demonstration, along with the qualified professional engineer's certification, to the Agency with the facility's initial operating permit application.

d) The owner or operator of a new CCR surface impoundment or a lateral expansion of a CCR surface impoundment must submit plans and specifications in a construction permit application that demonstrate the CCR surface impoundment will be constructed under subsection (a). Upon completion of construction, the owner or operator must obtain a certification from a qualified professional engineer that the CCR surface impoundment or lateral expansion was constructed in accordance with the requirements in subsection (a) and submit the certification to the Agency in the facility's initial operating permit application.

Section 845.320 Fault Areas

a) Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments, must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR surface impoundment.

b) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).

c) The owner or operator of an existing CCR surface impoundment must complete the demonstration required by subsection (a) and submit the completed demonstration, along with the qualified professional engineer's certification, to the Agency with the facility's initial operating permit application.

d) The owner or operator of a new CCR surface impoundment or a lateral expansion of a CCR surface impoundment must submit plans and specifications in a construction permit application that demonstrate the CCR surface impoundment will be constructed under subsection (a). Upon completion of construction, the owner or operator must obtain a certification from a qualified professional engineer that the CCR surface impoundment or lateral expansion was constructed in accordance with the requirements in subsection (a) and submit the certification to the Agency in the facility's initial operating permit application.

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Section 845.330 Seismic Impact Zones

a) Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments, must not be located in seismic impact zones unless the owner or operator demonstrates that all structural components, including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

b) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).

c) The owner or operator of an existing CCR surface impoundment must complete the demonstration required by subsection (a) and submit the completed demonstration, along with the qualified professional engineer's certification, to the Agency with the facility's initial operating permit application.

d) The owner or operator of a new CCR surface impoundment or a lateral expansion of a CCR surface impoundment must submit plans and specifications in a construction permit application that demonstrate the CCR surface impoundment will be constructed under subsection (a). Upon completion of construction, the owner or operator must obtain a certification from a qualified professional engineer that the CCR surface impoundment or lateral expansion was constructed in accordance with the requirements of subsection (a) and submit the certification to the Agency in the facility's initial operating permit application.

Section 845.340 Unstable Areas and Floodplains

a) An existing or new CCR surface impoundment, or any lateral expansion of a CCR surface impoundment, must not be located in an unstable area unless the owner or operator demonstrates that recognized and generally accepted engineering practices have been incorporated into the design of the CCR surface impoundment to ensure that the integrity of the structural components of the CCR surface impoundment will not be disrupted.

b) The owner or operator must consider all the following factors, at a minimum, when determining whether an area is unstable:

1) On-site or local soil conditions, including liquefaction, that may result in significant differential settling;

2) On-site or local geologic or geomorphologic features; and

3) On-site or local human-made features or events (both surface and subsurface).

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c) An existing or new CCR surface impoundment, or any lateral expansion of a CCR surface impoundment, must not be located in a floodplain unless the owner or operator demonstrates that recognized and generally accepted engineering practices have been incorporated into the design of the CCR surface impoundment to ensure that the CCR surface impoundment will not restrict the flow of the base flood, reduce the temporary water storage capacity of a floodplain, or result in washout of CCR, so as to pose a hazard to human life, wildlife, or land or water resources. For purposes of this subsection (c):

1) Base flood means a flood that has a 1 percent or greater chance of recurring in any year or a flood of a magnitude equaled or exceeded once in 100 years on average within the time of historical river level records.

2) Floodplain means the lowland and relatively flat areas adjoining inland and coastal waters, including flood-prone areas of offshore islands, which are inundated by the base flood.

3) Washout means the carrying away of CCR by waters of the base flood.

d) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsections (a) and (c).

e) The owner or operator of an existing CCR surface impoundment must complete the demonstration required by subsections (a) and (c) of this Section and submit the completed demonstration, along with a qualified professional engineer's certification, to the Agency with the facility's initial operating permit application.

f) The owner or operator of a new CCR surface impoundment, or a lateral expansion of a CCR surface impoundment, must submit plans and specifications in a construction permit application that demonstrate the CCR surface impoundment will be constructed under subsections (a)and (c). Upon completion of construction, the owner or operator must obtain a certification from a qualified professional engineer that the CCR surface impoundment or lateral expansion was constructed in accordance with the requirements in subsections (a) and (c) and submit the certification to the Agency in the facility's initial operating permit application.

Section 845.350 Failure to Meet Location Standards

a) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of this Subpart is subject to the requirements of Section 845.700.

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b) An owner or operator of a new CCR surface impoundment, or any lateral expansion of a CCR surface impoundment, who fails to make the demonstration showing compliance with the requirements of this Subpart is prohibited from placing CCR in the CCR surface impoundment.

SUBPART D: DESIGN CRITERIA

Section 845.400 Liner Design Criteria for Existing CCR Surface Impoundments

a) An existing CCR surface impoundment is considered to be an existing lined surface impoundment if it has been constructed with either a composite liner that meets the requirements of subsection (b) or an alternative composite liner that meets the requirements of subsection (c).

b) Composite Liner

1) A composite liner must consist of two components: the upper component consisting of, at a minimum, a 30-mil geomembrane liner, and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). The geomembrane liner components consisting of high-density polyethylene (HDPE) must be at least 60 mil. The geomembrane liner or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component.

2) The composite liner must be:

A) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

B) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component, including on slopes;

C) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

D) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.

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c) Alternative Composite Liner

1) An alternative composite liner must consist of two components: the upper component consisting of, at a minimum, a 30-mil geomembrane liner, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. The geomembrane liner components consisting of high-density polyethylene (HDPE) must be at least 60 mil. If the lower component of the alternative liner is compacted soil, the geomembrane liner must be installed in direct and uniform contact with the compacted soil.

2) The liquid flow rate through the lower component of the alternative composite liner must be no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison must be no greater than 1×10^{-7} cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods.

3) The liquid flow rate comparison must be made using the following equation, which is derived from Darcy's Law for gravity flow through porous media.

$$Q/A = q = k ((h/t)+1)$$

Where:
Q = flow rate (cubic centimeters/second)
A = Surface area of the liner (squared centimeters)
q = flow rate per unit area (cubic centimeters/ second/squared centimeter)
k = hydraulic conductivity of the liner (centimeters /second)
h = hydraulic head above the liner (centimeters); and
t = thickness of the liner (centimeters)

4) The alternative composite liner must meet the requirements specified in subsection (b).

d) The hydraulic conductivity of the compacted soil must be determined using recognized and generally accepted methods.

e) The owner or operator of an existing CCR surface impoundment that has not completed an Agency approved closure before July 30, 2021 must submit an initial operating permit application under Section 845.230 that demonstrates whether the CCR surface impoundment was constructed with either of the following:

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1) A composite liner that meets the requirements of subsection (b); or

2) An alternative composite liner that meets the requirements of subsection (c).

f) A CCR surface impoundment is considered to be an unlined CCR surface impoundment if either:

1) The owner or operator of the CCR surface impoundment determines that the CCR surface impoundment is not constructed with a liner that meets the requirements of subsection (b) or (c); or

2) The owner or operator of the CCR surface impoundment fails to document whether the CCR surface impoundment was constructed with a liner that meets the requirements of subsection (b) or (c).

g) All unlined CCR surface impoundments are subject to the requirements of Section 845.700.

h) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer attesting that the CCR surface impoundment meets the requirements of subsection (a) and submit the certification to the Agency in the facility's initial operating permit application.

Section 845.410 Liner Design Criteria for New CCR Surface Impoundments and Any Lateral Expansion of a CCR Surface Impoundment

a) New CCR surface impoundments and lateral expansions of existing and new CCR surface impoundments must be designed, constructed, operated, and maintained with either a composite liner or an alternative composite liner that meets the requirements of Section 845.400(b) or (c).

b) Any liner specified in this Section must be installed to cover all surrounding earth likely to be in contact with CCR. Dikes must not be constructed so as to damage the composite liner.

c) Before construction, the owner or operator must obtain certification from a qualified professional engineer that the design of the composite liner or, if applicable, the design of an alternative composite liner complies with the requirements of this Section and submit this certification to the Agency in the facility's construction permit application.

d) Upon completion of construction, the owner or operator must obtain a certification from a qualified professional engineer that the composite liner or, if applicable, the alternative composite liner has been constructed in accordance

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with the requirements of this Section and submit this certification to the Agency in the facility's initial operating permit application.

Section 845.420 Leachate Collection and Removal System

A new CCR surface impoundment must be designed, constructed, operated and maintained with a leachate collection and removal system. The leachate collection and removal system must be designed, constructed, operated, and maintained to collect and remove leachate from the leachate collection system of the CCR surface impoundment during its active life and post-closure care period.

a) The leachate collection and removal system must:

1) Be placed above the liner required by Section 845.400 or Section 845.410;

2) Have placed above it a filter layer that has a hydraulic conductivity of at least 1×10^{-5} cm/sec;

3) Have a bottom slope of three percent or more towards the collection pipes;

4) Be constructed of:

A) Granular drainage materials with a hydraulic conductivity of 1×10^{-1} cm/sec or more and a thickness of 24 inches or more above the crown of the collection pipe; or

B) Synthetic drainage materials with a transmissivity of 6×10^{-4} m^2/sec or more;

5) Be constructed of materials that are chemically resistant to CCR and any non-CCR waste managed in the CCR surface impoundment and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste and any waste cover materials and equipment used at the CCR surface impoundment;

6) Be designed, constructed and operated with collection pipes at the base of the granular material to prevent clogging with fines during the active life and post-closure care period;

7) Have collection pipes

A) Designed such that leachate is collected at a sump and is pumped or flows out of the CCR surface impoundment;

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B) With slopes that allow flow from all points within the CCR surface impoundment to the sump or drain outlet; and

C) Large enough to conduct periodic cleaning;

8) Have a protective layer or other means of deflecting the force of CCR pumped into the CCR surface impoundment;

9) Be designed and operated to minimize clogging during the active life and post-closure care period; and

10) At a minimum, the leachate collection and removal system must be operated to remove free liquids from the CCR surface impoundment at the time of closure and during post closure care.

b) The owner or operator must obtain certification from a qualified professional engineer that the design of the leachate collection system complies with the requirements of this Section and submit this certification to the Agency in the facility's construction permit application.

c) Upon completion, the owner or operator must obtain a certification from a qualified professional engineer that the leachate collection system has been constructed in accordance with the requirements of this Section and submit this certification to the Agency in the facility's initial operating permit application.

Section 845.430 Slope Maintenance

The slopes and pertinent surrounding areas of the CCR surface impoundment must be designed, constructed, operated, and maintained with one of the forms of slope protection specified in subsection (a) that meets all the performance standards of subsection (b).

a) Slope protection must consist of one of the following:

1) A vegetative cover consisting of grassy vegetation;

2) An engineered cover consisting of a single form or combination of forms of engineered slope protection measures; or

3) A combination of the forms of cover specified in subsection (a)(1) or (a)(2).

b) Any form of cover for slope protection must meet the following performance standards:

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1) The cover must be installed and maintained on the slopes and pertinent surrounding areas of the CCR surface impoundment;

2) The cover must provide protection against surface erosion, wave action, and adverse effects of rapid drawdown;

3) The cover must be maintained to allow for the observation of, and access to, the slopes and pertinent surrounding areas during routine and emergency events;

4) Woody vegetation must be removed from the slopes or pertinent surrounding areas. Any removal of woody vegetation with a diameter greater than ½ inch must be directed by a person familiar with the design and operation of the CCR surface impoundment and in consideration of the complexities of removal of a tree or shrubbery, who must ensure the removal does not create a risk of destabilizing the CCR surface impoundment or otherwise adversely affect the stability and safety of the CCR surface impoundment or personnel undertaking the removal; and

5) The height of vegetation must not exceed 12 inches.

Section 845.440 Hazard Potential Classification Assessment

a) Hazard Potential Classification Assessments

1) The owner or operator of the CCR surface impoundment must conduct an initial and annual hazard potential classification assessment of the CCR surface impoundment. The owner or operator must document the hazard potential classification of each CCR surface impoundment as either a Class 1 or Class 2 CCR surface impoundment. The owner or operator must also document the basis for each hazard potential classification.

2) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the initial hazard potential classification and each annual classification was conducted in accordance with the requirements of this Section.

3) Timeframe for Submission of the Hazard Potential Classification Assessments and Certifications

A) The owner or operator of a new CCR surface impoundment must submit the initial hazard potential classification assessment certification with the initial operating permit application before the initial receipt of CCR in the surface impoundment.

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B) The owner or operator of an existing CCR surface impoundment must submit the initial hazard potential classification assessment certification with its first annual inspection report required by Section 845.540(b).

C) The owner or operator of a CCR surface impoundment must submit the annual hazard potential classification assessment certification each year with the annual inspection required by Section 845.540(b).

D) The owner or operator of a CCR surface impoundment must place each hazard potential classification assessment in the facility's operating record (see Section 845.800(d)(4)).

b) The requirements of this Section apply to all CCR surface impoundments, except for those CCR surface impoundments that are incised CCR surface impoundments. If an incised CCR surface impoundment is subsequently modified (e.g., a dike is constructed) such that the CCR surface impoundment no longer meets the definition of an incised CCR surface impoundment, the CCR surface impoundment is subject to the requirements of this Section.

Section 845.450 Structural Stability Assessment

a) The owner or operator of a CCR surface impoundment must conduct initial and annual structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR surface impoundment is consistent with recognized and generally accepted engineering practices for the maximum volume of CCR and CCR wastewater that can be impounded in the CCR surface impoundment. The assessment must, at a minimum, document whether the CCR surface impoundment has been designed, constructed, operated, and maintained with:

1) Stable foundations and abutments;

2) Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

3) Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR surface impoundment;

4) Slope protection consistent with Section 845.430;

5) A single spillway or a combination of spillways configured as specified in subsection (a)(5)(A). The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage

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flow during and following the peak discharge from the event specified in subsection (a)(5)(B).

A) All spillways must be either:

i) Of non-erodible construction and designed to carry sustained flows; or

ii) Earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.

B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:

i) Probable maximum flood for a Class 1 CCR surface impoundment; or

ii) 1000-year flood for a Class 2 CCR surface impoundment.

6) Hydraulic structures underlying the base of the CCR surface impoundment or passing through the dike of the CCR surface impoundment that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris that may negatively affect the CCR surface impoundment; and

7) For CCR surface impoundments with downstream slopes that can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

b) The annual assessment described in this Section must identify any structural stability deficiencies associated with the CCR surface impoundment in addition to recommending corrective measures. If a deficiency or a release is identified during the periodic assessment, the owner or operator of the surface impoundment must submit to the Agency a construction permit application including documentation detailing proposed corrective measures and must obtain any necessary permits from the Agency as soon as feasible.

c) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the initial structural stability assessments and each annual assessment thereafter was conducted in accordance with the requirements.

d) Timeframe for Submission of Structural Stability Assessment

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1) The owner or operator of a new CCR surface impoundment must submit the initial structural stability assessment certification with the initial operating permit application before the initial receipt of CCR in the surface impoundment.

2) The owner or operator of an existing CCR surface impoundment must submit the initial structural stability assessment certification with its first annual inspection report required by Section 845.540(b).

3) The owner or operator of a CCR surface impoundment must submit the annual structural stability assessment certification each year with the annual inspection required by Section 845.540(b).

4) The owner or operator of a CCR surface impoundment must place each structural stability assessment in the facility's operating record (see Section 845.800(d)(5)).

e) The requirements of this Section apply to all CCR surface impoundments, except for those CCR surface impoundments that are incised CCR surface impoundments. If an incised CCR surface impoundment is subsequently modified (e.g., a dike is constructed) such that the CCR surface impoundment no longer meets the definition of an incised CCR surface impoundment, the CCR surface impoundment is subject to the requirements of this Section.

Section 845.460 Safety Factor Assessment

a) The owner or operator of a CCR surface impoundment must conduct an initial and annual safety factor assessment for each CCR surface impoundment and document whether the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in this Section for the critical cross-section of the embankment. The critical cross-section is the cross section anticipated to be the most susceptible of all cross-sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

1) For new CCR surface impoundments, the calculated static factor of safety under the end-of-construction loading condition must equal or exceed 1.30. The assessment of this loading condition is only required for the initial safety factor assessment and is not required for subsequent assessments.

2) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

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3) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

4) The calculated seismic factor of safety must equal or exceed 1.00.

5) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

b) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the initial safety factor assessment and each annual assessment thereafter was conducted in accordance with the requirements of this Section.

c) Timeframe for Submission of the Safety Factor Assessment

1) The owner or operator of a new CCR surface impoundment must submit the initial safety factor assessment certification with the initial operating permit application before the initial receipt of CCR in the surface impoundment.

2) The owner or operator of an existing CCR surface impoundment must submit the initial safety factor assessment certification with its first annual inspection report required by Section 845.540(b).

3) The owner or operator of a CCR surface impoundment must submit the annual safety factor assessment certification each year with the annual inspection required by Section 845.540(b).

4) The owner or operator of a new CCR surface impoundment must place each safety factor assessment in the facility's operating record as required by Section 845.800(d)(6).

d) Failure to Document Minimum Safety Factors

1) For new CCR surface impoundments, until the date an owner or operator of a CCR surface impoundment documents that the calculated factors of safety achieve the minimum safety factors specified in this Section, the owner or operator is prohibited from placing CCR in the CCR surface impoundment.

2) An owner or operator of the CCR surface impoundment who either fails to complete a timely safety factor assessment or fails to demonstrate minimum safety factors as required by this Section is subject to the requirements of Section 845.700.

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e) The requirements of this Section apply to all CCR surface impoundments, except for those CCR surface impoundments that are incised CCR surface impoundments. If an incised CCR surface impoundment is subsequently modified (e.g., a dike is constructed) such that the CCR surface impoundment no longer meets the definition of an incised CCR surface impoundment, the CCR surface impoundment is subject to the requirements of this Section.

SUBPART E: OPERATING CRITERIA

Section 845.500 Air Criteria

a) The owner or operator of a CCR surface impoundment, or any lateral expansion of a CCR surface impoundment, must adopt measures that will effectively minimize CCR from becoming airborne at the facility, including CCR fugitive dust originating from CCR surface impoundments, roads, and other CCR management and material handling activities.

b) CCR Fugitive Dust Control Plan. The owner or operator of the CCR surface impoundment must prepare and operate in accordance with a CCR fugitive dust control plan as specified in this subsection (b). This requirement applies in addition to, not in place of, any applicable standards under the Occupational Safety and Health Act (29 USC 15), including 29 CFR 1910.1018, 29 CFR 1910.1024, 29 CFR 1910.1025, 29 CFR 1910.1027, and 1910.1053, or any other State or federal law.

1) The CCR fugitive dust control plan must identify and describe the CCR fugitive dust control measures the owner or operator will use to minimize CCR from becoming airborne at the facility. The owner or operator must select, and include in the CCR fugitive dust control plan, the CCR fugitive dust control measures that are most appropriate for site conditions, along with an explanation of how the measures selected are applicable and appropriate for site conditions. Examples of control measures that may be appropriate include: locating CCR inside an enclosure or partial enclosure; operating a water spray or fogging system; reducing fall distances at material drop points; using wind barriers, compaction, or vegetative covers; establishing and enforcing reduced vehicle speed limits; paving and sweeping roads; covering trucks transporting CCR; reducing or halting operations during high wind events; or applying a daily cover.

2) The CCR fugitive dust control plan must include procedures to log every complaint from members of the public received by the owner or operator involving CCR fugitive dust events at the facility. The owner or operator must:

A) Include for each logged complaint the date of the complaint, the date of the incident, the name and contact information of the

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complainant, if given, and all actions taken to assess and resolve the complaint; and

B) Submit quarterly reports to the Agency no later than 14 days from the end of the quarter of all complaints received in that quarter, including the information required by subsection (b)(2)(A).

3) The CCR fugitive dust control plan must include a description of the procedures the owner or operator will follow to periodically assess the effectiveness of the control plan.

4) The owner or operator of a CCR surface impoundment must prepare an initial CCR fugitive dust control plan for the facility by October 31, 2021, or by initial receipt of CCR in any CCR surface impoundment at the facility if the owner or operator becomes subject to this Part after October 31, 2021.

5) Amendment of the Plan. The owner or operator of a CCR surface impoundment subject to the requirements may amend the written CCR fugitive dust control plan at any time provided the revised plan is submitted to the Agency. The owner or operator must amend the written plan whenever there is a change in conditions that would substantially affect the written plan in effect, such as the construction and operation of a new CCR surface impoundment.

6) The owner or operator must place the initial and any amendments to the fugitive dust control plan in the facility's operating record as required by Section 845.800(d)(7). The most recent fugitive dust control plan must be placed in the facility's operating record and available on the owner's or operator's CCR website before submitting a permit application under this Part.

7) The owner or operator must obtain a certification from a qualified professional engineer that the initial CCR fugitive dust control plan, or any subsequent amendment of it, meets the requirements of this Section.

c) Annual CCR Fugitive Dust Control Report. The owner or operator of a CCR surface impoundment must prepare an annual CCR fugitive dust control report that includes a description of the actions taken by the owner or operator to control CCR fugitive dust and the four quarterly fugitive dust complaint reports submitted under subsection (b)(2)(B). The annual CCR fugitive dust control report must be submitted as a part of the annual consolidated report required by Section 845.550.

Section 845.510 Hydrologic and Hydraulic Capacity Requirements for CCR Surface Impoundments

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a) The owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified in subsections (a)(1) and (2).

1) The inflow design flood control system must adequately manage flow into the CCR surface impoundment during and following the peak discharge of the inflow design flood specified in subsection (a)(3).

2) The inflow design flood control system must adequately manage flow from the CCR surface impoundment to collect and control the peak discharge resulting from the inflow design flood specified in subsection (a)(3).

3) The inflow design flood, at a minimum, is:

A) For a Class 1 CCR surface impoundment, as determined under Section 845.440(a), the probable maximum flood;

B) For a Class 2 CCR surface impoundment, as determined under Section 845.440(a), the 1000-year flood; or

C) For an incised CCR surface impoundment, the 25-year flood.

b) Discharge from the CCR surface impoundment must be handled in accordance with the surface water requirements in Section 845.110(b)(3) and 35 Ill. Adm. Code Subtitle C.

c) Inflow Design Flood Control System Plan

1) Content of the Plan. The owner or operator must prepare initial and annual inflow design flood control system plans for the CCR surface impoundment. These plans must document how the inflow design flood control system has been designed and constructed to meet the requirements of this Section. Each plan must be supported by appropriate engineering calculations.

2) Amendment of the Plan. The owner or operator of the CCR surface impoundment may amend the written inflow design flood control system plan at any time. The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

3) The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic inflow design flood control system plans meet the requirements of this Section.

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4) Timeframe for Plan Submission

A) The owner or operator of a new CCR surface impoundment must submit to the Agency the initial inflow design flood control system plan certification with the initial operating permit application before the initial receipt of CCR in the surface impoundment.

B) The owner or operator of an existing CCR surface impoundment must submit the initial inflow design flood control system plan certification with its first annual inspection report required by Section 845.540(b).

C) The owner or operator of a CCR surface impoundment must submit the annual inflow design flood control system plan certification each year with the annual inspection required by Section 845.540(b).

D) The owner or operator of a new CCR surface impoundment must place each inflow design flood control system plan in the facility's operating record (see Section 845.800(d)(8)).

Section 845.520 Emergency Action Plan

a) The owner or operator of a CCR surface impoundment must prepare and maintain a written Emergency Action Plan (EAP). The owner or operator must place the EAP and any amendment of the EAP in the facility's operating record (see Section 845.800(d)(9)).

b) At a minimum, the EAP must:

1) Define the events or circumstances involving the CCR surface impoundment that represent a safety emergency, along with a description of the procedures that will be followed to detect a safety emergency in a timely manner;

2) Define responsible persons, their respective responsibilities, and notification procedures for a safety emergency involving the CCR surface impoundment;

3) Provide contact information of emergency responders;

4) Include a map that delineates the downstream area that would be affected if a CCR surface impoundment fails and a physical description of the CCR surface impoundment; and

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5) Include provisions for an annual face-to-face meeting or exercise between representatives of the owner or operator of the CCR surface impoundment and the local emergency responders.

c) The owner or operator of a CCR surface impoundment must prepare an initial Emergency Action Plan for the facility by October 31, 2021, or by initial receipt of CCR in any CCR surface impoundment at the facility if the owner or operator becomes subject to this Part after October 31, 2021.

d) Amendment of the Plan

1) The owner or operator of a CCR surface impoundment may amend the written EAP at any time.

2) The owner or operator must amend the written EAP whenever there is a change in conditions that would substantially affect the EAP in effect.

3) The written EAP must be evaluated, at a minimum, every five years to ensure the information required in this Section is accurate.

e) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the written EAP, and any subsequent amendment of the EAP, meets the requirements of this Section.

f) Activation of the EAP. The EAP must be implemented once events or circumstances involving the CCR surface impoundment that represent a safety emergency are detected, including conditions identified during any structural stability assessments, annual inspections, and inspections by a qualified person. The owner or operator of the CCR surface impoundment must submit records documenting all activations of the EAP to the Agency and place the documentation in the facility's operating record as required by Section 845.800(d)(10).

g) The owner or operator of a CCR surface impoundment must document the annual face-to-face meeting or exercise between representatives of the owner or operator of the CCR surface impoundment and the local emergency responders as required by subsection (b)(5). The owner or operator of the CCR surface impoundment must place this documentation in the facility's operating record as required by Section 845.800(d)(11).

Section 845.530 Safety and Health Plan

a) The owner or operator of the CCR surface impoundment must develop a Safety and Health Plan and ensure that employees, contract workers, and third-party contractors are informed regarding the Safety and Health Plan. The owner or

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operator must conduct ongoing worker hazard analyses and ensure employees, contract workers, and third-party contractors are aware of those analyses. The plan must be updated as needed based on the worker hazard analyses, but at least annually. The plan, and all amendments to the plan, must be placed in the facility's operating record as required by Section 845.800(d)(12), and on the owner's or operator's publicly accessible internet site.

b) For worker exposure safety, in addition to all other applicable local, State and federal requirements, the owner or operator of the CCR surface impoundment, for all chemical constituents identified in the CCR under Sections 845.230(a)(15) and 845.230(d)(2)(C), must:

1) Consider the recommendations in the most recent "NIOSH Pocket Guide to Chemical Hazards", Department of Human Health and Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (available at cdc.gov/niosh/npg/default.html);

2) Implement the Occupational Safety and Health Administration regulations in Chapter 17 of Title 29 of the Code of Federal Regulations for all hazards not otherwise classified as defined in 29 CFR 1910.1200(c); and

3) Provide safety data sheets (Globally Harmonized System of Classification and Labeling of Chemicals adopted by OSHA) or create a facility-specific safety data sheet under 29 CFR 1910.1200(g).

c) The Safety and Health Plan must include a personnel training program that meets the following minimum requirements:

1) Employees, contract workers, and third-party contractors must successfully complete a training program that informs them of the hazards at the facility to ensure compliance with the requirements of this Part. The facility must maintain an outline of the training program used (or to be used) at the facility and a brief description of training program updates.

2) At a minimum, the training program must be designed to ensure that employees, contract workers, and third-party contractors understand and are able to respond effectively to the following:

A) Procedures for using, inspecting, repairing, and replacing facility emergency and monitoring equipment;

B) Communications or alarm systems;

C) Response to fires or explosions;

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D) Response to a spill or release of CCR;

E) The training under the Occupational Safety and Health Standards in 29 CFR 1910.120, 29 CFR 1926.65, and the OSHA 10-hour or 30-hour construction safety training;

F) Information about chemical hazards and hazardous materials identified in subsection (b); and

G) The use of engineering controls, administrative controls, and personal protective equipment.

d) Employees, contract workers, and third-party contractors must successfully complete the program required in subsection (c) before undertaking any activity to construct, operate or close a CCR surface impoundment.

e) Employees, contract workers, and third-party contractors must take part in an annual review of the initial training required in subsection (c).

f) The owner or operator of the CCR surface impoundment must perform, at a minimum, the following hazard communication activities:

1) Post signs at the facility identifying the hazards of CCR, including dust inhalation when handling CCR;

2) Post signs at the facility identifying unstable CCR areas that may make operation of heavy equipment hazardous; and

3) Post signs at the facility where the CCR surface impoundment is located identifying safety measures and necessary precautions, including the proper use of personal protective equipment.

Section 845.540 Inspection Requirements for CCR Surface Impoundments

a) Inspections by a Qualified Person.

1) All CCR surface impoundments and any lateral expansion of a CCR surface impoundment must be examined by a qualified person as follows:

A) At intervals not exceeding seven days and after each 25-year, 24-hour storm, inspect for the following:

i) Any appearances of actual or potential structural weakness and other conditions that are disrupting, or have the potential to disrupt, the operation or safety of the CCR surface impoundment;

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ii) Deterioration, malfunctions or improper operation of overtopping control systems, where present;

iii) Sudden drops in the level of the CCR surface impoundment's contents;

iv) Erosion that creates rills, gullies, or crevices six inches or deeper, other signs of deterioration including failed or eroded vegetation in excess of 100 square feet, or cracks in dikes or other containment devices; and

v) Any visible releases;

B) At intervals not exceeding seven days, inspect the discharge of all outlets of hydraulic structures that pass underneath the base of the CCR surface impoundment or through the dike, of the CCR surface impoundment, for abnormal discoloration, flow or discharge of debris or sediment; and

C) At intervals not exceeding 30 days, monitor all CCR surface impoundment instrumentation.

2) The owner or operator must prepare a report for each inspection that includes the date of the inspection, condition of the CCR surface impoundment, any repairs made to the CCR surface impoundment, and the date of the repair. The results of the inspection by a qualified person must be recorded in the facility's operating record as required by Section 845.800(d)(13).

3) The owner or operator of a CCR surface impoundment must initiate the inspections required by subsection (a) by April 30, 2021, or by initial receipt of CCR in a CCR surface impoundment if the owner or operator becomes subject to this Part after April 30, 2021. The inspections required by subsection (a) must continue until the completion of closure by removal or the completion of post-closure care.

4) If a 25-year, 24-hour storm is identified more than 48 hours before the next scheduled weekly inspection, an additional inspection must be conducted within 24 hours after the end of the identified storm event, before the scheduled seven-day inspection.

b) Annual Inspections By a Qualified Professional Engineer.

1) The CCR surface impoundment must be inspected on an annual basis by a qualified professional engineer to ensure that the design, construction,

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operation, and maintenance of the CCR surface impoundment is consistent with recognized and generally accepted engineering standards. The inspection must, at a minimum, include:

A) A review of available information regarding the status and condition of the CCR surface impoundment, including files available in the operating record (e.g., CCR surface impoundment design and construction information required by Sections 845.220(a)(1) and 845.230(d)(2)(A), previous structural stability assessments required under Section 845.450, the results of inspections by a qualified person, and results of previous annual inspections);

B) A visual inspection of the CCR surface impoundment to identify signs of distress or malfunction of the CCR surface impoundment and appurtenant structures;

C) A visual inspection of any hydraulic structures underlying the base of the CCR surface impoundment or passing through the dike of the CCR surface impoundment for structural integrity and continued safe and reliable operation;

D) The annual hazard potential classification certification, if applicable (see Section 845.440);

E) The annual structural stability assessment certification, if applicable (see Section 845.450);

F) The annual safety factor assessment certification, if applicable (see Section 845.460); and

G) The inflow design flood control system plan certification (see Section 845.510(c)).

2) Inspection Report. The qualified professional engineer must prepare a report following each inspection that addresses the following:

A) Any changes in geometry of the impounding structure since the previous annual inspection;

B) The location and type of existing instrumentation and the maximum recorded readings of each instrument since the previous annual inspection;

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C) The approximate minimum, maximum, and present depth and elevation of the impounded water and CCR since the previous annual inspection;

D) The storage capacity of the impounding structure at the time of the inspection;

E) The approximate volume of the impounded water and CCR at the time of the inspection;

F) Any appearances of an actual or potential structural weakness of the CCR surface impoundment, in addition to any existing conditions that are disrupting or have the potential to disrupt the operation and safety of the CCR surface impoundment and appurtenant structures; and

G) Any other changes that may have affected the stability or operation of the impounding structure since the previous annual inspection.

3) By January 31 of each year, the inspection report must be completed and included with the annual consolidated report required by Section 845.550.

4) Frequency of Inspections. The owner or operator of the CCR surface impoundment must conduct the inspection required by subsections (b)(1) and (2) on an annual basis. The deadline for conducting a subsequent inspection is based on the date of conducting the previous inspection.

5) If a deficiency or release is identified during an inspection, the owner or operator must submit to the Agency documentation detailing proposed corrective measures and obtain any necessary permits from the Agency.

Section 845.550 Annual Consolidated Report

a) By January 31 of each year, the owner or operator of the CCR surface impoundment must prepare an annual consolidated report for the preceding calendar year that includes the following:

1) Annual CCR fugitive dust control report (see Section 845.500(c));

2) Annual inspection report (see Section 845.540(b)), including:

A) Annual hazard potential classification certification, if applicable (see Section 845.440);

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B) Annual structural stability assessment certification, if applicable (see Section 845.450);

C) Annual safety factor assessment certification, if applicable (see Section 845.460); and

D) Inflow design flood control system plan certification (see Section 845.510(c)).

3) Annual Groundwater Monitoring and Corrective Action Report (see Section 845.610(e)).

b) The owner or operator of the CCR surface impoundment must submit the annual consolidated report to the Agency in addition to placing the annual consolidated report in the facility's operating record as required by Section 845.800(d)(14).

SUBPART F: GROUNDWATER MONITORING AND CORRECTIVE ACTION

Section 845.600 Groundwater Protection Standards

a) For existing CCR surface impoundments and for inactive CCR surface impoundments:

1) The groundwater protection standards at the waste boundary must be:

A) Antimony: 0.006 mg/L

B) Arsenic: 0.010 mg/L

C) Barium: 2.0 mg/L

D) Beryllium: 0.004 mg/L

E) Boron: 2 mg/L

F) Cadmium: 0.005 mg/L

G) Chloride: 200 mg/L

H) Chromium: 0.1 mg/L

I) Cobalt: 0.006 mg/L

J) Fluoride: 4.0 mg/L

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K) Lead: 0.0075 mg/L

L) Lithium: 0.04 mg/L

M) Mercury: 0.002 mg/L

N) Molybdenum: 0.1 mg/L

O) pH: 6.5-9.0 units

P) Selenium: 0.05 mg/L

Q) Sulfate: 400 mg/L

R) Thallium: 0.002 mg/L

S) Total Dissolved Solids: 1200 mg/L

T) Radium 226 and 228 combined: 5 pCi/L

2) For constituents with a background concentration higher than the levels identified in subsection (a)(1), the background concentration must be the groundwater protection standard.

b) For new CCR surface impoundments, the groundwater protection standards at the waste boundary must be background for the constituents listed in subsection (a)(1), calcium, and turbidity.

c) The owner or operator of a CCR surface impoundment may not obtain alternative groundwater quality standards in 35 Ill. Adm. Code 620.450(a)(4) for the constituents in subsections (a) and (b) before the end of post-closure care under Section 845.780, when closing with a final cover system, or before the end of groundwater monitoring under Section 845.740(b), when closing by removal.

Section 845.610 General Requirements

a) All CCR surface impoundments and lateral expansions of CCR surface impoundments are subject to the groundwater monitoring and corrective action requirements of this Subpart.

b) Required Submissions and Agency Approvals for Groundwater Monitoring

1) Existing CCR Surface Impoundments. The owner or operator of an existing CCR surface impoundment must submit the following to the Agency in an initial operating permit application:

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A) A hydrogeologic site characterization meeting the requirements of Section 845.620;

B) Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630;

C) A groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by Section 845.640; and

D) A monitoring program that includes a minimum of eight independent samples for each background and downgradient well as required by Section 845.650(b).

2) New CCR Surface Impoundments. The owner or operator of a new CCR surface impoundment and all lateral expansions of a CCR surface impoundment must submit the information required in subsections (b)(1)(A) through (C) in a construction permit application, and the information required in subsection (b)(1)(D) in an operating permit application.

3) All owners and operators of CCR surface impoundments must:

A) Conduct groundwater monitoring under a monitoring program approved by the Agency under this Subpart;

B) Evaluate the groundwater monitoring data for statistically significant levels over background levels for the constituents listed in Section 845.600 after each sampling event;

C) Determine compliance with the groundwater protection standards in Section 845.600 after each sampling event; and

D) Submit all groundwater monitoring data to the Agency and any analysis performed under subsections (b)(3)(B) and (b)(3)(C) within 60 days after completion of sampling, and place the groundwater monitoring data in the facility's operating record as required by Section 845.800(d)(15).

c) Once the groundwater monitoring system and the groundwater monitoring program have been established at the CCR surface impoundment as required by this Subpart, the owner or operator must conduct groundwater monitoring and, if necessary, corrective action throughout the active life and post-closure care period of the CCR surface impoundment or the time period specified in Section 845.740(b) when closure is by removal.

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d) If a CCR surface impoundment has a release, the owner or operator must immediately take all necessary measures to control all sources of the release to reduce or eliminate, to the maximum extent feasible, further releases of contaminants into the environment. The owner or operator of the CCR surface impoundment must comply with all applicable requirements of Sections 845.660, 845.670, and 845.680.

e) Annual Groundwater Monitoring and Corrective Action Report

1) The owner or operator of the CCR surface impoundment must prepare and submit to the Agency an annual groundwater monitoring and corrective action report as a part of the annual consolidated report required by Section 845.550.

2) For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action plan for the CCR surface impoundment, summarize key actions completed, including the status of permit applications and Agency approvals, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year.

3) At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available:

A) A map, aerial image, or diagram showing the CCR surface impoundment, all background (or upgradient) and downgradient monitoring wells, including the well identification numbers, that are part of the groundwater monitoring program for the CCR surface impoundment, and a visual delineation of any exceedances of the groundwater protection standards;

B) Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

C) A potentiometric surface map for each groundwater elevation sampling event required by Section 845.650(b)(2);

D) In addition to all the monitoring data obtained under this Subpart, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, and the dates the samples were collected;

E) A narrative discussion of any statistically significant increases over background levels for the constituents listed in Section 845.600; and

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F) Other information required to be included in the annual report as specified in this Subpart.

4) A section at the beginning of the annual report must provide an overview of the current status of groundwater monitoring program and corrective action plan for the CCR surface impoundment. At a minimum, the summary must:

A) Specify whether groundwater monitoring data shows a statistically significant increase over background concentrations for one or more constituents listed in Section 845.600;

B) Identify those constituents having a statistically significant increase over background concentrations and the names of the monitoring wells associated with the increase;

C) Specify whether there have been any exceedances of the groundwater protection standards for one or more constituents listed in Section 845.600;

D) Identify those constituents with exceedances of the groundwater protection standards in Section 845.600 and the names of the monitoring wells associated with the exceedance;

E) Provide the date when the assessment of corrective measures was initiated for the CCR surface impoundment;

F) Provide the date when the assessment of corrective measures was completed for the CCR surface impoundment;

G) Specify whether a remedy was selected under Section 845.670 during the current annual reporting period, and if so, the date of remedy selection; and

H) Specify whether remedial activities were initiated or are ongoing under Section 845.780 during the current annual reporting period.

Section 845.620 Hydrogeologic Site Characterization

a) The owner or operator of the CCR surface impoundment must design and implement a hydrogeologic site characterization.

b) The hydrogeologic site characterization must include, but is not limited to, the following:

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1) Geologic well logs/boring logs;

2) Climatic aspects of the site, including seasonal and temporal fluctuations in groundwater flow;

3) Identification of nearby surface water bodies and drinking water intakes;

4) Identification of nearby pumping wells and associated uses of the groundwater;

5) Identification of nearby dedicated nature preserves;

6) Geologic setting;

7) Structural characteristics;

8) Geologic cross-sections;

9) Soil characteristics;

10) Identification of confining layers;

11) Identification of potential migration pathways;

12) Groundwater quality data;

13) Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy;

14) A map displaying any known underground mines beneath a CCR surface impoundment;

15) Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface;

16) Hydraulic characteristics of the geologic layers identified as migration pathways and geologic layers that limit migration, including:

    A) Water table depth;

    B) Hydraulic conductivities;

    C) Effective and total porosities;

    D) Direction and velocity of groundwater flow; and

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E) Map of the potentiometric surface;

17) Groundwater classification under 35 Ill. Adm. Code 620; and

18) Any other information requested by the Agency that is relevant to the hydrogeologic site characterization.

Section 845.630 Groundwater Monitoring Systems

a) Performance Standard. The owner or operator of a CCR surface impoundment must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples that:

1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR surface impoundment. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:

A) Hydrogeologic conditions do not allow the owner or operator of the CCR surface impoundment to determine what wells are hydraulically upgradient; or

B) Sampling at other wells will provide an indication of background groundwater quality that is demonstratively as representative or more representative than that provided by the upgradient wells; and

2) Accurately represent the quality of groundwater passing the waste boundary of the CCR surface impoundment. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination. All potential contaminant pathways must be monitored.

b) The number, spacing, and depths of monitoring system wells must be determined based upon site-specific technical information identified in the hydrogeologic site characterization conducted under Section 845.620.

c) The groundwater monitoring system must include a sufficient number of monitoring wells necessary to meet the performance standards specified in subsection (a) based on the site-specific information specified in subsection (b). The groundwater monitoring system must contain:

1) A minimum of one upgradient and three downgradient monitoring wells; and

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2) Additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR surface impoundment and the quality of groundwater passing the waste boundary of the CCR surface impoundment.

d) Multiunit Groundwater Monitoring System

1) The owner or operator of multiple CCR surface impoundments may install a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR surface impoundment.

2) The multiunit groundwater monitoring system must be equally as capable of detecting monitored constituents at the waste boundary of the CCR surface impoundment as the individual groundwater monitoring system specified in subsections (a) through (c) for each CCR surface impoundment, based on the following factors:

A) Number, spacing, and orientation of each CCR surface impoundment;

B) Hydrogeologic setting;

C) Site history; and

D) Engineering design of the CCR surface impoundment.

e) Monitoring wells must be properly constructed in a manner consistent with the standards of 77 Ill. Adm. Code 920.170.

1) The owner or operator must document and include in the facility's operating record the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices. The qualified professional engineer must be given access to this documentation when completing the groundwater monitoring system certification required by subsection (g).

2) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices must be operated and maintained so that they perform to the design specifications throughout the life of the monitoring program.

f) The owner or operator of a new CCR surface impoundment must submit a construction permit application containing documentation showing that the groundwater monitoring system is designed to meet the requirements of this Section. The owner or operator of all CCR surface impoundments must submit an operating permit application containing documentation showing that the

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groundwater monitoring system has been constructed to meet the requirements of this Section.

g) The owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of this Section. If the groundwater monitoring system includes the minimum number of monitoring wells specified in subsection (c)(1), the certification must document the basis supporting this determination. The certification must be submitted to the Agency with the appropriate permit application.

Section 845.640 Groundwater Sampling and Analysis Requirements

a) The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells required by Section 845.630. The owner or operator of the CCR surface impoundment must develop a sampling and analysis program that includes procedures and techniques for:

1) Sample collection;

2) Sample preservation and shipment;

3) Analytical procedures;

4) Chain of custody control; and

5) Quality assurance and quality control.

b) The groundwater monitoring program must include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure constituents and other monitoring parameters in groundwater samples. For purposes of this Subpart, the term "constituent" refers to both constituents and other monitoring parameters listed in Section 845.600.

c) The owner or operator must perform the following each time ground water is sampled:

1) Measure groundwater elevations in each well before purging;

2) Determine the rate and direction of groundwater flow; and

3) Measure groundwater elevations in wells that monitor the same CCR management area within a time period short enough to avoid temporal

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variations in groundwater flow that could preclude accurate determination of groundwater flow rate and direction.

d) The owner or operator of the CCR surface impoundment must establish background groundwater quality in a hydraulically upgradient or background well for each of the constituents listed in Section 845.600. Background groundwater quality may be established at wells that are not located hydraulically upgradient from the CCR surface impoundment if it meets the requirements of Section 845.630(a)(1).

e) The number of samples collected when conducting monitoring (for both downgradient and background wells) must be consistent with the statistical procedures chosen under subsection (f) and the performance standards under subsection (g). The sampling procedures must be those specified by Section 845.650(a) through (c).

f) Statistical Methods

1) The owner or operator of the CCR surface impoundment must select one of the statistical methods specified in subsection (f)(1) to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen must be conducted separately for each constituent in each monitoring well.

A) A parametric analysis of variance followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent.

B) An analysis of variance based on ranks followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent.

C) A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.

D) A control chart approach that gives control limits for each constituent.

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E) Another statistical test method that meets the performance standards of subsection (g).

2) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR surface impoundment. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data. The certification must be submitted to the Agency with the appropriate permit application.

3) The owner or operator of the CCR surface impoundment must submit the following to the Agency in an operating permit application:

A) Documentation of the statistical method chosen; and

B) The qualified professional engineer certification required by subsection (f)(2).

g) Any statistical method chosen under subsection (f) must comply with the following performance standards, as appropriate, based on the statistical test method used:

1) The statistical method used to evaluate groundwater monitoring data must be appropriate for the distribution of constituents. Normal distributions of data values must use parametric methods. Non-normal distributions must use non-parametric methods. If the distribution of the constituents is shown by the owner or operator of the CCR surface impoundment to be inappropriate for a normal theory test, then the data must be transformed or a distribution-free (non-parametric) theory test must be used. If the distributions for the constituents differ, more than one statistical method may be needed.

2) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test must be done at a Type I error level of at least 0.01 for each testing period. If a multiple comparison procedure is used, the Type I experiment wise error rate for each testing period must be at least 0.05; however, the Type I error of at least 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.

3) If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated constituent values must be such that this approach is at least as effective as any other

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approach in this Section for evaluating groundwater data. The constituent values must be determined after considering the number of samples in the background database, the data distribution, and the range of the concentration values for each constituent of concern.

4) If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, must be such that this approach is at least as effective as any other approach in this Section for evaluating groundwater data. These constituents must be determined after considering the number of samples in the background database, the data distribution, and the range of the concentration values for each constituent of concern.

5) The statistical method must account for data below the limit of detection with one or more statistical procedures at least as effective as any other approach in this Section for evaluating groundwater data. Any practical quantitation limit that is used in the statistical method must be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility. For the constituents identified in Section 845.600(a)(1), the practical quantitation limit must be less than the groundwater protection standards.

6) If necessary, the statistical method must include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

h) The owner or operator of the CCR surface impoundment must determine whether there is a statistically significant increase over background values for each constituent in Section 845.600.

1) In determining whether a statistically significant increase has occurred, the owner or operator must compare the groundwater quality of each constituent at each monitoring well designated under Section 845.630(a)(2) or (d)(1) to the background value of that constituent, according to the statistical procedures and performance standards specified by subsections (f) and (g).

2) Within 60 days after completing sampling and analysis, the owner or operator must determine whether there has been a statistically significant increase over background for any constituent at each monitoring well.

i) The owner or operator must measure total recoverable metals concentrations in measuring groundwater quality. Measurement of total recoverable metals

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captures both the particulate fraction and dissolved fraction of metals in natural waters. Groundwater samples must not be field filtered before analysis.

j) All groundwater samples taken under this Subpart must be analyzed by a certified laboratory using Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, incorporated by reference in Section 845.150.

Section 845.650 Groundwater Monitoring Program

a) The owner or operator of a CCR surface impoundment must conduct groundwater monitoring consistent with this Section. At a minimum, groundwater monitoring must include groundwater monitoring for all constituents with a groundwater protection standard in Section 845.600(a), calcium, and turbidity. The owner or operator of the CCR surface impoundment must submit a groundwater monitoring plan to the Agency with its operating permit application.

b) Monitoring Frequency

1) The monitoring frequency for all constituents with a groundwater protection standard in Section 845.600(a), calcium, and turbidity must be at least quarterly during the active life of the CCR surface impoundment and the post-closure care period or period specified in Section 845.740(b) when closure is by removal except as allowed in subsection (b)(4).

A) For existing CCR surface impoundments, a minimum of eight independent samples from each background and downgradient well must be collected and analyzed for all constituents with a groundwater protection standard listed in Section 845.600(a), calcium, and turbidity within 180 days after April 21, 2021.

B) For new CCR surface impoundments, and all lateral expansions of CCR surface impoundments, a minimum of eight independent samples for each background well and downgradient well must be collected and analyzed for all constituents with a groundwater protection standard listed in Section 845.600(a), calcium, and turbidity during the first 180 days of sampling.

2) The groundwater elevation monitoring frequency must be monthly.

3) Measurement of water elevation within the CCR surface impoundment must be conducted each time the groundwater elevations are measured (see subsection 845.650(b)(2)) before dewatering for closure.

4) After completion of five years of monitoring under this Part, the owner or operator of a CCR surface impoundment may ask the Agency for approval

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of a semiannual monitoring frequency by demonstrating all of the following:

A) The groundwater monitoring effectiveness will not be compromised by the reduced frequency of monitoring;

B) Sufficient data has been collected to characterize groundwater;

C) The groundwater monitoring schedule currently does not show any statistically significant increasing trends; and

D) The concentrations of constituents monitored under Section 845.650(a) at the down-gradient monitoring wells are below the applicable groundwater protection standards of Section 845.600.

5) If, after an Agency approval of a semiannual monitoring frequency under subsection (b)(4), a statistically significant increasing trend is detected or an exceedance above the GWPS is detected, the monitoring must revert to a quarterly frequency.

c) The number of samples collected and analyzed for each background well and downgradient well during subsequent quarterly sampling events must be consistent with Section 845.640 and must account for any unique characteristics of the site; but must include at least one sample from each background and downgradient well.

d) If one or more constituents are detected, and confirmed by an immediate resample, to be in exceedance of the groundwater protection standards in Section 845.600 in any sampling event, the owner or operator must notify the Agency which constituent exceeded the groundwater protection standard and place the notification in the facility's operating record as required by Section 845.800(d)(16). The owner or operator of the CCR surface impoundment also must:

1) Characterize the nature and extent of the release and any relevant site conditions that may affect the remedy ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up all releases from the CCR surface impoundment under Section 845.660. The owner or operator of the CCR surface impoundment must submit the characterization to the Agency and place the characterization in the facility's operating record as required by Section 845.800(d)(16). Characterization of the release includes the following minimum measures:

A) Install additional monitoring wells necessary to define the contaminant plumes;

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B) Collect data on the nature and estimated quantity of material released, including specific information on the constituents listed in Section 845.600 and the levels at which they are present in the material released;

C) Install at least one additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with subsections (a) and (b); and

D) Sample all wells in accordance with subsections (a) and (b) to characterize the nature and extent of the release.

2) Notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site as indicated by sampling of wells in accordance with subsection (d)(1). The owner or operator must send notifications made under this subsection (d)(2) to the Agency and place the notifications in the facility's operating record (see Section 845.800(d)(16)).

3) Except as provided in subsection (e), within 90 days after the detected exceedance of the groundwater protection standard, initiate an assessment of corrective measures (see Section 845.660).

e) Alternative Source Demonstration (ASD). The owner or operator of a CCR surface impoundment may, within 60 days after the detected exceedance of the groundwater protection standard, submit a demonstration to the Agency that a source other than the CCR surface impoundment caused the contamination and the CCR surface impoundment did not contribute to the contamination, or that the exceedance of the groundwater protection standard resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction. Either type of ASD must include a report that contains the factual or evidentiary basis for any conclusions and a certification of accuracy by a qualified professional engineer.

1) The owner or operator must place the ASD on the facility's publicly accessible Internet site (CCR website) under Section 845.810 within 24 hours after the submission to the Agency.

2) Within two business days after receiving the ASD, the Agency must email a notice to its listserv for the facility that the ASD is available to view on the facility's CCR website.

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3) Members of the public may submit to the Agency written comments on the ASD within 14 days after the Agency provides notice under subsection (e)(2).

4) The Agency must provide a written response to the owner and operator either concurring or not concurring with the ASD within 30 days after receiving the ASD. The Agency must also mail or email its response to each person who timely submitted a written public comment under subsection (e)(3) and supplied a mailing or email address.

5) If the Agency concurs with the ASD, the owner or operator must continue monitoring as required by this Section. The owner or operator must also include the ASD in the annual groundwater monitoring and corrective action report required by Section 845.610(e).

6) If the Agency does not concur with the ASD, the owner or operator must initiate the assessment of corrective measures under Section 845.660.

7) If the Agency does not concur with the ASD, the owner or operator may petition the Board for review of the Agency's non-concurrence under 35 Ill. Adm. Code 105. The filing of a petition for review under subsection (e)(7) does not automatically stay any requirements of this Part as to the owner or operator, including the 90-day deadline to initiate an assessment of corrective measures (see Section 845.660(a)(1)).

Section 845.660 Assessment of Corrective Measures

a) Unless the Agency has concurred with an alternative source demonstration made under Section 845.650(e), the owner or operator must initiate an assessment of corrective measures to prevent further releases, to remediate any releases, and to restore the affected area.

1) The assessment of corrective measures must be initiated within 90 days after finding that any constituent listed in Section 845.600 has been detected in exceedance of the groundwater protection standards in Section 845.600, at the downgradient waste boundary or immediately upon detection of a release of CCR from a CCR surface impoundment.

2) The assessment of corrective measures must be completed and submitted to the Agency within 90 days after initiation of assessment of corrective measures, unless the owner or operator demonstrates to the Agency the need for additional time to complete the assessment of corrective measures due to site-specific conditions or circumstances. The owner or operator must submit this demonstration, along with a certification from a qualified professional engineer attesting that the demonstration is accurate, to the Agency within 60 days after initiating an assessment of corrective

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measures. The Agency must either approve or disapprove the demonstration within 30 days. The 90-day deadline to complete the assessment of corrective measures may be extended for no longer than 60 days. The owner or operator must also include the Agency approved demonstration in the annual groundwater monitoring and corrective action report required by Section 845.610(e), in addition to the certification by a qualified professional engineer.

b) The owner or operator of the CCR surface impoundment must continue to monitor groundwater in accordance with the monitoring program as specified in Section 845.650.

c) The assessment under subsection (a) must include an analysis of the effectiveness of potential corrective measures in meeting all the requirements and objectives of the corrective action plan, as described by Section 845.670, addressing at least the following:

1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;

2) The time required to begin and complete the corrective action plan; and

3) The institutional requirements, such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the corrective action plan.

d) The owner or operator of the CCR surface impoundment must discuss the results of the corrective measures assessment, at least 30 days before the selection of remedy, in a public meeting with interested and affected parties (see Section 845.240).

e) When the owner or operator of a CCR surface impoundment is completing closure and corrective action simultaneously, the owner or operator may combine the corrective measures assessment required by this Section and the closure alternatives analysis required by Section 845.710 into one assessment of alternatives.

Section 845.670 Corrective Action Plan

a) The owner or operator must prepare a semi-annual report describing the progress in selecting a remedy and developing a corrective action plan. The semi-annual report must be submitted to the Agency and placed in the operating record as required by Section 845.800(d)(17).

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b) Within one year after completing the assessment of corrective measures as specified in Section 845.660, and after completion of the public meeting in Section 845.660(d), the owner or operator of the CCR surface impoundment must submit, in a construction permit application to the Agency, a corrective action plan that identifies the selected remedy. This requirement applies in addition to, not in place of, any applicable standards under any other State or federal law.

c) The corrective action plan must meet the following requirements:

1) Be based on the results of the corrective measures assessment conducted under Section 845.660;

2) Identify a selected remedy that at a minimum, meets the standards listed in subsection (d);

3) Contain the corrective action alternatives analysis specified in subsection (e); and

4) Contain proposed schedules for implementation, including an analysis of the factors in subsection (f);

d) The selected remedy in the corrective action plan must:

1) Be protective of human health and the environment;

2) Attain the groundwater protection standards specified in Section 845.600;

3) Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents listed in Section 845.600 into the environment;

4) Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and

5) Comply with standards for management of wastes as specified in Section 845.680(d).

e) Corrective Action Alternatives Analysis. In selecting a remedy that meets the standards of subsection (d), the owner or operator of the CCR surface impoundment must consider the following evaluation factors:

1) The long- and short-term effectiveness and protectiveness of each potential remedy, along with the degree of certainty that the remedy will prove successful based on consideration of the following:

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A) Magnitude of reduction of existing risks;

B) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;

C) The type and degree of long-term management required, including monitoring, operation, and maintenance;

D) Short-term risks that might be posed to the community or the environment during implementation of a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants;

E) Time until groundwater protection standards in Section 845.600 are achieved;

F) The potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, containment, or changes in groundwater flow;

G) The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and

H) Potential need for replacement of the remedy.

2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of each of the following potential factors:

A) The extent to which containment practices will reduce further releases; and

B) The extent to which treatment technologies may be used.

3) The ease or difficulty of implementing each potential remedy based on consideration of the following types of factors:

A) Degree of difficulty associated with constructing the technology;

B) Expected operational reliability of the technologies;

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C) Need to coordinate with and obtain necessary approvals and permits from other agencies;

D) Availability of necessary equipment and specialists; and

E) Available capacity and location of needed treatment, storage, and disposal services.

4) The degree to which community concerns are addressed by each potential remedy.

f) The owner or operator must specify, as part of the corrective action plan, a schedule for implementing, of and completing, remedial activities. The schedule must require the completion of remedial activities within a reasonable time, taking into consideration the factors in this subsection (f). The owner or operator of the CCR surface impoundment must consider the following factors in determining the schedule of remedial activities:

1) Extent and nature of contamination, as determined by the characterization required under Section 845.650(d);

2) Reasonable probabilities of remedial technologies achieving compliance with the groundwater protection standards established by Section 845.600 and other objectives of the remedy;

3) Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;

4) Potential risks to human health and the environment from exposure to contamination before completion of the remedy;

5) Resource value of the aquifer, including:

A) Current and future uses, including potential residential, agricultural, commercial industrial and ecological uses;

B) Proximity and withdrawal rate of users;

C) Groundwater quantity and quality;

D) The potential impact to the subsurface ecosystem, wildlife, other natural resources, crops, vegetation, and physical structures caused by exposure to CCR constituents;

E) The hydrogeologic characteristic of the facility and surrounding land; and

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F) The availability of alternative water supplies; and

6) Other relevant factors.

Section 845.680 Implementation of the Corrective Action Plan

a) Within 90 days after the Agency's approval of the corrective action plan submitted under Section 845.670, the owner or operator must initiate corrective action. Based on the schedule approved by the Agency for implementation and completion of corrective action, the owner or operator must:

1) Establish and implement a corrective action groundwater monitoring program that:

A) At a minimum, meets the requirements of the monitoring program under Section 845.650;

B) Documents the effectiveness of the corrective action remedy; and

C) Demonstrates compliance with the groundwater protection standard under subsection (c).

2) Implement the corrective action remedy approved by the Agency under Section 845.670; and

3) Take any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors. Interim measures must, to the greatest extent feasible, be consistent with the objectives of, and contribute to the performance of, any remedy that may be required by Section 845.670. The following factors must be considered by an owner or operator in determining whether interim measures are necessary:

A) Time required to develop and implement a final remedy;

B) Actual or potential exposure of nearby populations or environmental receptors to any of the constituents listed in Section 845.600;

C) Actual or potential contamination of sensitive ecosystems or current or potential drinking water supplies;

D) Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;

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E) Weather conditions that may cause any of the constituents listed in Section 845.600 to migrate or be released;

F) Potential for exposure to any of the constituents listed in Section 845.600 as a result of an accident or failure of a container or handling system; and

G) Other situations that may pose threats to human health and the environment.

b) If the Agency or an owner or operator of the CCR surface impoundment determines, at any time, that compliance with the requirements of Section 845.670(d) is not being achieved through the remedy selected, the owner or operator must implement other methods or techniques that could feasibly achieve compliance with the requirements. These methods or techniques must receive approval by the Agency before implementation.

c) Corrective action must be considered complete when:

1) The owner or operator of the CCR surface impoundment demonstrates compliance with the groundwater protection standards established by Section 845.600 has been achieved at all points within the plume of contamination that lies beyond the waste boundary;

2) Compliance with the groundwater protection standards has been achieved by demonstrating that concentrations of constituents listed in Section 845.600 have not exceeded the groundwater protection standards for a period of three consecutive years, using the statistical procedures and performance standards in Section 845.640(f) and (g); and

3) All actions required to complete the remedy have been satisfied.

d) All CCR managed under a remedy approved by the Agency under Section 845.670, or an interim measure required under subsection (a)(3), must be managed in a manner that complies with this Part.

e) Upon completion of the corrective action plan, the owner or operator must submit to the Agency a corrective action completion report and certification.

1) The corrective action completion report must contain supporting documentation, including:

A) Any engineering and hydrogeology reports, including, monitoring well completion reports and boring logs, all CQA reports, certifications, and designations of CQA officers-in-absentia required by Section 845.290;

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B) A written summary of the implementation of the corrective action plan as stated in the construction permit and this Part;

C) Groundwater monitoring data demonstrating compliance with subsection (c);

D) Any remedial actions completed under subsection(d);

E) Documentation showing compliance with the selected remedy requirements of Section 845.670(b); and

F) Any other information relied upon by the qualified professional engineer in making the closure certification.

2) The corrective action completion certification must include a statement from a qualified professional engineer attesting that the corrective action plan has been completed in compliance with the requirements of subsection (c).

3) The owner or operator must place the corrective action completion report and certification in the facility's operating record as required by Section 845.800(d)(18).

SUBPART G: CLOSURE AND POST-CLOSURE CARE

Section 845.700 Required Closure or Retrofit of CCR Surface Impoundments

a) Required Closure. The owner or operator of the following CCR surface impoundments must stop placing CCR or non-CCR waste streams in the CCR surface impoundment and must initiate closure of the CCR surface impoundment:

1) An existing CCR surface impoundment that has not demonstrated compliance with any of the following location restrictions:

A) Uppermost aquifer location (see Section 845.300);

B) Wetlands (see Section 845.310);

C) Fault areas (see Section 845.320);

D) Seismic impact zones (see Section 845.330); or

E) Unstable areas and floodplains (see Section 845.340).

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2) The owner or operator of any CCR surface impoundment that has failed to complete the initial or any subsequent annual safety factor assessment required by Section 845.460 or that has failed to document the calculated factors of safety for the CCR surface impoundment to achieve the minimum safety factors specified in Section 845.460(a).

b) Required Closure or Retrofit. The owner or operator of an existing unlined CCR surface impoundment, as determined under Section 845.400(f), must stop placing CCR and non-CCR waste streams into that CCR surface impoundment and either retrofit or close the CCR surface impoundment in accordance with the requirements of Subpart G. The owner or operator of a CCR surface impoundment electing to retrofit must submit, in accordance with the schedule in subsection (h), the written preliminary retrofit plan under subsection 845.770(a)(3) and a construction permit application to retrofit under Section 845.770;

c) Beginning on April 21, 2021, the owner or operator of the CCR surface impoundment required to close under subsection (a), or electing to close under subsection (b), must immediately take steps to categorize the CCR surface impoundment under subsection (g) and to comply with the closure alternatives analysis requirements in Section 845.710. Within 30 days after April 21, 2021, the owner or operator must send the category designation, including a justification for the category designation, for each CCR surface impoundment to the Agency for review. The owner or operator of the CCR surface impoundment must submit a construction permit application containing a final closure plan under the schedule in subsection (h).

d) Timeframes for Closure

1) Except as provided in subsection (d)(2), the owner or operator must stop placing CCR and non-CCR waste streams in the impoundment and initiate closure within six months after failing to complete any of the demonstrations listed in subsection (a).

2) For CCR surface impoundments required to close under subsection (a)(1) or electing to close under subsection (b):

A) If, on April 21, 2021, the owner or operator of a CCR surface impoundment has not satisfied an alternative closure requirement of 40 CFR 257.103 that allows for the continued receipt of CCR or non-CCR waste streams, the owner or operator must not place CCR or non-CCR waste streams into the CCR surface impoundment after April 21, 2021.

B) If, by November 30, 2020, the owner or operator of a CCR surface impoundment has submitted a complete demonstration to USEPA

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seeking an alternative deadline to stop receiving waste or complete closure under 40 CFR 257.103(f), the deadline to stop receiving waste will be tolled until USEPA issues a decision. If USEPA determines that a submission is incomplete, an owner or operator must immediately stop receiving waste and comply with all applicable deadlines of Section 845.700(d)(1).

C) If USEPA disapproves the requested alternative deadline to stop receiving waste and complete closure, the owner or operator of the CCR surface impoundment must immediately stop receiving waste and initiate closure within six months after the USEPA denial of the extension and will be subject to Section 845.760(a).

D) If, USEPA approves a demonstration that alternative disposal capacity is infeasible under 40 CFR 257.103(f)(1), the owner or operator must stop placing CCR or non-CCR waste streams into the CCR surface impoundment by the end of the initial time extension approved under 40 CFR 257.103 or once alternative capacity becomes available, whichever is sooner. In no case may the owner or operator of the CCR surface impoundment place CCR or non-CCR waste streams into an eligible CCR surface impoundment after October 15, 2024, or into any other CCR surface impoundment subject to closure under Section 845.700(a) or (b) after October 15, 2023.

E) If USEPA approves a demonstration for permanent cessation of coal-fired power boilers by a certain date under 40 CFR 257.103(f)(2), the owner or operator must:

i) For CCR surface impoundments that are 40 acres or smaller, stop operation of the coal-fired boiler and complete closure by October 17, 2023; or

ii) For CCR surface impoundments that are larger than 40 acres, stop operation of the coal-fired boiler and complete closure by October 17, 2028.

F) The USEPA's decision to approve or deny the demonstration requesting an alternative deadline to initiate closure must, within 30 days be submitted to the Agency and placed in the facility’s operating record as required by Section 845.800(d)(19).

G) Failure to remain in compliance with any of the requirements of this Part will result in the automatic loss of authorization under subsections (d)(2)(D) and (d)(2)(E).

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H) The owner or operator of the CCR surface impoundment with a USEPA-approved extension will not be given extensions of the timeframes for completion of closure under Section 845.760(c).

e) Semi-Annual Reports. The owner or operator of a CCR surface impoundment closing under the time frames in subsections (d)(2)(B) and (d)(2)(C) must prepare semi-annual reports consistent with the requirements in 40 CFR 257.103(f)(1)(x), incorporated by reference in Section 845.150, until the owner or operator has initiated closure.

f) An owner or operator of a CCR surface impoundment required to close under this Section must prepare the notification required under Section 845.730(d) that the CCR surface impoundment is closing under this Section.

g) Closure Prioritization

1) The owner or operator of a CCR surface impoundment required to close under this Section must assign the CCR surface impoundment to one of the following categories. Category 1 has the highest priority for closure. Category 7 has the lowest priority for closure.

A) Category 1 includes CCR surface impoundments that have impacted an existing potable water supply well or that have impacted groundwater quality within the setback of an existing potable water supply well.

B) Category 2 includes CCR surface impoundments that are an imminent threat to human health or the environment or have been designated by the Agency under subsection (g)(5).

C) Category 3 includes CCR surface impoundments located in areas of environmental justice concern, as determined by the Agency under subsection (g)(6).

D) Category 4 includes inactive CCR surface impoundments that have an exceedance of the groundwater protection standards in Section 845.600.

E) Category 5 includes existing CCR surface impoundments that have exceedances of the groundwater protection standards in Section 845.600.

F) Category 6 includes inactive CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600.

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G) Category 7 includes existing CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600.

2) If a CCR surface impoundment can be categorized in more than one category, the owner or operator of the CCR surface impoundment must assign the CCR surface impoundment the highest priority category.

3) Whenever an owner or operator of a CCR surface impoundment has more than one CCR surface impoundment that must close under this Section, the owner or operator must close the CCR surface impoundments in order of priority.

4) If the CCR surface impoundment meets the criteria for Category 1, the owner or operator must take immediate steps to mitigate the impact to any existing potable water supply. The owner or operator of the CCR surface impoundment, must act to replace the water supply with a supply of equal or better quality and quantity within 30 days after notice that the impact has occurred.

5) The Agency may designate a CCR surface impoundment as a Category 2 surface impoundment when:

A) The CCR surface impoundment has failed to document that the calculated factors of safety for the CCR surface impoundment achieve the minimum safety factors specified in Section 845.460(a);

B) The CCR surface impoundment has not demonstrated compliance with the location restrictions in Subpart C;

C) The owner or operator has been enjoined under Section 43 of the Act;

D) An exceedance of the groundwater protection standards in Section 845.600 has migrated off-site; or

E) The Agency finds that an emergency condition exists creating an immediate danger to public health or welfare, or the environment.

6) For purposes of, and only for, this Part, areas of environmental justice concern are identified as any area that meets either of the following:

A) Any area within one mile of a census block group where the number of low-income persons is twice the statewide average, where low income means the number or percent of a census block

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group's population in households where the household income is less than or equal to twice the federal poverty level; or

B) Any area within one mile of a census block group where the number of minority persons is twice the statewide average, where minority means the number or percent of individuals in a census block group who list their racial status as a race other than white alone or list their ethnicity as Hispanic or Latino.

7) For purposes of subsection (g)(6), if any part of a facility falls within one mile of the census block group, the entire facility, including all its CCR surface impoundments, must be considered an area of environmental justice concern.

8) The Agency may designate a CCR surface impoundment as another Category when site-specific conditions contradict the designations provided by the owner or operator in subsection (c) and the categories in subsection (g)(1).

h) Application Schedule

1) Category 1, Category 2, Category 3, and Category 4 CCR surface impoundment owners or operators must submit either a construction permit application containing a final closure plan or a construction permit application to retrofit the CCR surface impoundment in accordance with the requirements of this Part by February 1, 2022.

2) Category 5 CCR surface impoundment owners or operators must submit either a construction permit application containing a final closure plan or a construction permit application to retrofit the CCR surface impoundment in accordance with the requirements of this Part by August 1, 2022.

3) Category 6 and Category 7 CCR surface impoundment owners or operators must submit either a construction permit application containing a final closure plan or a construction permit application to retrofit the CCR surface impoundment in accordance with the requirements of this Part by August 1, 2023.

4) Owners or operators consolidating one or more CCR surface impoundments for closure must meet the application schedule of the highest priority CCR surface impoundment.

5) If the Agency denies a construction permit application submitted under this Section, the owner and operator must submit a revised construction permit application addressing all deficiencies identified by the Agency. The revised construction permit application for closure must be submitted

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to the Agency within 90 days after the Agency's denial if the Agency's denial is not appealed under Section 845.270. If the Agency's denial is appealed and upheld, the owner or operator must submit a revised construction permit application for closure within 90 days after a final decision by the Board is rendered. The owner or operator of the CCR surface impoundment must discuss the owner's or operator's proposed response to all deficiencies identified by the Agency in a public meeting with interested and affected parties held under Section 845.240.

Section 845.710 Closure Alternatives

a) Closure of a CCR surface impoundment, or any lateral expansion of a CCR surface impoundment, must be completed either by leaving the CCR in place and installing a final cover system or through removal of the CCR and decontamination of the CCR surface impoundment, as described in Sections 845.720 through 845.760.

b) Before selecting a closure method, the owner or operator of each CCR surface impoundment must complete a closure alternatives analysis. The closure alternatives analysis must examine the following for each closure alternative:

1) The long- and short-term effectiveness and protectiveness of the closure method, including identification and analyses of the following factors:

A) The magnitude of reduction of existing risks;

B) The magnitude of residual risks in terms of likelihood of future releases of CCR;

C) The type and degree of long-term management required, including monitoring, operation, and maintenance;

D) The short-term risks that might be posed to the community or the environment during implementation of a closure, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants;

E) The time until closure and post-closure care or the completion of groundwater monitoring under Section 845.740(b) is completed;

F) The potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, containment or changes in groundwater flow;

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G) The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and

H) Potential need for future corrective action of the closure alternative.

2) The effectiveness of the closure method in controlling future releases based on analyses of the following factors:

A) The extent to which containment practices will reduce further releases; and

B) The extent to which treatment technologies may be used.

3) The ease or difficulty of implementing a potential closure method based on analyses of the following types of factors:

A) Degree of difficulty associated with constructing the technology;

B) Expected operational reliability of the technologies;

C) Need to coordinate with and obtain necessary approvals and permits from other agencies;

D) Availability of necessary equipment and specialists; and

E) Available capacity and location of needed treatment, storage, and disposal services.

4) The degree to which the concerns of the residents living within communities where the CCR will be handled, transported and disposed of are addressed by the closure method.

c) In the closure alternatives analysis, the owner or operator of the CCR surface impoundment must:

1) Analyze complete removal of the CCR as one closure alternative, along with the modes for transporting the removed CCR, including by rail, barge, low-polluting trucks, or a combination of these transportation modes;

2) Identify whether the facility has an onsite landfill with remaining capacity that can legally accept CCR, and, if not, whether constructing an onsite landfill is possible; and

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3) Include any other closure method in the alternatives analysis if requested by the Agency.

d) The analysis for each alternative completed under this Section must:

1) Meet or exceed a class 4 estimate under the AACE Classification Standard, incorporated by reference in Section 845.150, or a comparable classification practice as provided in the AACE Classification Standard;

2) Contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards;

3) Include a description of the fate and transport of contaminants with the closure alternative over time, including consideration of seasonal variations; and

4) Assess impacts to waters in the State.

e) At least 30 days before submission of a construction permit application for closure, the owner or operator of the CCR surface impoundment must discuss the results of the closure alternatives analysis in a public meeting with interested and affected parties (see Section 845.240).

f) After completion of the public meeting under subsection (e), the owner or operator of a CCR surface impoundment must select a closure method and submit a final closure plan to the Agency under Section 845.720(b). All materials demonstrating completion of the closure alternatives analysis specified in this Section must be submitted with the final closure plan.

g) The selected closure method must meet the requirements and standards of this Part, ensure the protection of human health and the environment, and achieve compliance with the groundwater protection standards in Section 845.600.

Section 845.720 Closure Plan

a) Preliminary Written Closure Plan

1) Content of the Preliminary Closure Plan. The owner or operator of a new CCR surface impoundment or an existing CCR surface impoundment not required to close under Section 845.700 must prepare a preliminary written closure plan that describes the steps necessary to close the CCR surface impoundment at any point during the active life of the CCR surface impoundment consistent with recognized and generally accepted engineering practices. The preliminary written closure plan must include, at a minimum, the following:

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A) A narrative description of how the CCR surface impoundment will be closed in accordance with this Part.

B) If closure of the CCR surface impoundment will be accomplished through removal of CCR from the CCR surface impoundment, a description of the procedures to remove the CCR and decontaminate the CCR surface impoundment in accordance with Section 845.740.

C) If closure of the CCR surface impoundment will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with Section 845.750, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in Section 845.750.

D) An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR surface impoundment.

E) An estimate of the largest area of the CCR surface impoundment ever requiring a final cover (see Section 845.750), at any time during the CCR surface impoundment's active life.

F) A schedule for completing all activities necessary to satisfy the closure criteria in this Section, including an estimate of the year in which all closure activities for the CCR surface impoundment will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR surface impoundment, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR surface impoundment closure. When preparing the preliminary written closure plan, if the owner or operator of a CCR surface impoundment estimates that the time required to complete closure will exceed the timeframes specified in Section 845.760(a), the preliminary written closure plan must include the site-specific information, factors and considerations that would support any time extension sought under Section 845.760(b).

2) The owner or operator of the CCR surface impoundment must submit the preliminary written closure plan to the Agency with its initial operating permit application. The owner or operator of the CCR surface

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impoundment must submit the most recently amended preliminary closure plan to the Agency with each operating permit renewal application. The owner or operator must place preliminary and amended preliminary written closure plans in the facility's operating record as required by Section 845.800(d)(20).

3) Amendment of a Preliminary Written Closure Plan.

A) The owner or operator may amend the preliminary written closure plan at any time.

B) The owner or operator must amend the preliminary written closure plan whenever:

i) There is a change in the operation of the CCR surface impoundment that would substantially affect the written closure plan in effect; or

ii) Before closure activities have started, unanticipated events necessitate a revision of the written closure plan.

C) The owner or operator must amend the closure plan at least 60 days before a planned change in the operation of the facility or CCR surface impoundment, or within 60 days after an unanticipated event requires the need to revise an existing written closure plan.

4) The owner or operator of the CCR surface impoundment must obtain and submit with its initial and renewal operating permit applications a written certification from a qualified professional engineer that the initial and any amendment of the preliminary written closure plan meets the requirements of this Part.

b) Final Closure Plan

1) The owner or operator of a CCR surface impoundment must submit to the Agency, as a part of a construction permit application for closure, a final closure plan. The plan must be submitted before the installation of a final cover system or removal of CCR from the surface impoundment for the purpose of closure.

2) Except as otherwise provided in Section 22.59 of the Act, the owner or operator of a CCR surface impoundment must not close a CCR surface impoundment without a construction permit issued under this Part.

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3) The final closure plan must identify the proposed selected closure method, and must include the information required in subsection (a)(1) and the closure alternatives analysis specified in Section 845.710.

4) If a final written closure plan revision is necessary after closure activities have started for a CCR surface impoundment, the owner or operator must submit a request to modify the construction permit within 60 days following the triggering event.

5) The owner or operator of the CCR surface impoundment must obtain and submit with its construction permit application for closure a written certification from a qualified professional engineer that the final written closure plan meets the requirements of this Part.

Section 845.730 Initiation of Closure

Initiation of closure activities. Except as provided for in this Section, the owner or operator of a CCR surface impoundment must initiate closure of the CCR surface impoundment within the applicable timeframes specified in either subsection (a) or (b). For purposes of this Section, closure of the CCR surface impoundment has been initiated if the owner or operator has stopped placing waste in the CCR surface impoundment and has submitted to the Agency a construction permit application under Section 845.220(d).

a) Known Final Receipt. The owner or operator must initiate closure of the CCR surface impoundment within 30 days after the date on which the CCR surface impoundment either:

1) Receives the known final placement of waste, either CCR or any non-CCR waste stream; or

2) Removes the known final volume of CCR from the CCR surface impoundment for the purpose of beneficial use of CCR.

b) Temporarily Idled CCR Surface Impoundments.

1) Except as provided by subsection (b)(2), the owner or operator must initiate closure of a CCR surface impoundment that has not received CCR or any non-CCR waste stream, or is no longer removing CCR for the purpose of beneficial use, within two years after the last receipt of waste or within two years after the last removal of CCR material for the purpose of beneficial use.

2) Notwithstanding subsection (b)(1), the owner or operator of the CCR surface impoundment may secure an additional two years to initiate closure of the idle surface impoundment if the Agency approves the owner's or operator's written demonstration that the CCR surface

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impoundment will continue to accept wastes or will start removing CCR for the purpose of beneficial use. The documentation must be supported by, at a minimum, the information specified in this subsection (b)(2). The owner or operator may obtain two-year extensions, provided the owner or operator continues to be able to demonstrate that there is reasonable likelihood that the CCR surface impoundment will accept wastes in the foreseeable future or will remove CCR from the surface impoundment for the purpose of beneficial use. The owner or operator must place each Agency approved demonstration, if more than one time extension is sought, in the facility's operating record as required by Section 845.800(d)(21) before the end of any two-year period.

A) Information documenting that the CCR surface impoundment has remaining storage or disposal capacity or that the CCR surface impoundment can have CCR removed for the purpose of beneficial use; and

B) Information demonstrating that that there is a reasonable likelihood that the CCR surface impoundment will resume receiving CCR or non-CCR waste streams in the foreseeable future or that CCR can be removed for the purpose of beneficial use. The narrative must include a best estimate as to when the CCR surface impoundment will resume receiving CCR or non-CCR waste streams. The situations listed in this subsection (b)(2)(B) are examples of situations that would support a determination that the CCR surface impoundment will resume receiving CCR or non-CCR waste streams in the foreseeable future.

i) Normal plant operations include periods during which the CCR surface impoundment does not receive CCR or non-CCR waste streams, such as the alternating use of two or more CCR surface impoundments whereby, at any point in time, one CCR surface impoundment is receiving CCR while CCR is being removed from a second CCR surface impoundment after its dewatering.

ii) The CCR surface impoundment is dedicated to a coal-fired boiler surface impoundment that is temporarily idled (e.g., CCR is not being generated) and there is a reasonable likelihood that the coal-fired boiler will resume operations in the future.

iii) The CCR surface impoundment is dedicated to an operating coal-fired boiler (i.e., CCR is being generated); however, no CCR is being placed in the CCR surface impoundment because the CCR is being entirely diverted to beneficial

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uses, but there is a reasonable likelihood that the CCR surface impoundment will again be used in the foreseeable future.

iv) The CCR surface impoundment currently receives only non-CCR waste streams and those non-CCR waste streams are not generated for an extended period of time, but there is a reasonable likelihood that the CCR surface impoundment will again receive non-CCR waste streams in the future.

3) In order to obtain additional time extensions to initiate closure of a CCR surface impoundment beyond the two years provided by subsection (b)(1), the owner or operator of the CCR surface impoundment must submit the demonstration required by subsection (b)(2) to the Agency for review and approval. The written documentation must include the following statement signed by the owner or operator or an authorized representative:

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

c) The timeframes specified in subsections (a) and (b) do not apply to an owner or operator of a CCR surface impoundment closing the CCR surface impoundment as required by Section 845.700:

d) By the date the owner or operator initiates closure of a CCR surface impoundment, the owner or operator must prepare a notification of intent to close a CCR surface impoundment. The notification must be placed in the facility's operating record as required by Section 845.800(d)(21).

Section 845.740 Closure by Removal

a) Closure by Removal of CCR. An owner or operator may elect to close a CCR surface impoundment by removing all CCR and decontaminating all areas affected by releases of CCR from the CCR surface impoundment. CCR removal and decontamination of the CCR surface impoundment are complete when all CCR and CCR residues, containment system components such as the impoundment liner and contaminated subsoils, and CCR impoundment structures and ancillary equipment have been removed. Closure by removal must be

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completed before the completion of a groundwater corrective action under Subpart F.

b) After closure by removal has been completed, the owner or operator must continue groundwater monitoring under Subpart F for three years after the completion of closure or for three years after groundwater monitoring does not show an exceedance of the groundwater protection standard established under Section 845.600, whichever is longer.

c) The owner or operator of a CCR surface impoundment removing CCR during closure must responsibly handle and transport the CCR consistent with this subsection.

1) Transportation

A) Manifests

i) When transporting CCR off-site by motor vehicle, manifests must be carried as specified in 35 Ill. Adm. Code 809. For purposes of this Part, coal combustion fly ash that is removed from a CCR surface impoundment is not exempt from the manifest requirement.

ii) When transporting CCR off-site by any other mode or method, including trains or barges, manifests must be carried specifying, at a minimum, the following information: the volume of the CCR; the location from which the CCR was loaded onto the mode of transportation and the date the loading took place; and the location where the CCR is being taken and the date it will be delivered.

B) The owner or operator of a CCR surface impoundment from which CCR is removed and transported off-site must develop a CCR transportation plan, which must include:

i) Identification of the transportation method selected, including whether a combination of transportation methods will be used;

ii) The frequency, time of day, and routes of CCR transportation;

iii) Any measures to minimize noise, traffic, and safety concerns caused by the transportation of the CCR;

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iv) Measures to limit fugitive dust from any transportation of CCR;

v) Installation and use of a vehicle washing station;

vi) A means of covering the CCR for any mode of CCR transportation, including conveyor belts; and

vii) A requirement that, for transport by motor vehicle, the CCR is transported by a permitted special waste hauler under 35 Ill. Adm. Code 809.201.

2) The owner or operator of a CCR surface impoundment must develop and implement onsite dust controls, which must include:

A) A water spray or other commercial dust suppressant to suppress dust in CCR handling areas and haul roads; and

B) Handling of CCR to minimize airborne particulates and offsite particulate movement during any weather event or condition.

3) The owner or operator of a CCR surface impoundment must provide the following public notices:

A) Signage must be posted at the property entrance warning of the hazards of CCR dust inhalation; and

B) When CCR is transported off-site, a written notice explaining the hazards of CCR dust inhalation, the transportation plan, and tentative transportation schedule must be provided to units of local government through which the CCR will be transported.

4) The owner or operator of the surface impoundment must take measures to prevent contamination of surface water, groundwater, soil and sediments from the removal of CCR, including the following:

A) CCR removed from the surface impoundment may only be temporarily stored, and must be stored in a lined landfill, CCR surface impoundment, enclosed structure, or CCR storage pile.

B) CCR storage piles must:

i) Be tarped or constructed with wind barriers to suppress dust and to limit stormwater contact with storage piles;

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ii) Be periodically wetted or have periodic application of dust suppressants;

iii) Have a storage pad, or a geomembrane liner, with a hydraulic conductivity no greater than 1 x 10^{-7} cm/sec, that is properly sloped to allow appropriate drainage;

iv) Be tarped over the edge of the storage pad where possible;

v) Be constructed with fixed and mobile berms, where appropriate, to reduce run-on and run-off of stormwater to and from the storage pile, and minimize stormwater-CCR contact; and

vi) Have a groundwater monitoring system that is consistent with the requirements of Section 845.630 and approved by the Agency.

C) The owner or operator of the CCR surface impoundment must incorporate general housekeeping procedures such as daily cleanup of CCR, tarping of trucks, maintaining the pad and equipment, and good practices during unloading and loading.

D) The owner or operator of the CCR must minimize the amount of time the CCR is exposed to precipitation and wind.

E) The discharge of stormwater runoff that has contact with CCR must be covered by an individual National Pollutant Discharge Elimination System (NPDES) permit. The owner or operator must develop and implement a Stormwater Pollution Prevention Plan (SWPPP) in addition to any other requirements of the facility's NPDES permit. Any construction permit application for closure must include a copy of the SWPPP.

d) At the end of each month during which CCR is being removed from a CCR surface impoundment, the owner or operator must prepare a report that:

1) Describes the weather, precipitation amounts, the amount of CCR removed from the CCR surface impoundment, the amount and location of CCR being stored on-site, the amount of CCR transported offsite, the implementation of good housekeeping procedures required by subsection (c)(4)(C), and the implementation of dust control measures; and

2) Documents worker safety measures implemented. The owner or operator of the CCR surface impoundment must place the monthly report in the facility's operating record as required by Section 845.800(d)(23).

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e) Upon completion of CCR removal and decontamination of the CCR surface impoundment under subsection (a), the owner or operator of the CCR surface impoundment must submit to the Agency a completion of CCR removal and decontamination report and a certification from a qualified professional engineer that CCR removal and decontamination of the CCR surface impoundment has been completed in accordance with this Section. The owner or operator must place the CCR removal and decontamination report and certification in the facility's operating record as required by Section 845.800(d)(32).

f) Upon completion of groundwater monitoring required under subsection (b), the owner or operator of the CCR surface impoundment must submit to the Agency a completion of groundwater monitoring report and a certification from a qualified professional engineer that groundwater monitoring has been completed in accordance with this Section. The owner or operator must place the groundwater monitoring report and certification in the facility's operating record as required by Section 845.800(d)(24).

Section 845.750 Closure with a Final Cover System

Closure Performance Standard When Leaving CCR in Place:

a) The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will:

1) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

2) Preclude the probability of future impoundment of water, sediment, or slurry;

3) Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;

4) Minimize the need for further maintenance of the CCR surface impoundment; and

5) Be completed in the shortest amount of time consistent with recognized and generally accepted engineering practices.

b) Drainage and Stabilization of CCR Surface Impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR

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surface impoundment must meet the requirements of this subsection (b) before installing the final cover system required by subsection (c).

1) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.

2) Remaining wastes must be stabilized sufficiently to support the final cover system.

c) Final Cover System. If a CCR surface impoundment is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and, at a minimum, meets the requirements of this subsection (c). The final cover system must consist of a low permeability layer and a final protective layer. The design of the final cover system must be included in the preliminary and final written closure plans required by Section 845.720 and the construction permit application for closure submitted to the Agency.

1) Standards for the Low Permeability Layer. The low permeability layer must have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a hydraulic conductivity no greater than 1×10^{-7} cm/sec, whichever is less. The low permeability layer must be constructed in accordance with the standards in either subsection (c)(1)(A) or (c)(1)(B), unless the owner or operator demonstrates that another low permeability layer construction technique or material provides equivalent or superior performance to the requirements of either subsection (c)(1)(A) or (c)(1)(B) and is approved by the Agency.

A) A compacted earth layer constructed in accordance with the following standards:

i) The minimum allowable thickness must be 0.91 meter (three feet); and

ii) The layer must be compacted to achieve a hydraulic conductivity of 1×10^{-7} cm/sec or less and minimize void spaces.

B) A geomembrane constructed in accordance with the following standards:

i) The geosynthetic membrane must have a minimum thickness of 40 mil (0.04 inches) and, in terms of hydraulic flux, must be equivalent or superior to a three-foot layer of soil with a hydraulic conductivity of 1×10^{-7} cm/sec;

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ii) The geomembrane must have strength to withstand the normal stresses imposed by the waste stabilization process; and

iii) The geomembrane must be placed over a prepared base free from sharp objects and other materials that may cause damage.

2) Standards for the Final Protective Layer. The final protective layer must meet the following requirements, unless the owner or operator demonstrates that another final protective layer construction technique or material provides equivalent or superior performance to the requirements of this subsection (c)(2) and is approved by the Agency.

A) Cover the entire low permeability layer;

B) Be at least three feet thick, be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer;

C) Consist of soil material capable of supporting vegetation;

D) Be placed as soon as possible after placement of the low permeability layer; and

E) Be covered with vegetation to minimize wind and water erosion.

3) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

4) The owner or operator of the CCR surface impoundment must obtain and submit with its construction permit application for closure a written certification from a qualified professional engineer that the design of the final cover system meets the requirements of this Section.

d) This subsection specifies the allowable uses of CCR in the closure of CCR surface impoundments closing under Section 845.700. Notwithstanding the prohibition on further placement in Section 845.700, CCR may be placed in these surface impoundments, but only for purposes of grading and contouring in the design and construction of the final cover system, if:

1) The CCR placed was generated at the facility and is located at the facility at the time closure was initiated;

2) CCR is placed entirely above the elevation of CCR in the surface impoundment, following dewatering and stabilization (see subsection (b));

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3) The CCR is placed entirely within the perimeter berms of the CCR surface impoundment; and

4) The final cover system is constructed with either:

A) A slope not steeper than 5% grade after allowance for settlement; or

B) At a steeper grade, if the Agency determines that the steeper slope is necessary, based on conditions at the site, to facilitate run-off and minimize erosion, and that side slopes are evaluated for erosion potential based on a stability analysis to evaluate possible erosion potential. The stability analysis, at a minimum, must evaluate the site geology; characterize soil shear strength; construct a slope stability model; establish groundwater and seepage conditions, if any; select loading conditions; locate critical failure surface; and iterate until minimum factor of safety is achieved.

Section 845.760 Completion of Closure Activities

a) Except as provided for in subsection (b), the owner or operator must complete closure of existing and new CCR surface impoundments, and any lateral expansion of a CCR surface impoundment, within the timeframe approved by the Agency in the final closure plan, or within five years of obtaining a construction permit for closure, whichever is less.

b) Extensions of Closure Timeframes

1) The timeframes for completing closure of a CCR surface impoundment specified under subsection (a) may be extended if the owner or operator has demonstrated to the Agency that it was not feasible to complete closure of the CCR surface impoundment within the required timeframes due to factors beyond the facility's control.

2) The demonstration must include a narrative explaining the basis for additional time.

3) The owner or operator must submit the demonstration to the Agency with a renewal construction permit application for closure.

4) Factors that may support a demonstration include:

A) Complications stemming from the climate and weather, such as unusual amounts of precipitation or a significantly shortened construction season;

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B) Time required to dewater a surface impoundment due to the volume of CCR contained in the CCR surface impoundment or the characteristics of the CCR in the surface impoundment;

C) Statement that the geology and terrain surrounding the CCR surface impoundment will affect the amount of material needed to close the CCR surface impoundment; or

D) Time required or delays caused by the need to coordinate with and obtain necessary approvals and permits from the Agency or other agencies.

c) Maximum Time Extensions

1) CCR surface impoundments of 40 acres or smaller that are not closing by removal may extend the time to complete closure by no longer than two years.

2) CCR surface impoundments larger than 40 acres that are not closing by removal may extend the timeframe to complete closure of the CCR surface impoundment multiple times, in two-year increments. For each two-year extension sought, the owner or operator must substantiate the factual circumstances demonstrating the need for the extension. No more than a total of five two-year extensions may be obtained for any CCR surface impoundment.

3) CCR surface impoundments that are closing by removal may extend the time to complete closure multiple times, in two-year increments. For each two-year extension sought, the owner or operator must substantiate the factual circumstances demonstrating the need for the extension. In no instance may the time allowed for closure by removal be extended beyond the completion of a groundwater corrective action as required by Section 845.680(c)(1).

d) In order to obtain an additional time extension to complete closure of a CCR surface impoundment beyond the times provided by subsection (a), the owner or operator of the CCR surface impoundment must include with the demonstration required by subsection (b) the following statement signed by the owner or operator or an authorized representative:

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that

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there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

e) Upon completion of all closure activities required by this Part and approved in the final closure plan, the owner or operator of the CCR surface impoundment must submit to the Agency a closure report and a closure certification.

1) The closure report must contain supporting documentation, including:

A) Engineering and hydrogeology reports, including monitoring well completion reports and boring logs, all CQA reports, certifications, and designations of CQA officers-in-absentia required by Section 845.290;

B) Photographs, including time, date and location information of the photographs, of the final cover system and groundwater collection system, if applicable, and any other photographs relied upon to document construction activities;

C) A written summary of closure requirements and completed activities as stated in the closure plan and this Part; and

D) Any other information relied upon by the qualified professional engineer in making the closure certification.

2) The closure certification must include a statement from a qualified professional engineer that closure has been completed in accordance with the Agency-approved final closure plan and the requirements of this Section.

3) The owner or operator must place the closure report and certification in the facility's operating record as required by Section 845.800(d)(24).

f) Within 30 days after the Agency's approval of the closure report and closure certification submitted under subsection (e), the owner or operator must prepare a notification of closure of the CCR surface impoundment. The notification must include the certification by a qualified professional engineer required by subsection (e)(2). The owner or operator must place the notification in the facility's operating record as required by Section 845.800(d)(25).

g) If an owner or operator of a CCR surface impoundment has completed closure of the CCR surface impoundment before April 21, 2021, the owner or operator must notify the Agency of the completed closure by September 30, 2021, if that notification has not previously been submitted.

h) Deed Notations

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1) Following closure of a CCR surface impoundment, the owner or operator must record a notation on the deed to the property, or some other instrument that is normally examined during title search.

2) The notation on the deed must in perpetuity notify any potential purchaser of the property that:

   A) The land has been used as a CCR surface impoundment; and

   B) Its use is restricted under the post-closure care requirements as provided by Section 845.780(d)(1)(C) or groundwater monitoring requirements in Section 845.740(b).

3) Within 30 days after recording a notation on the deed to the property, the owner or operator must submit to the Agency a notification stating that the notation has been recorded. The owner or operator must place the notification in the facility's operating record as required by 845.800(d)(26).

Section 845.770 Retrofitting

Retrofit of a CCR surface impoundment must be completed in accordance with the requirements of this Section.

a) To retrofit an existing CCR surface impoundment, the owner or operator must:

   1) First remove all CCR, including any liners except as specified in subsection (a)(4), as necessary, and contaminated soils and sediments from the CCR surface impoundment;

   2) Comply with the requirements in Sections 845.410 and 845.420; and

   3) Within 30 days after April 21, 2021, the owner or operator electing to retrofit a CCR surface impoundment under this Section must submit a written preliminary retrofit plan to the Agency and post the written preliminary retrofit plan in the facility's operating record as required by Section 845.800(d)(27). The written preliminary retrofit plan must include a prioritization categorization under Section 845.700(g) and the expected construction permit application date under Section 845.700(h); and

   4) An owner or operator may request the Agency to approve the use of an existing competent geomembrane liner as a supplemental liner by submitting visual inspection, and analytical testing results to demonstrate that the existing liner is not contaminated with CCR constituents.

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b) A CCR surface impoundment undergoing a retrofit remains subject to all other requirements of this Part, including the requirement to conduct any necessary corrective action.

c) Written Retrofit Plan

1) Content of the Plan. The owner or operator must prepare a written retrofit plan that describes the steps necessary to retrofit the CCR surface impoundment consistent with recognized and generally accepted engineering practices. The written retrofit plan must include, at a minimum, all the following information:

A) A narrative description of the specific measures that will be taken to retrofit the CCR surface impoundment in accordance with this Section.

B) A description of the procedures to remove all CCR, liners as necessary, and contaminated soils and sediments from the CCR surface impoundment.

C) An estimate of the maximum amount of CCR and other contaminated materials that will be removed as part of the retrofit operation.

D) An estimate of the largest area of the CCR surface impoundment that will be affected by the retrofit operation.

E) A schedule for completing all activities necessary to satisfy the retrofit criteria in this Section, including an estimate of the year in which retrofit activities of the CCR surface impoundment will be completed.

2) The owner or operator must submit the written retrofit plan with the construction permit application and must obtain a construction permit before retrofitting a CCR surface impoundment.

3) Amendment of a Written Retrofit Plan.

A) The owner or operator may submit a permit modification application to amend the initial or any subsequent written retrofit plan at any time.

B) The owner or operator must seek to amend the written retrofit plan whenever:

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i) There is a change in the operation of the CCR surface impoundment that would substantially affect the written retrofit plan in effect; or

ii) unanticipated events necessitate a revision of the written retrofit plan either before or after retrofit activities have started.

C) The owner or operator must seek to amend the retrofit plan at least 60 days before a planned change in the operation of the facility or CCR surface impoundment, or within 60 days after an unanticipated event requires the revision of an existing written retrofit plan. If a written retrofit plan needs to be revised after retrofit activities have started for a CCR surface impoundment, the owner or operator must submit a request to modify the construction permit within 60 days following the triggering event.

4) The owner or operator of the CCR surface impoundment must obtain a written certification from a qualified professional engineer that the activities outlined in the written retrofit plan, including any amendment of the plan, meet the requirements of this Section.

d) By the date the owner or operator submits a construction permit application to the Agency to retrofit a CCR surface impoundment, the owner or operator must prepare a notification of intent to retrofit a CCR surface impoundment. The owner or operator has completed the notification when it has been placed in the facility's operating record as required by Section 845.800(d)(28).

e) When activities related to retrofitting the CCR surface impoundment include the removal of CCR from the surface impoundment, the handling and removal of CCR must be performed in a manner consistent with the requirements of Section 845.740.

f) Deadline for Completion of Activities Related to the Retrofit of a CCR Surface Impoundment. Any CCR surface impoundment that is being retrofitted must complete all retrofit activities within the timeframe approved by the Agency in the retrofit plan, or within five years after obtaining a construction permit, whichever is less. The same procedures specified for the extension closure timeframes in Section 845.760(b) apply to extension of retrofit timeframes.

g) Upon completion of all retrofit activities required by this Part and approved by the Agency in a construction permit, the owner or operator of the CCR surface impoundment must submit to the Agency a retrofit completion report and certification.

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1) The retrofit completion report must contain supporting documentation, including:

A) Engineering and hydrogeology reports, including monitoring well completion reports and boring logs, all CQA reports, certifications, and designations of CQA officers-in-absentia required by Section 845.290;

B) Photographs, including time, date and location information of the photographs, of the liner system and leachate collection system, and any other photographs relied upon to document construction activities;

C) A written summary of retrofit requirements and completed activities as stated in the construction permit and this Part; and

D) Any other information relied upon by the qualified professional engineer in making the closure certification.

2) The retrofit certification must include a statement from a qualified professional engineer that retrofit has been completed in accordance with the retrofit plan specified in subsection (c) and the requirements of this Part.

3) The owner or operator must place the retrofit completion report and certification in the facility's operating record as required by Section 845.800(d)(29).

h) Within 30 days after the Agency's approval of the retrofit completion report and certification submitted under subsection (g), the owner or operator must prepare a notification of completion of retrofit activities. The notification must include the certification by a qualified professional engineer as required by subsection (g)(2). The owner or operator has completed the notification when it has been placed in the facility's operating record as required by Section 845.800(d)(30).

i) At any time after the initiation of a CCR surface impoundment retrofit, the owner or operator may stop the retrofit and seek to initiate closure of the CCR surface impoundment in accordance with the requirements of this Subpart G. The owner or operator of the CCR surface impoundment must obtain an approved construction permit for closure.

Section 845.780 Post-Closure Care Requirements

a) Applicability

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1) Except as provided by subsection (a)(2), this Section applies to the owners or operators of CCR surface impoundments who have completed an Agency approved closure.

2) An owner or operator of a CCR surface impoundment that elects to close a CCR surface impoundment by removing CCR as provided by Section 845.740 is not subject to the post-closure care criteria of this Section.

b) Post-closure Care Maintenance Requirements. Following closure of the CCR surface impoundment, the owner or operator must conduct post-closure care for the CCR surface impoundment, which must consist of at least the following:

1) Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;

2) If the CCR surface impoundment is subject to the design criteria of Section 845.420, maintaining the integrity and effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements of Section 845.420; and

3) Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with the requirements of Subpart F.

c) Post-closure Care Period

1) Except as provided by subsection (c)(2), the owner or operator of the CCR surface impoundment must conduct post-closure care for 30 years.

2) At the end of the 30-year post-closure care period, the owner or operator of the CCR surface impoundment must continue to conduct post-closure care until the groundwater monitoring data shows the concentrations are:

A) Below the groundwater protection standards in Section 845.600; and

B) Not increasing for those constituents over background, using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that:

i) Concentrations have been reduced to the maximum extent feasible; and

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ii) Concentrations are protective of human health and the environment.

d) Written Post-closure Care Plan

1) Content of the Plan. The owner or operator of a CCR surface impoundment must prepare a written post-closure care plan that includes, at a minimum, the information specified in this subsection (d)(1).

A) A description of the monitoring and maintenance activities required in subsection (b) for the CCR surface impoundment and the frequency at which these activities will be performed;

B) The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and

C) A description of the planned uses of the property during the post-closure care period. Post-closure use of the property must not disturb the integrity of the final cover, liners, or any other component of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements of this Part. Any other disturbance is allowed if the owner or operator of the CCR surface impoundment demonstrates that disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The demonstration must be certified by a qualified professional engineer and must be submitted to the Agency.

2) Deadline to Prepare the Initial Written Post-closure Care Plan. The owner or operator of a CCR surface impoundment must submit to the Agency an initial written post-closure care plan consistent with the requirements specified in subsection (d)(1), with its initial operating permit application.

3) Amendment of a Written Post-closure Care Plan.

A) The owner or operator may submit an operating permit modification application to amend the initial or any subsequent written post-closure care plan developed under subsection (d)(1) at any time.

B) The owner or operator must seek to amend the written closure care plan whenever:

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i) There is a change in the operation of the CCR surface impoundment that would substantially affect the written post-closure care plan in effect; or

ii) unanticipated events necessitate a revision of the written post-closure care plan, after post-closure activities have started.

C) The owner or operator must seek to amend the written post-closure care plan at least 60 days before a planned change in the operation of the facility or CCR surface impoundment, or within 60 days after an unanticipated event requires the need to revise an existing written post-closure care plan. If a written post-closure care plan is revised after post-closure activities have started for a CCR surface impoundment, the owner or operator must submit a request to modify the operating permit within 30 days following the triggering event.

4) The owner or operator of the CCR surface impoundment must obtain a written certification from a qualified professional engineer that the initial, and any amendment of the, written post-closure care plan meets the requirements of this Section.

e) Upon the completion of the post-closure care period, the owner or operator of the CCR surface impoundment must submit a request to the Agency to terminate post-closure care. The request must include a certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the post-closure care plan specified in subsection (d) and the requirements of this Section.

f) Notification of Completion of Post-closure Care Period. Within 30 days after the Agency's approval of the owner's or operator's request to terminate post-closure care, the owner or operator must prepare a notification of completion of post-closure care and must place the notification in the facility's operating record as required by Section 845.800(d)(31).

SUBPART H: RECORDKEEPING

Section 845.800 Facility Operating Record

a) Each owner or operator of a CCR surface impoundment subject to the requirements of this Part must maintain files of all information required by this Section in a written operating record at the facility.

b) Unless specified otherwise, each file must be retained for at least three years past the date the Agency approved the owner's or operator's request to terminate post-

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closure care, when closure is with a final cover system, or the completion of groundwater monitoring under Section 845.740(b), when closure is by removal.

c) An owner or operator of more than one CCR surface impoundment subject to the provisions of this Part may comply with the requirements of this Section in one recordkeeping system provided the system identifies each file by the name and identification number of each CCR surface impoundment. The files may be maintained on microfilm, on a computer, on computer disks, on a storage system accessible by a computer, on magnetic tape disks, or on microfiche.

d) Unless otherwise required below, the owner or operator of a CCR surface impoundment must place the following information, as it becomes available, in the facility's operating record:

1) Copies of all permit applications and permits issued under this Part;

2) Documentation recording the public meetings held under Section 845.240;

3) Weekly CQA reports under Section 845.290(b);

4) Hazard potential classification assessments for CCR surface impoundments (see Section 845.440(a)(3)(D));

5) Structural stability assessments for CCR surface impoundments (see Section 845.450(d)(4));

6) Safety factor assessments for CCR surface impoundments (see Section 845.460(c)(4));

7) The CCR fugitive dust control plan and any subsequent amendment of the plan (see Section 845.500(b)(6)), except that only the most recent fugitive dust control plan must be maintained in the facility's operating record, irrespective of the time requirement specified in subsection (b);

8) Inflow design flood control system plans for CCR surface impoundments (see Section 845.510(c)(4)(D));

9) Emergency Action Plan (see Section 845.520(a)), except that only the most recent EAP must be maintained in the facility's operating record irrespective of the time requirement specified in subsection (b);

10) Documentation prepared by the owner or operator recording all activations of the EAP (see Section 845.520(f));

11) Documentation prepared by the owner or operator recording the annual face-to-face meeting or exercise between representatives of the owner or

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operator of the CCR surface impoundment and the local emergency responders (see Section 845.520(g));

12) Safety and Health Plan (see Section 845.530(a));

13) Documentation recording the results of each inspection and instrumentation monitoring by a qualified person (see Section 845.540(a)(2));

14) Annual consolidated report (see Section 845.550), which contains the following:

A) The annual CCR fugitive dust control report (see Section 845.500(c));

B) The annual inspection report (see Section 845.540(b)(3)); and

C) The annual groundwater monitoring and corrective action report (see Section 845.610(e));

15) All groundwater monitoring data submitted to the Agency and any analysis performed (see Section 845.610(b)(3)(D));

16) Within 30 days after detecting one or more monitored constituents above the groundwater protection standard, the notifications required by Section 845.650(d) and (e);

17) The semi-annual report describing the progress in selecting and designing the remedy (see Section 845.670(a));

18) Within 30 days after completing the corrective action plan, the notification required by Section 845.680(e);

19) USEPA-approved or denied demonstration as required by Section 845.700(d)(2)(F);

20) The preliminary written closure plan and any amendment of the plan (see Section 845.720(a)) except that only the most recent closure plan must be maintained in the facility's operating record, irrespective of the time requirement specified in subsection (b);

21) The written demonstrations, including the certification required by Section 845.730(b)(3), for a time extension for initiating closure (see Section 845.730(b)(2));

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22) The notification of intent to close a CCR surface impoundment (see Section 845.730(d));

23) The monthly reports for closure by removal (see Section 845.740(d));

24) The closure report and certification (see Section 845.760(e)(3)), or the completion of groundwater monitoring report and certification (see Section 845.740(f));

25) The notification of completion of closure of a CCR surface impoundment (see Section 845.760(f));

26) The notification recording a notation on the deed (see Section 845.760(h));

27) The preliminary written retrofit plan for a CCR surface impoundment (see Section 845.770(a)(3));

28) The notification of intent to initiate retrofit of a CCR surface impoundment (see Section 845.770(d));

29) The retrofit completion report and certification (see Section 845.770(g)(3));

30) The notification of completion of retrofit activities (see Section 845.770(h));

31) The notification of completion of post-closure care period (see Section 845.780(f));

32) The completion of CCR removal and decontamination report and certification (see Section 845.740(e)); and

33) The most current cost estimates (see Section 845.940(d)).

Section 845.810 Publicly Accessible Internet Site Requirements

a) Each owner or operator of a CCR surface impoundment subject to the requirements of this Part must maintain a publicly accessible Internet site (CCR website) containing the information specified in this Section. The owner's or operator's website must be titled "Illinois CCR Rule Compliance Data and Information".

b) An owner or operator of more than one CCR surface impoundment subject to the provisions of this Part may comply with the requirements of this Section by using the same Internet site for multiple CCR surface impoundments, provided the CCR

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website clearly delineates information by the name and identification number of each CCR surface impoundment.

c) Unless otherwise required in this Section, the information required to be posted to the CCR website must be made available to the public on the CCR website until 3 years after post-closure care (when closure is with a final cover system) or the completion of groundwater monitoring under Section 845.740(b) (when closure is by removal).

d) Unless otherwise required in this Section, the information must be posted to the CCR website within 14 days after placing the pertinent information required by Section 845.800 in the operating record.

e) The owner or operator must place all the information specified under Section 845.800(d) on the owner's or operator's CCR website.

f) The owner or operator must place all the information specified in Section 845.240(e) on the owner's or operator's CCR website at least 30 days before the public meeting.

g) The owner or operator must notify the Agency of the web address of the publicly accessible Internet site, including any change to the web address. The Agency must maintain a list of these web addresses on the Agency's website.

SUBPART I: FINANCIAL ASSURANCE

Section 845.900 General Provisions

a) This Subpart provides procedures by which the owner or operator of a CCR surface impoundment subject to this Part provides financial assurance satisfying the requirements of Section 22.59(f) of the Act.

b) The owner or operator must provide financial assurance to ensure the following:

1) Completion of closure;

2) Completion of post-closure care, if applicable; and

3) Remediation of releases from a CCR surface impoundment.

c) The owner or operator must maintain financial assurance equal to or greater than the current cost estimates always calculated under Section 845.930, except as otherwise provided by Section 845.910.

d) Financial assurance must be provided, by a trust agreement, a surety bond guaranteeing payment, a surety bond guaranteeing payment or performance, or an

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irrevocable letter of credit (see Section 845.950). The owner or operator must provide financial assurance to the Agency within the timeframes in Section 845.950(c).

e) This Subpart does not apply to the State of Illinois, its agencies and institutions, any unit of local government, or any not-for-profit electric cooperative as defined in Section 3.4 of the Electric Supplier Act [220 ILCS 30].

f) The Agency is authorized to enter into contracts and agreements necessary to carry out the purposes of this Subpart and of Section 22.59(f) of the Act. Neither the State, nor the Director of the Agency, nor any State employee will be liable for any damages or injuries arising out of, or resulting from, any action taken under this Part.

g) The Agency may sue in any court of competent jurisdiction to enforce its rights under financial instruments. The filing of an enforcement action before the Board is not a condition precedent to such an Agency action, except when this Subpart or the terms of the instrument provide otherwise.

h) The Agency must have the authority to approve or disapprove any financial assurance mechanism posted or submitted under this Subpart.

i) The following Agency actions may be appealed to the Board as a permit denial under Section 845.270(e) and Section 22.59(f)(3) of the Act:

1) A refusal to accept financial assurance tendered by the owner or operator;

2) A refusal to release the owner or operator from the requirement to maintain financial assurance;

3) A refusal to release excess funds from a trust;

4) A refusal to approve a reduction in the penal sum of a bond; and

5) A refusal to approve a reduction in the amount of a letter of credit.

j) An owner or operator must notify the Agency by certified mail of the beginning of a voluntary or involuntary proceeding under Title 11 of the United States Code (Bankruptcy) naming any of the owners or operators as debtor, within 10 days after the proceeding starts.

k) An owner or operator that fulfills the requirements of Section 845.960, 845.970, 845.980, or 845.990 by obtaining a trust fund, surety bond, or letter of credit will be deemed to be without the required financial assurance in the event of bankruptcy of the trustee or issuing institution, or a suspension or revocation of the authority of the trustee institution to act as trustee or of the institution issuing

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the surety bond or letter of credit to issue those instruments. The owner or operator must establish alternative financial assurance within 60 days after such an event.

Section 845.910 Upgrading Financial Assurance

a) The owner or operator must increase the total amount of financial assurance to equal or exceed the current cost estimate within 60 days after either of the following occurrences:

1) An increase in the current cost estimate; or

2) A decrease in the value of a trust fund.

b) The owner or operator of a CCR surface impoundment must make annual adjustments for inflation if required under Section 845.930 or 845.940.

Section 845.920 Release of Financial Institution and Owner or Operator

a) The Agency must release a trustee, surety, or other financial institution when:

1) An owner or operator substitutes alternative financial assurance such that the total financial assurance for the CCR surface impoundment is equal to or greater than the current cost estimate, without counting the amounts to be released; or

2) The Agency releases the owner or operator from the requirements of this Subpart under subsection (b).

b) The Agency must release an owner or operator of a CCR surface impoundment from the requirements of this Subpart under the following circumstances:

1) Completed Closure. In the Agency's approval of the closure report and certification under Section 845.760, the Agency must notify the owner or operator in writing that it is no longer required by this Subpart to maintain financial assurance for closure of the CCR surface impoundment.

2) Completed Post-Closure Care. In the Agency's approval of the owner's or operator's request to terminate post-closure care under Section 845.780, the Agency must notify the owner or operator in writing that it is no longer required by this Subpart to maintain financial assurance for post-closure care of the CCR surface impoundment.

3) Completed Corrective Action. In the Agency's approval of the corrective action completion report and certification under Section 845.680, the Agency must notify the owner or operator in writing that it is no longer

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required by this Subpart to maintain financial assurance for corrective action.

Section 845.930 Cost Estimates

a) The owner or operator must prepare and submit to the Agency, for approval, written cost estimates for:

1) The total costs for closure and post-closure care;

2) Preliminary corrective action costs; and

3) The total costs of the corrective action plan for remediation of any releases from a CCR surface impoundment.

b) Written Cost Estimate for Closure and Post-closure

1) The owner or operator must have a detailed written estimate, in current dollars, of the cost of closing the CCR surface impoundment in accordance with this Part and providing post-closure care on an annual basis, when required, in accordance with this Part. The cost estimate is the total cost for closure and post-closure care.

2) The cost estimate must equal the cost of final closure and post-closure care at the point in the CCR surface impoundment's active life when the extent and manner of its operation would make closure and post-closure care the most expensive.

3) The cost estimate must be based on the assumption that the Agency will contract with a third party at the appropriate prevailing wages, under the Prevailing Wage Act [820 ILCS 130], if applicable, to implement the closure and post-closure care plans. A third party is a party who is neither a parent nor a subsidiary of the owner or operator.

4) The cost estimate may not be reduced by allowance for the salvage value of facility structures or equipment, for the resale value of land, for the sale of CCR or its beneficial reuse if permitted by the Agency under this Part, or for other assets associated with the facility at the time of partial or final closure.

5) The owner or operator must not incorporate a zero cost for CCR, if permitted by the Agency under this Part, that might have economic value.

6) The cost estimate must, at a minimum, include all costs for all activities necessary to close the CCR surface impoundment and provide post-closure care in accordance with all requirements.

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7) The post-closure care portion of the cost estimate must, at a minimum, be based on the following elements:

A) Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;

B) If the CCR surface impoundment is subject to the design criteria of Section 845.420, maintaining the integrity and effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements of Section 845.420; and

C) Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with the requirements of this Part.

c) Cost Estimate for Corrective Action

1) Preliminary Corrective Action Cost Estimate. An owner or operator of a CCR surface impoundment with a release that has caused an exceedance of the groundwater protection standard in Section 845.600, or groundwater quality standard in 35 Ill. Adm. Code 620, must provide a preliminary corrective action cost estimate that is equal to 25% of the costs calculated under subsection (b).

2) Corrective Action Cost Estimate. The owner or operator must provide to the Agency a detailed written estimate, in current dollars, of the cost of hiring a third party at the appropriate prevailing wages, under the Prevailing Wage Act, if applicable, to implement the approved corrective action plan in accordance with this Part. The corrective action cost estimate must account for the total costs of corrective action activities as described in the approved corrective action plan for the entire corrective action period.

3) The owner or operator must annually adjust the cost estimates in this subsection (c) for inflation (see Section 845.940(a)) until the approved corrective action plan is completed.

4) The owner or operator must increase the corrective action cost estimates in this subsection (c) and the amount of financial assurance provided if changes in the corrective action plan or CCR surface impoundment conditions increase the maximum costs of corrective action.

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5) The owner or operator may reduce the amount of the corrective action cost estimate, upon Agency approval, if the cost estimate exceeds the maximum remaining costs of corrective action.

Section 845.940 Revision of Cost Estimates

a) During the active life of the CCR surface impoundment, the owner or operator must adjust the cost estimates for closure, post-closure care, and corrective action for inflation on an annual basis. The adjustments must occur within 60 days before the anniversary date of the establishment of the financial instruments used to comply with Section 845.950. The adjustment may be made by recalculating the maximum costs of closure, post-closure care, or corrective action in current dollars, or by using an inflation factor derived from the annual Implicit Price Deflator for Gross National Product (Deflator) as published by the U.S. Department of Commerce in its Survey of Current Business (Table 1.1.9) (see subsections (a)(1) and (a)(2)). The inflation factor is the result of dividing the latest published annual Deflator by the Deflator for the previous year.

1) The first adjustment is made by multiplying the cost estimate by the inflation factor. The result is the adjusted cost estimate.

2) Subsequent adjustments are made by multiplying the latest adjusted cost estimate by the latest inflation factor.

b) During the active life of the CCR surface impoundment, the owner or operator must revise the cost estimate within 30 days after the Agency has approved a request to modify the corrective action plan, closure plan, or post-closure care plan, if the change in the modified plan increases the cost of corrective action, closure or post-closure care. The revised cost estimate must be adjusted for inflation (see subsection (a)).

c) At least 60 days before submitting any closure plan to the Agency, the owner or operator must revise the cost estimate if the selected closure method increases the estimated closure or post-closure care costs.

d) The owner or operator must keep the most current cost estimates in the facility's operating record during the operating life of the CCR surface impoundment.

Section 845.950 Mechanisms for Financial Assurance

a) The owner or operator of a CCR surface impoundment must use any of the mechanisms listed in this subsection (a) to provide financial assurance for closure and post-closure care, and for corrective action at a CCR surface impoundment. An owner or operator of a CCR surface impoundment must also meet the requirements of subsections (b), (c), and (d). The mechanisms are as follows:

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1) A trust fund (see Section 845.960);

2) A surety bond guaranteeing payment (see Section 845.970);

3) A surety bond guaranteeing performance (see Section 845.980); or

4) An irrevocable letter of credit (see Section 845.990).

b) The owner or operator of a CCR surface impoundment must ensure that the language of the mechanisms listed in subsection (a), when used for providing financial assurance for closure, post-closure, and corrective action, is consistent with the forms prescribed by the Agency and satisfies the following:

1) The amount of funds assured is sufficient to cover the costs of closure, post-closure care, and corrective action; and

2) The funds will be available in a timely fashion when needed.

c) The owner or operator of a CCR surface impoundment must provide financial assurance utilizing one or more of the mechanisms listed in subsection (a) within the following timeframes:

1) An owner or operator of an existing CCR surface impoundment must provide financial assurance to the Agency for closure and post-closure care within 60 days after April 21, 2021;

2) An owner or operator of a new CCR surface impoundment must provide financial assurance to the Agency for closure and post-closure care at least 60 days before the date of initial receipt of CCR in the CCR surface impoundment.

3) In the case of corrective action required by this Part, the owner or operator of the CCR surface impoundment must provide preliminary financial assurance for corrective action no later than when the owner or operator initiates an assessment of corrective measures under Section 845.650(d)(3). The preliminary financial assurance for corrective action must be maintained until replaced with financial assurance based on the cost estimate of the corrective action. The owner or operator of the CCR surface impoundment must provide financial assurance based on the approved corrective action plan to the Agency within 60 days after either the Agency's approval or April 21, 2021, whichever is later.

d) The owner or operator must provide continuous financial assurance coverage until the owner or operator is released from the financial assurance requirements of this Subpart under Section 845.920(b).

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e) Use of Multiple Financial Assurance Mechanisms. An owner or operator may satisfy the requirements of this Subpart by establishing more than one financial mechanism per CCR surface impoundment. These mechanisms are limited to trust funds, surety bonds guaranteeing payment, and letters of credit. The mechanisms must be as specified in Sections 845.960, 845.970, and 845.990, as applicable, except that it is the combination of mechanisms, rather than the single mechanism, that must provide financial assurance for an aggregate amount at least equal to the current cost estimate for closure, post-closure care, and corrective action, except that mechanisms guaranteeing performance, rather than payment, may not be combined with other instruments. The owner or operator may use any or all the mechanisms to provide financial assurance for corrective action, closure and post-closure care.

f) Use of a Financial Assurance Mechanism for Multiple CCR Surface Impoundments in Illinois. An owner or operator may use a financial assurance mechanism specified in this Subpart to meet the requirements of this Subpart for more than one CCR surface impoundment located in Illinois. Evidence of financial assurance submitted to the Agency must include a list showing, for each CCR surface impoundment, the identification number (see Section 845.130), name, address and the amount of funds assured by the mechanism. The amount of funds available through the mechanism must be at least the sum of funds that would be available if a separate mechanism had been established and maintained for each CCR surface impoundment. The amount of funds available to the Agency must be enough to close and provide post-closure care for all of the owner's or operator's CCR surface impoundments. In directing funds available through a single mechanism for the closure and post-closure care of any single CCR surface impoundment covered by that mechanism, the Agency must direct only that amount of funds designated for that CCR surface impoundment, unless the owner or operator agrees to the use of additional funds available under that mechanism.

Section 845.960 Trust Fund

a) An owner or operator may satisfy the requirements of this Subpart by establishing a fully funded trust fund that conforms to the requirements of this Section and submitting to the Agency an original signed duplicate of the trust agreement.

b) The trustee must be an entity that has the authority to act as a trustee and of whom either of the following is true:

1) It is an entity whose trust operations are examined by the Illinois Department of Financial and Professional Regulation under the Illinois Banking Act [205 ILCS 5]; or

2) It is an entity that complies with the Corporate Fiduciary Act [205 ILCS 620].

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c) The trust agreement must be on forms prescribed by the Agency. The trust agreement must be updated within 60 days after a change in the amount of the current closure, post-closure, and corrective action cost estimates covered by the agreement.

d) The trust fund must be fully funded from the date that the trust agreement becomes effective.

e) The trustee must evaluate the trust fund annually, as of the day the trust was created or on such earlier date as may be provided in the agreement. The trustee must notify the owner or operator and the Agency of the value within 30 days after the evaluation date.

f) If the owner or operator of a CCR surface impoundment establishes a trust fund after having used one or more alternative mechanisms specified in this Subpart, the trust fund must be fully funded and established according to the specifications of this Section.

g) Release of Excess Funds

1) If the value of the financial assurance is greater than the total amount of the current cost estimate, the owner or operator may submit a written request to the Agency for a release of the amount in excess of the current cost estimate.

2) Within 60 days after receiving a request from the owner or operator for a release of funds, the Agency must instruct the trustee to release to the owner or operator the funds as the Agency specifies in writing to be in excess of the current cost estimate.

h) Reimbursement for Closure, Post-closure Care, and Corrective Action Expenses

1) After initiating corrective action, closure, or post-closure care an owner or operator, or any other person authorized to perform corrective action, closure, or post-closure care, may request reimbursement for closure, post-closure care, or corrective action expenditures by submitting itemized bills to the Agency.

2) Within 60 days after receiving the itemized bills for closure, post-closure care, or correction action activities, the Agency must determine whether the expenditures are in accordance with the closure, post-closure care, or corrective action plan. The Agency must instruct the trustee to make reimbursement in amounts the Agency specifies in writing as expenditures made in accordance with the closure, post-closure care, or corrective action plan.

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3) If the Agency determines, based on information available to it, that the cost of closure and post-closure care or corrective action will be greater than the value of the trust fund, it must withhold reimbursement of amounts it determines are necessary to preserve the fund in order to accomplish closure and post-closure care or corrective action until it determines that the owner or operator is no longer required to maintain financial assurance for closure and post-closure care or corrective action. If the fund is inadequate to pay all claims, the Agency must pay claims according to the following priorities:

A) Persons with whom the Agency has contracted to perform closure, post-closure care, or corrective action activities (first priority);

B) Persons who have completed closure, post-closure care, or corrective action authorized by the Agency (second priority);

C) Persons who have completed work that furthered the closure, post-closure care, or corrective action (third priority);

D) The owner or operator and related business entities (last priority).

Section 845.970 Surety Bond Guaranteeing Payment

a) An owner or operator may satisfy the requirements of this Subpart by obtaining a surety bond that conforms to the requirements of this Section and submitting the bond to the Agency.

b) The surety company issuing the bond must, at a minimum, be among those listed as acceptable sureties on federal bonds in Circular 570 of the U.S. Department of the Treasury. Circular 570 is available on the Internet from the following website: https://fiscal.treasury.gov/surety-bonds/circular-570.html.

c) The surety bond must be on forms prescribed by the Agency.

d) Any payments drawn from or made under the bond will be placed in the Coal Combustion Residual Surface Impoundment Financial Assurance Fund within the State Treasury.

e) Conditions

1) The bond must guarantee that the owner or operator will:

A) Provide closure and post-closure care in accordance with the approved closure and post-closure care plans and, if the bond is a corrective action bond, provide corrective action in accordance

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with this Part; and

B) Provide alternative financial assurance, as specified in this Subpart, and obtain the Agency's written approval of the assurance provided within 90 days after receipt by both the owner or operator and the Agency of a notice from the surety that the bond will not be renewed for another term.

2) The surety will become liable on the bond obligation when, during the term of the bond, the owner or operator fails to perform as guaranteed by the bond. The owner or operator fails to perform when the owner or operator:

A) Abandons the CCR surface impoundment;

B) Is adjudicated bankrupt;

C) Fails to initiate closure of the CCR surface impoundment or post-closure care or corrective action when ordered to do so by the Board under Title VIII of the Act (Enforcement), or when ordered to do so by a court of competent jurisdiction;

D) Notifies the Agency that it has initiated closure or corrective action, or initiates closure or corrective action, but fails to close the CCR surface impoundment or provide post-closure care or corrective action in accordance with the Agency-approved closure and post-closure care or corrective action plans;

E) For a corrective action bond, fails to implement or complete corrective action at a CCR surface impoundment in accordance with Section 845.670; or

F) Fails to, within 90 days after receipt by both the owner or operator and the Agency of a notice from the surety that the bond will not be renewed for another term:

i) Provide alternative financial assurance, as specified in this Subpart; and

ii) Obtain the Agency's written approval of the assurance.

3) If the owner or operator does not establish alternative financial assurance, as specified in this Subpart, and obtain written approval of that alternative assurance from the Agency within 90 days after receipt by both the owner or operator and the Agency of a notice of nonrenewal from the surety (see subsection (g)(2)), the Agency must draw on the bond. During the last 30

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days of a notice of nonrenewal, the Agency must draw on the bond if the owner or operator has failed to provide alternative financial assurance, as specified in this Section, and obtain from the Agency written approval of that assurance.

f) Penal Sum

1) The penal sum of the bond must be in an amount at least equal to the current cost estimate.

2) Whenever the current cost estimate decreases, the penal sum may be reduced to the amount of the current cost estimate following written approval by the Agency.

3) Whenever the current cost estimate increases to an amount greater than the penal sum, the owner or operator, within 90 days after the increase, must either cause the penal sum to be increased to an amount at least equal to the current cost estimate and submit evidence of that increase to the Agency or obtain other financial assurance, as specified in this Subpart, to cover the increase and submit evidence of the alternative financial assurance to the Agency.

g) Term

1) The bond must be issued for a term of at least one year and must not be cancelable during that term.

2) The surety bond must provide that, on the current expiration date and on each successive expiration date, the term of the surety bond will be automatically extended for a period of at least one year unless, at least 120 days before the current expiration date, the surety notifies both the owner or operator and the Agency by certified mail of a decision not to renew the bond. Under the terms of the surety bond, the 120 days will begin on the date when both the owner or operator and the Agency have received the notice, as evidenced by the return receipts.

3) The Agency must release the surety by providing written authorization for termination of the bond to the owner or operator and the surety when either of the following occurs:

A) An owner or operator substitutes alternative financial assurance, as specified in this Subpart; or

B) The Agency releases the owner or operator from the requirements of this Subpart in accordance with Section 845.920(b).

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h) Cure of Default and Refunds

1) The Agency must release the surety if, after the surety becomes liable on the bond, the owner or operator or another person provides financial assurance for closure and post-closure care of the CCR surface impoundment or corrective action at a CCR surface impoundment; unless the Agency determines that the closure, post-closure care, or corrective action plan, or the amount of substituted financial assurance, is inadequate to provide closure and post-closure care or implement corrective action in compliance with this Part.

2) After closure and post-closure care have been completed in accordance with the plans and requirements of this Part or after the completion of corrective action at a CCR surface impoundment in accordance with this Part, the Agency must refund any unspent money that was paid into the Coal Combustion Residual Surface Impoundment Financial Assurance Fund by the surety, subject to appropriation of funds by the Illinois General Assembly.

Section 845.980 Surety Bond Guaranteeing Performance

a) An owner or operator may satisfy the requirements of this Subpart by obtaining a surety bond that conforms to the requirements of this Section and submitting the bond to the Agency.

b) The surety company issuing the bond must, at a minimum, be among those listed as acceptable sureties on federal bonds in Circular 570 of the U.S. Department of the Treasury. Circular 570 is available on the Internet from the following website: https://fiscal.treasury.gov/surety-bonds/circular-570.html.

c) The surety bond must be on forms prescribed by the Agency.

d) Any payments made under the bond will be placed in the Coal Combustion Residual Surface Impoundment Financial Assurance Fund within the State Treasury.

e) Conditions

1) The bond must guarantee that the owner or operator will:

A) Provide closure and post-closure care in accordance with the approved closure and post-closure care plans and, if the bond is a corrective action bond, provide corrective action in accordance with this Part; and

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B) Provide alternative financial assurance, as specified in this Subpart, and obtain the Agency's written approval of the assurance provided within 90 days after receipt by both the owner or operator and the Agency of a notice from the surety that the bond will not be renewed for another term.

2) The surety will become liable on the bond obligation when, during the term of the bond, the owner or operator fails to perform as guaranteed by the bond. The owner or operator fails to perform when the owner or operator:

A) Abandons the CCR surface impoundment;

B) Is adjudicated bankrupt;

C) Fails to initiate closure of the CCR surface impoundment or post-closure care or corrective action when ordered to do so by the Board under Title VIII of the Act (Enforcement), or when ordered to do so by a court of competent jurisdiction;

D) Notifies the Agency that it has initiated closure or corrective action, or initiates closure or corrective action, but fails to close the CCR surface impoundment or provide post-closure care or corrective action in accordance with the Agency-approved closure and post-closure care or corrective action plans;

E) For a corrective action bond, fails to implement or complete corrective action at a CCR surface impoundment in accordance with Section 845.670; or

F) Fails to, within 90 days after receipt by both the owner or operator and the Agency of a notice from the surety that the bond will not be renewed for another term:

i) Provide alternative financial assurance, as specified in this Subpart; and

ii) Obtain the Agency's written approval of the assurance.

3) Upon failure of the owner or operator to perform as guaranteed by the bond, the surety must have the option of:

A) providing closure and post-closure care in accordance with the approved closure and post-closure care plans;

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B) carrying out corrective action in accordance with the corrective action plan; or

C) paying the penal sum.

f) Penal Sum

1) The penal sum of the bond must be in an amount at least equal to the current cost estimate.

2) Whenever the current cost estimate decreases, the penal sum may be reduced to the amount of the current cost estimate following written approval by the Agency.

3) Whenever the current cost estimate increases to an amount greater than the penal sum, the owner or operator, within 90 days after the increase, must either cause the penal sum to be increased to an amount at least equal to the current cost estimate and submit evidence of that increase to the Agency or obtain other financial assurance, as specified in this Subpart, and submit evidence of the alternative financial assurance to the Agency.

g) Term

1) The bond must be issued for a term of at least one year and must not be cancelable during that term.

2) The surety bond must provide that, on the current expiration date and on each successive expiration date, the term of the surety bond will be automatically extended for a period of at least one year unless, at least 120 days before the current expiration date, the surety notifies both the owner or operator and the Agency by certified mail of a decision not to renew the bond. Under the terms of the surety bond, the 120 days will begin on the date when both the owner or operator and the Agency have received the notice, as evidenced by the return receipts.

3) The Agency must release the surety by providing written authorization for termination of the bond to the owner or operator and the surety when either of the following occurs:

A) An owner or operator substitutes alternative financial assurance, as specified in this Subpart; or

B) The Agency releases the owner or operator from the requirements of this Subpart in accordance with Section 845.920(b).

h) Cure of Default and Refunds

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1) The Agency must release the surety if, after the surety becomes liable on the bond, the owner or operator or another person provides financial assurance for closure and post-closure care of the CCR surface impoundment or corrective action at a CCR surface impoundment; unless the Agency determines that the closure, post-closure care, or corrective action plan, or the amount of substituted financial assurance, is inadequate to provide closure and post-closure care or implement corrective action in compliance with this Part.

2) After closure and post-closure care have been completed in accordance with the plans and requirements of this Part or after the completion of corrective action at a CCR surface impoundment in accordance with this Part, the Agency must refund any unspent money that was paid into the Coal Combustion Residual Surface Impoundment Financial Assurance Fund by the surety, subject to appropriation of funds by the Illinois General Assembly.

i) The surety will not be liable for deficiencies in the performance of closure, post-closure care, or corrective action by the owner or operator after the Agency releases the owner or operator from the requirements of this Subpart.

Section 845.990 Letter of Credit

a) An owner or operator may satisfy the requirements of this Subpart by obtaining an irrevocable standby letter of credit that conforms to the requirements of this Section and submitting the letter to the Agency.

b) The issuing institution must be an entity that has the authority to issue letters of credit and:

1) Whose letter of credit operations are regulated by the Illinois Department of Financial and Professional Regulation under the Illinois Banking Act [205 ILCS 5]; or

2) Whose deposits are insured by the Federal Deposit Insurance Corporation.

c) Forms

1) The letter of credit must be on forms prescribed by the Agency.

2) The letter of credit must be accompanied by a letter from the owner or operator, referring to the letter of credit by number, the name and address of the issuing institution, and the effective date of the letter, and providing the following information: the name and address of the CCR surface impoundment, the identification number (see Section 845.130), and the

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amount of funds assured by the letter of credit for closure and post-closure care of the CCR surface impoundment, or for corrective action at the CCR surface impoundment.

d) Any amounts drawn by the Agency under the letter of credit will be deposited in the Coal Combustion Residual Surface Impoundment Financial Assurance Fund within the State Treasury.

e) Conditions on Which the Agency Must Draw on the Letter of Credit:

1) The Agency must draw on the letter of credit if the owner or operator fails to perform closure or post-closure care in accordance with the approved closure and post-closure care plans or fails to perform corrective action at a CCR surface impoundment in accordance with this Part.

2) The Agency must draw on the letter of credit if the owner or operator:

A) Abandons the CCR surface impoundment;

B) Is adjudicated bankrupt;

C) Fails to initiate closure of the CCR surface impoundment or post-closure care or corrective action when ordered to do so by the Board under Title VIII of the Act (Enforcement), or when ordered to do so by a court of competent jurisdiction;

D) Notifies the Agency that it has initiated closure or corrective action, or initiates closure or corrective action, but fails to provide closure and post-closure care or corrective action in accordance with the Agency-approved closure and post-closure care or corrective action plans;

E) For a corrective action letter of credit, fails to implement or complete corrective action at a CCR surface impoundment in accordance with Section 845.670; or

F) Fails to, within 90 days after receipt by both the owner or operator and the Agency of a notice from the surety that the bond will not be renewed for another term:

i) Provide alternative financial assurance, as specified in this Subpart; and

ii) Obtain the Agency's written approval of the assurance.

3) If the owner or operator does not establish alternative financial assurance,

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as specified in this Subpart, and obtain written approval of that alternative assurance from the Agency within 90 days after receipt by both the owner or operator and the Agency of a notice of expiration from the issuing institution (see subsection (g)(2)), the Agency must draw on the letter of credit. During the last 30 days of a notice of expiration, the Agency must draw on the letter of credit if the owner or operator has failed to provide alternative financial assurance, as specified in this Section, and obtain from the Agency written approval of that assurance.

f) Amount

1) The letter of credit must be issued in an amount at least equal to the current cost estimate.

2) Whenever the current cost estimate decreases, the amount of credit may be reduced to the amount of the current cost estimate following written approval by the Agency.

3) Whenever the current cost estimate increases to an amount greater than the amount of the credit, the owner or operator, within 90 days after the increase, must either cause the amount of the credit to be increased to an amount at least equal to the current cost estimate and submit evidence of that increase to the Agency or obtain other financial assurance, as specified in this Subpart, to cover the increase and submit evidence of the alternative financial assurance to the Agency.

g) Term

1) The letter of credit must be issued for a term of at least one year and must be irrevocable during that term.

2) The letter of credit must provide that, on the current expiration date and on each successive expiration date, the letter of credit will be automatically extended for a period of at least one year unless, at least 120 days before the current expiration date, the issuing institution notifies both the owner or operator and the Agency by certified mail of a decision not to extend the letter of credit for another term. Under the terms of the letter of credit, the 120 days will begin on the date when both the owner or operator and the Agency have received the notice, as evidenced by the return receipts.

3) The Agency must return the letter of credit to the issuing institution for termination when either of the following occurs:

A) An owner or operator substitutes alternative financial assurance, as specified in this Subpart; or

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B) The Agency releases the owner or operator from the requirements of this Subpart in accordance with Section 845.920(b).

h) Cure of Default and Refunds

1) The Agency must release the financial institution if, after the Agency is allowed to draw on the letter of credit, the owner or operator or another person provides financial assurance for closure and post-closure care of the CCR surface impoundment or corrective action at a CCR surface impoundment; unless the Agency determines that the closure, post-closure care, or corrective action plan, or the amount of substituted financial assurance, is inadequate to provide closure and post-closure care or implement corrective action in compliance with this Part.

2) After closure and post-closure care have been completed in accordance with the plans and requirements of this Part or after the completion of corrective action at a CCR surface impoundment in accordance with this Part, the Agency must refund any unspent money that was drawn and paid into the Coal Combustion Residual Surface Impoundment Financial Assurance Fund by the financial institution, subject to appropriation of funds by the Illinois General Assembly.

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Document 10

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Luminant

Illinois Power Resource Generating, LLC
1500 Eastport Plaza Dr.
Collinsville, IL 62234

October 25, 2021

Illinois Environmental Protection Agency
DWPC – Permits MC #15
Attn: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

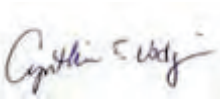
Re: Duck Creek Power Plant GMF Pond; IEPA ID # W0578010001-04

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.200, Illinois Power Resource Generating, LLC (IPRG) is submitting an operating permit application for the Duck Creek Power Plant GMF Pond (IEPA ID # W0578010001-04). One hardcopy and one digital copy are provided with this submittal.

The permit application was prepared in accordance with 35 I.A.C. § 845.230(d)(2) (Existing, Inactive and Inactive Closed CCR Surface Impoundment that have not completed an Agency approved closure before July 30, 2021). This submittal includes the completed permit forms as required by § 845.210.

Sincerely,



Cynthia Vodopivec
SVP-Environmental Health and Safety

Enclosures

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Prepared for

Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive, Collinsville, Illinois 62234

INITIAL OPERATING PERMIT

DUCK CREEK GMF POND

Prepared by

425 South Woods Mill Road, Suite 300
St. Louis, MO 63017

October 25, 2021

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Attachment Q	Safety Factor Assessment (845.460)
Attachment R	Inflow Design Flood Control System Plan (845.510)
Attachment S	Safety and Health Plan (845.530)
Attachment T	Proposed Closure Priority Categorization (845.700)
Attachment U	5-Year Updates

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1. INTRODUCTION

Illinois Power Resources Generating, LLC (Dynegy) is operator of the coal-fired Duck Creek Power Plant (Plant) located near Canton, Illinois. The IEPA assigned identification numbers assigned to the Duck Creek GMF Pond is: W0578010001-04. The National Inventory of Dams (NID) number assigned for the Duck Creek GMF Pond is IL50573.

This initial operating permit application was developed in accordance with 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845).

This initial operating permit application is for the Duck Creek GMF Pond.

1.1. Facility Information

Section 845.210(b)(1): All permit applications must contain the name, address, email address and telephone number of the operator, or duly authorized agent, and the property owner to whom all inquiries and correspondence shall be addressed.

Facility:	Duck Creek GMF Pond Duck Creek Power Plant 17751 North Cilco Road Canton, IL 61520
Owner/Operator:	Illinois Power Resources Generating, LLC 1500 Eastport Plaza Drive Collinsville, Illinois 62234

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1.2. Owner Signatures

Section 845.210(b)(2): All permit applications must be signed by the owner, operator or a duly authorized agent of the operator.

The owner of the Duck Creek Power Plant is a corporation.

Section 845.210(b)(3): An application submitted by a corporation must be signed by a principal executive officer of at least the level of vice president, or his or her duly authorized representative, if that representative is responsible for the overall operation of the facility described in the application form..

The signature of Cynthia Vodopivec on behalf of Illinois Power Resources Generating, LLC can be found in the cover letter as well as the permit applications located in Section 3.

1.3. Legal Description

Section 845.210(c): All permit applications must contain a legal description of the facility boundary and a description of the boundaries of all units included in the facility.

A legal description has been developed in compliance with Section 845.210(c) and is included in Attachment A.

1.4. Previous Assessments

Section 845.210(d): Previous Assessments, Investigations Plans, and Programs

Previous assessments were performed in accordance with 40 CFR § 257 and are referenced within the permit application and included in the appropriate Attachments.

Section 845.210(d)(1): The Agency may approve the use of any hydrogeologic site investigation or characterization, groundwater monitoring well or system, or groundwater monitoring plan, bearing the seal and signature of an Illinois Licensed Professional Geologist or Licensed Professional Engineer, completed before April 21, 2021 to satisfy the requirements of this Part.

A previous hydrogeologic site investigation or characterization, groundwater monitoring well or system, or groundwater monitoring plan have been completed with a seal from an Illinois Licensed Professional Geologist or Licensed Professional Engineer. However, field investigations have

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been completed that supplement that work that will be utilized in the following sections of this report.

> *Section 845.210(d)(2): For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas) provided that the previously completed assessments meet the applicable requirements of those Sections.*

Previous assessments are provided for Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas) in Attachment D.

> *Section 845.210(d)(3): For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed assessment to serve as the initial assessment required by Section 845.440 (Hazard Potential Classification Assessment), Section 845.450 (Structural Stability Assessment) and Section 845.460 (Safety Factor Assessment) provided that the previously completed assessment: A) Was not completed more than five years ago; and B) Meets the applicable requirements of those Sections.*

Previous assessments are provided for Section 845.440 (Hazard Potential Classification Assessment), Section 845.450 (Structural Stability Assessment) and Section 845.460 (Safety Factor Assessment) in Attachments O, P, and Q respectively. The addendum and certification for the Hazard Potential Classification Assessment, Structural Stability Assessment and Safety Factor Assessment are located in Attachment U.

> *Section 845.210(d)(4): For inactive closed CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a post-closure care plan previously approved by the Agency.*

No post-closure care plan was previously approved by the Agency.

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2. OPERATING PERMIT

2.1. Initial Operating Permit

Section 845.230(d): Initial Operating Permit for Existing, Inactive and Inactive Closed CCR Surface Impoundments

The Duck Creek GMF Pond is defined by the IEPA as an existing CCR surface impoundment that has not completed post-closure care. Per Part 845, Illinois Power Resources Generating, LLC is submitting an initial operating permit application to IEPA by October 31, 2021. The permit applications (CCR-1 and CCR-2E) are provided in Section 3.

The following sections contain information or references to documents required for the Operating Permit application (Section 845.230).

2.2. History of Construction

Section 845.230(d)(2)(A): The history of construction specified in Section 845.220(a)(1);

The history of construction prepared in 2016 pursuant to 40 CFR § 257.73(c) is provided in Attachment B. An amendment to the history of construction has been prepared in compliance with Section 845.220(a)(1) and is provided in Attachment U.

2.3. Chemical Constituents

Section 845.230(d)(2)(B): An analysis of the chemical constituents found within the CCR to be placed in the CCR surface impoundment;

An analysis of the chemical constituents found within the CCR placed within the Duck Creek GMF Pond is provided in Attachment C.

Section 845.230(d)(2)(C): An analysis of the chemical constituents of all waste streams, chemical additives and sorbent materials entering or contained in the CCR surface impoundment;

An analysis of the chemical constituents of all waste streams, chemical additives and sorbent materials entering or contained within the Duck Creek GMF Pond is provided in Attachment C.

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2.4. Location Standards Demonstration

Section 845.230(d)(2)(D): A demonstration that the CCR surface impoundment, as built, meets, or an explanation of how the CCR surface impoundments fails to meet, the location standards in the following Sections:

The Duck Creek GMF Pond location standards as specified in Section 845.230(d)(2)(D) are described in the following sections.

Section 845.230(d)(2)(D)(i): Placement Above the Uppermost Aquifer;

The previous upper aquifer demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.60. The requirements described in 40 C.F.R. § 257.60 are identical to the requirements contained in Section 845.300. Pursuant to Section 845.210(d)(2), a certification is not required for this demonstration. The previously completed upper aquifer demonstration is included in Attachment D.

Section 845.230(d)(2)(D)(ii): Wetlands;

The previous wetlands demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.61. The requirements described in 40 C.F.R. § 257.61 are identical to the requirements contained in Section 845.310. Pursuant to Section 845.210(d)(2), a certification is not required for this demonstration. The previously completed wetlands demonstration is included in Attachment D.

Section 845.230(d)(2)(D)(iii): Fault Areas;

The previous fault area demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.62. The requirements described in 40 C.F.R. § 257.62 are identical to the requirements contained in Section 845.320. Pursuant to Section 845.210(d)(2), a certification is not required for this demonstration. The previously completed fault area demonstration is included in Attachment D.

Section 845.230(d)(2)(D)(iv): Seismic Impact Zone; and

The previous seismic impact zone demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.63. The requirements described in 40 C.F.R. § 257.63 are identical to the requirements contained in Section 845.330. Pursuant to Section 845.210(d)(2), a certification is not required for this

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demonstration. The previously completed seismic impact zone demonstration is included in Attachment D.

Section 845.230(d)(2)(D)(v): Unstable Areas and Floodplains;

The previous unstable area demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.64. The requirements described in 40 C.F.R. § 257.64 are identical to the requirements contained in Section 845.340. Pursuant to Section 845.210(d)(2), a certification is not required for the unstable area demonstration. The previously completed unstable area demonstration is included in Attachment D.

The boundaries of the impoundment were determined by a survey conducted by a professional surveyor licensed in the State of Illinois. The boundaries of the GMF Pond were compared to the existing FEMA floodplain map, and it was determined that the GMF Pond is not located within the floodplain. A certification attesting to this is provided in Attachment D.

2.5. Permanent Markers

Section 845.230(d)(2)(E): Evidence of permanent markers required by Section 845.130 have been installed;

Evidence of permanent markers at the Duck Creek GMF Pond as required by Section 845.130 is provided in Attachment E.

2.6. Slope Maintenance

Section 845.230(d)(2)(F): Documentation that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in Section 845.430;

The Duck Creek GMF Pond is not incised. Documentation of slope protection as required by Section 845.430 is provided in Attachment J.

2.7. Initial Emergency Action Plan

Section 845.230(d)(2)(G): Initial Emergency Action Plan and accompanying certification (see Section 845.520(e));

The initial emergency action plan and certification has been completed as specified by Section 845.520(e) and is provided in Attachment F.

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2.8. Fugitive Dust Control Plan

Section 845.230(d)(2)(H): Fugitive dust control plan and accompanying certification (see Section 845.500(b)(7));

The fugitive dust control plan and certification has been completed as specified by Section 845.500(b)(7) and is provided in Attachment G.

2.9. Groundwater Monitoring

Section 845.230(d)(2)(I): Groundwater monitoring information:

The groundwater monitoring information for the Duck Creek GMF Pond are described in the following sections.

Section 845.230(d)(2)(I)(i): Hydrogeologic site characterization (see Section 845.620);

Hydrogeologic site characterization for the Duck Creek GMF Pond are provided in Attachment H.

Section 845.230(d)(2)(I)(ii): Design and construction plans of a groundwater monitoring system (see Section 845.630);

Design and construction plans of a groundwater monitoring system are provided in Attachment I.

Section 845.230(d)(2)(I)(iii): A groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data (see Section 845.640); and

A groundwater sampling and analysis program that meets the requirements of Section 845.640 is provided in Attachment I.

Section 845.230(d)(2)(I)(iv): Proposed groundwater monitoring program that includes a minimum of eight independent samples for each background and downgradient well (see Section 845.650(b));

A proposed groundwater monitoring program that meets the requirements of Section 845.650(b) is provided in Attachment I.

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2.10. Initial Post-Closure Care Plan

Section 845.230(d)(2)(K): Initial written post-closure care plan, if applicable (see Section 845.780(d));

The Duck Creek GMF Pond closure will be completed by capping the CCR in place. The initial post closure care plan was developed in accordance with Section 845.780 and is provided in Attachment K.

2.11. Liner Certification

Section 845.230(d)(2)(L): The certification required by Section 845.400(h), or a statement that the CCR surface impoundment does not have a liner that meets the requirements of Section 845.400(b) or (c);

The liner certification has been completed as specified by Section 845.400(h) that states the surface impoundment does have a liner that meets the requirements of Section 845.400(c). A liner evaluation was conducted for the Duck Creek Power Plant GMF Pond in 2016 to evaluate conformance with liner design criteria set forth in 40 C.F.R. § 257.71 and 257.70 (as referenced in 257.71). Because the liner design criteria set forth in Section 845.400 are nearly identical to those presented in 40 C.F.R. § 257.71 and 257.70, the previous liner evaluation report and associated certification demonstrate that the Duck Creek Power Plant GMF Pond meets the design criteria for an alternative composite liner set forth in Section 845.400(c). The previous liner evaluation report and associated certification are provided in Attachment L.

2.12. History of Groundwater Exceedances

Section 845.230(d)(2)(M): History of known exceedances of the groundwater protection standards in Section 845.600, and any corrective action taken to remediate the groundwater;

A history of known exceedances and any corrective action taken is provided in Attachment M.

2.13. Financial Assurance Requirements

Section 845.230(d)(2)(N): A certification that the owner or operator meets the financial assurance requirements of Subpart I;

A certification meeting the requirement of Section 845.230(d)(2)(N) stating that the Owner meets the financial assurance requirements of *Subpart I* is provided in Attachment N.

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2.14. Hazard Potential Classification

Section 845.230(d)(2)(O): Hazard potential classification assessment and accompanying certification (see Section 845.440(a)(2));

The previous Hazard Potential Classification Assessment completed in compliance with 40 CFR §257.73(a) is provided in Attachment O. The addendum to the Hazard Potential Classification Assessment and certification as required by Section 845.440(a) is provided in Attachment U.

2.15. Structural Stability Assessment

Section 845.230(d)(2)(P): Structural stability assessment and accompanying certification (see Section 845.450(c));

The previous Structural Stability Assessment completed in compliance with 40 CFR §257.73(d) is provided in Attachment P. The addendum to the Structural Stability Assessment and certification as required by Section 845.450(c) is provided in Attachment U.

2.16. Safety Factor Assessment

Section 845.230(d)(2)(Q): Safety factor assessment and accompanying certification (see Section 845.460(b));

The previous Safety Factor Assessment completed in compliance with 40 CFR §257.73(e) is provided in Attachment Q. The addendum to the Safety Factor Assessment and certification as required by Section 845.460(b) is provided in Attachment U.

2.17. Inflow Design Flood Control System Plan

Section 845.230(d)(2)(R): Inflow design flood control system plan and accompanying certification (see Section 845.510(c)(3));

The previous Inflow Design Flood Control System Plan Assessment completed in compliance with 40 CFR §257.82 is provided in Attachment R. The addendum to the Inflow Design Flood Control Plan Assessmentas required by Section 845.510(c)(3) is provided in Attachment U.

2.18. Safety and Health Plan

Section 845.230(d)(2)(S): Safety and health plan (see Section 845.530); and

The safety and health plan in accordance with Section 845.530 is included in Attachment S.

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2.19. Proposed Closure Priority Categorization

Section 845.230(d)(2)(T): For CCR surface impoundments required to close under 845.700, the proposed closure priority categorization required by Section 845.700(g).

A CCR Surface Impoundment Category Designation and Justification letter was submitted to IEPA on May 19, 2021. The Duck Creek GMF Pond was designated as Category 3 Inactive CCR surface impoundment in compliance with groundwater protection standards in Section 845.600. This letter is provided in Attachment T.

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3. PERMIT APPLICATION

All permit applications must be made on the forms prescribed by the Agency and must be mailed or delivered to the address designated by the Agency on the forms. The permit applications (CCR-1 and CCR-2E) are provided below.

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Form CCR 1

Illinois Environmental Protection Agency
CCR Surface Impoundment Permit Application
Form CCR 1 – General Provisions

Bureau of Water ID Number:
W0578010001

CCR Permit Number:
Initial Permit

Facility Name:
Duck Creek Power Plant

For IEPA Use Only

SECTION 1: FACILITY, OPERATOR, AND OWNER INFORMATION (35 Ill. Adm. Code 845.210(b))

Facility, Operator, and Owner Information

1.1	Facility Name		
	Illinois Power Resources Generating, LLC - Duck Creek Power Plant		
1.2	Illinois EPA CCR Permit Number (if applicable)		
	Initial Permit		
1.3	Facility Contact Information		
	Name (first and last) Phil Morris	Title Senior Director - Environmental	Phone Number 618-343-7794
	Email address phil.morris@vistracorp.com		
1.4	Facility Mailing Address		
	Street or P.O. box 1500 Eastport Plaza Dr		
	City or town Collinsville	State IL	Zip Code 62234
1.5	Facility Location		
	Street, route number, or other specific identifier 17751 North CILCO Road		
	County name Fulton	County code (if known)	
	City or town Canton	State IL	Zip Code 61520
1.6	Name of Owner/Operator		
	Illinois Power Resources Generating, LLC		

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Facility, Operator, and Owner Info

1.7 Owner/Operator Contact Information

Name (first and last)	Title	Phone Number
Phil Morris	Senior Director - Environmental	618-343-7794

Email address: phil.morris@vistracorp.com

1.8 Owner/Operator Mailing Address

Street or P.O. box: 1500 Eastport Plaza Dr

City or town	State	Zip Code
Collinsville	IL	62234

SECTION 2: LEGAL DESCRIPTION (35 Ill. Adm. Code 845.210(c))

Legal Description

2.1 Legal Description of the facility boundary

See Attachment A.

SECTION 3: PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS (35 Ill. Adm. Code 845.810)

Internet Site

3.1 Web Address(es) to publicly accessible internet site(s) (CCR website)

www.luminant.com/illinois-ccr/

3.2 Is/are the website(s) titled "Illinois CCR Rule Compliance Data and Information"

☑	Yes	☐	No

SECTION 4: IMPOUNDMENT IDENTIFICATION

Impoundment Identification

4.1 List all the impoundment identification numbers for your facility and check the corresponding box to indicate that you have attached a written description for each impoundment.

W0578010001-04 (see Attachment A)	☑	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description

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			☐	Attached written description
			☐	Attached written description
			☐	Attached written description
			☐	Attached written description

SECTION 5: CHECKLIST AND CERTIFICATION STATEMENT

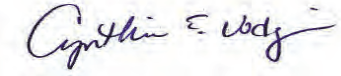
Checklist and Certification Statement

5.1 In Column 1 below, mark the sections of Form 1 that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing.

Column 1		Column 2	
Section 1: Facility, Operator, and Owner Information	☑	w/attachments	☐
Section 2: Legal Description	☑	w/attachments	☑
Section 3: Publicly Accessible Internet Site Requirement	☑	w/attachments	☐
Section 4: Impoundment Identification	☑	w/attachments	☑

5.2 **Certification Statement**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name) of Owner/Operator	Official Title
Cynthia Vodopivec	SVP - Environmental
Signature 	Date Signed 10/25/2021

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Form CCR 2E	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 2E – Initial Operating Permit for Existing or Inactive CCR Surface Impoundments That Have Not Completed an Agency-approved Closure Before July 30, 2021

Bureau of Water ID Number:	For IEPA Use Only
W0578010001	
CCR Permit Number:	
Initial Permit	
Facility Name:	
Duck Creek Power Plant	

SECTION 1: CONSTRUCTION HISTORY (35 Ill. Adm. Code 845.220 AND 35 Ill. Adm. Code 845.230)

Construction History

1.1	CCR surface impoundment name.
	GMF Pond
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).
	W0578010001-04
1.3	Description of the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210(c)).
	See Attachment A.
1.4	State the purpose for which the CCR surface impoundment is being used.
	See Attachment B.
1.5	How long has the CCR surface impoundment been in operation?
	See Attachment B.
1.6	List the types of CCR that have been placed in the CCR surface impoundment.
	See Attachment B.

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Construction History (Continued)

1.7	List name of the watershed within which the CCR surface impoundment is located.
	See Attachment B.
1.8	Size in acres of the watershed within which the CCR surface impoundment is located.
	See Attachment B.
1.9	Check the corresponding box to indicate that you have attached the following:

☑	Description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.
☑	Description of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR surface impoundment.
☑	Describe the method of site preparation and construction of each zone of the CCR surface impoundment.
☑	A listing of the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.
☑	Drawing satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(1)(F).
☑	Description of the type, purpose, and location of existing instrumentation.
☑	Area capacity curves for the CCR Impoundment.
☑	Description of each spillway and diversion design features and capacities and provide the calculations used in their determination.
☑	Construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.

1.10.1	Is there any record or knowledge of structural instability of the CCR surface impoundment?			
	☐	Yes	☑	No
1.10.2	If you answered yes to Item 1.10.1, provide detailed explanation of the structural instability.			

SECTION 2: ANALYSIS OF CHEMICAL CONSTITUENTS (35 Ill. Adm. Code 845.230(d)(2)(B))

Constituents

2.1	Check the corresponding boxes to indicate you have attached the following:

☑	An analysis of the chemical constituents found within the CCR to be placed in the CCR surface impoundment.
☑	An analysis of the chemical constituents of all waste streams, chemical additives and sorbent materials entering or contained in the CCR surface impoundment.

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SECTION 3: DEMONSTRATIONS AND CERTIFICATIONS (35 Ill. Adm. Code 845.230(d)(2)(D))

Demonstrations

3.1 Indicate whether you have attached a demonstration that the CCR surface impoundment, as built, meets, or an explanation of how the CCR surface impoundments fails to meet, the location standards in the following sections:

35 Ill. Adm. Code 845.300 (Placement Above the Uppermost Aquifer)	☐	Demonstration	☑	Explanation
35 Ill. Adm. Code 845.310 (Wetlands)	☑	Demonstration	☐	Explanation
35 Ill. Adm. Code 845.320 (Fault Areas)	☑	Demonstration	☐	Explanation
35 Ill. Adm. Code 845.330 (Seismic Impact Zones)	☑	Demonstration	☐	Explanation
35 Ill. Adm. Code 845.340 (Unstable Areas and Floodplains)	☑	Demonstration	☐	Explanation

SECTION 4: ATTACHMENTS

Attachments

4.1 Check the corresponding boxes to indicate that you have attached the following:

☑	Evidence that the permanent markers required by 35 Ill. Adm. Code 845.130 have been installed.
☑	Documentation that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in 35 Ill. Adm. Code 845.430.
☑	Initial Emergency Action Plan and accompanying certification required by 35 Ill. Adm. Code 845.520(e).
☑	Fugitive dust control plan and accompanying certification required by 35 Ill. Adm. Code 845.500(b)(7).
☐	Preliminary written closure plan as specified in 35 Ill. Adm. Code 845.720(a).
☑	Initial written post-closure care plan as specified in 35 Ill. Adm. Code 845.780(d), if applicable.
☑	A certification as specified in 35 Ill. Adm. Code 845.400(h), or a statement that the CCR surface impoundment does not have a liner than meets the requirements of 35 Ill. Adm. Code 845.400(b) or (c).
☑	History of known exceedances of the groundwater protection standards in 35 Ill. Adm. Code 845.600, and any corrective action taken to remediate the groundwater.
☑	Safety and health plan, as required by 35 Ill. Adm. Code 845.530.
☑	For CCR surface impoundments required to close under 35 Ill. Adm. Code 845.700, the proposed closure priority categorization required by 35 Ill. Adm. Code 845.700(g).

SECTION 5: GROUNDWATER MONITORING

Groundwater

5.1 Check the corresponding boxes to indicate you have attached the following groundwater monitoring information:

☑	A hydrogeologic site characterization meeting the requirements of 35 Ill. Adm. Code 845.620.
☑	Design and construction plans of a groundwater monitoring system meeting the requirements of 35 Ill. Adm. Code 845.630.

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		☑	A groundwater sampling and analysis program that includes section of the statistical procedures to be used for evaluating groundwater monitoring data, required by 35 Ill. Adm. Code 845.640.
		☑	Proposed groundwater monitoring program that includes a minimum of eight independent samples for each background and downgradient well, required by 35 Ill. Adm. Code 845.650(b).
SECTION 6: CERTIFICATIONS			
Certifications	6.1	Check the corresponding boxes to indicate you have attached the following certifications:	
		☑	A certification that the owner or operator meets the financial assurance requirements of Subpart I, as required by 35 Ill. Adm. Code 845.230(d)(2)(N).
		☑	Hazard potential classification assessment and accompanying certifications required by 35 Ill. Adm. Code 845.440(a)(2).
		☑	Structural stability assessment and accompanying certification, required by 35 Ill. Adm. Code 845.450(c).
		☑	Safety factor assessment and accompanying certification, as required by 35 Ill. Adm. Code 845.460(b).
		☑	Inflow design flood control system plan and accompanying certification, as required by 35 Ill. Adm. Code 845.510(c)(3).

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ATTACHMENT A

October 2021

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Land Description of the Duck Creek Power Plant
GMF Pond Facility Boundary
39.42 Acres

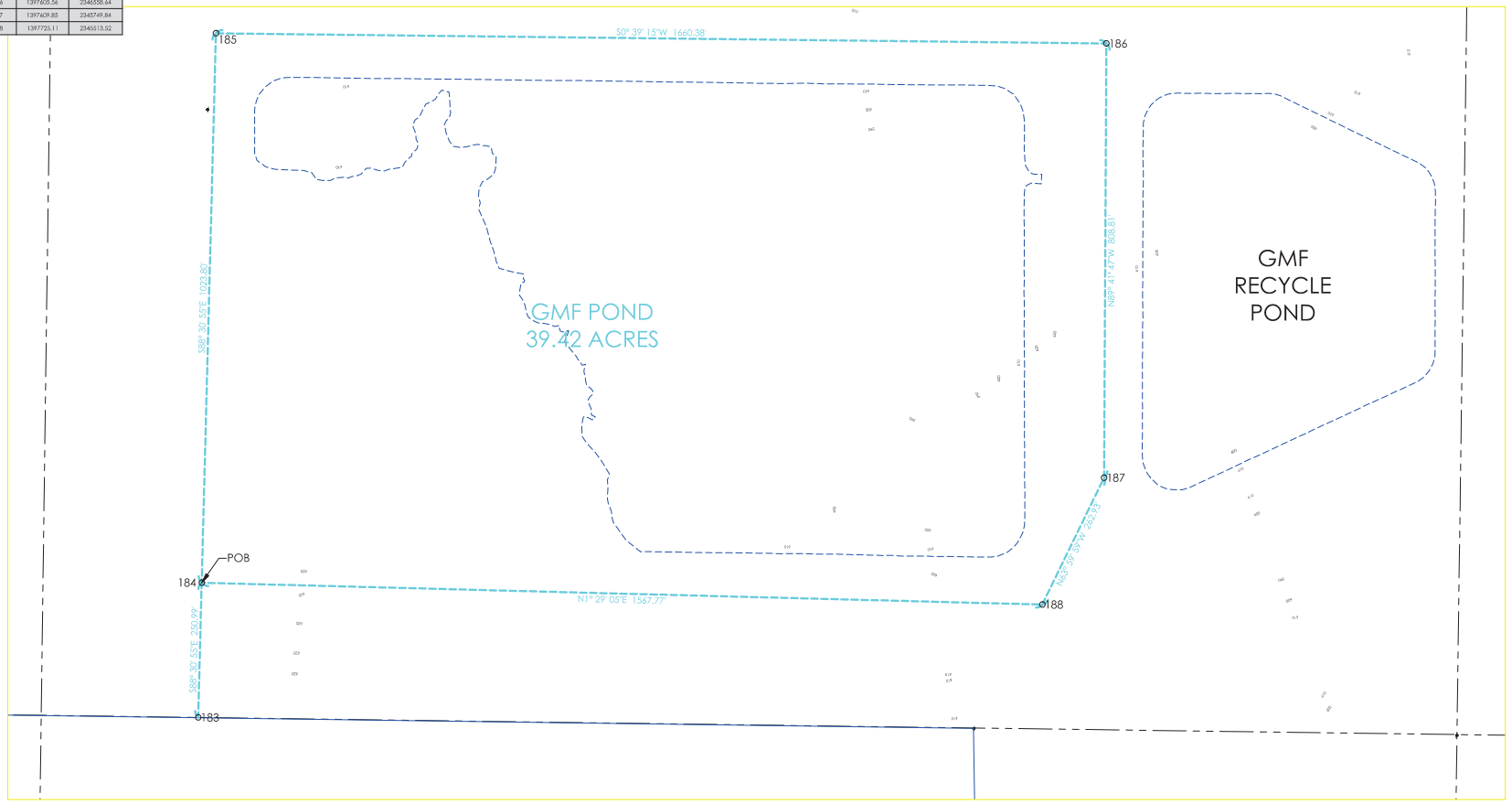
Part of the Northwest Quarter of Section 18, Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County, Illinois and being more particularly described as follows:

Commencing at the Four Way Township Corner Being the same as the Southeast corner of Section 36 T. 6 N., R. 4 E., also being the same as the Southwest corner of Section 31 T. 6 N., R. 5 E. of the Fourth Principal Meridian; thence North 0 degrees 46 minutes 44 seconds East along the Township line dividing T. 6 N., R 4 E. and T. 6 N., R. 5 E. a distance of 20,948.09 feet; thence South 88 degrees 30 minutes 55 seconds East a distance of 250.99 feet to the Point of Beginning of the Tract described herein; thence continuing South 88 degrees 30 minutes 55 seconds East a distance of 1023.8 feet; thence South 0 degrees 39 minutes 15 seconds west, a distance of 1660.38 feet; thence North 89 degrees 41 minutes 47 seconds West a distance of 808.81 feet; thence North 63 degrees 59 minutes 59 seconds West, a distance of 262.93 feet; thence North 01 degrees 29 minutes 05 seconds East a distance of 1567.77 feet to the Point of Beginning and containing 39.42 Acres.

FACILITY CORNER COORDINATES		
Point #	Northing	Easting
183	1399298.86	2345303.24
184	1399292.36	2345554.14
185	1399265.83	2346577.60
186	1397605.56	2346558.64
187	1397609.85	2345749.84
188	1397725.11	2345513.52

Luminant

ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT



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Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

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Drawing Name:
GMF POND
BOUNDARY
EXHIBIT

Date:	Project No.
9/21/2021	
Type: SITE	Drawing No. 3
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

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Land Description of the Duck Creek Power Plant
GMF Pond Facility Boundary
39.42 Acres

Part of the Northwest Quarter of Section 18, Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County, Illinois and being more particularly described as follows:

Commencing at the Four Way Township Corner Being the same as the Southeast corner of Section 36 T. 6 N., R. 4 E., also being the same as the Southwest corner of Section 31 T. 6 N., R. 5 E. of the Fourth Principal Meridian; thence North 0 degrees 46 minutes 44 seconds East along the Township line dividing T. 6 N., R 4 E. and T. 6 N., R. 5 E. a distance of 20,948.09 feet; thence South 88 degrees 30 minutes 55 seconds East a distance of 250.99 feet to the Point of Beginning of the Tract described herein; thence continuing South 88 degrees 30 minutes 55 seconds East a distance of 1023.8 feet; thence South 0 degrees 39 minutes 15 seconds west, a distance of 1660.38 feet; thence North 89 degrees 41 minutes 47 seconds West a distance of 808.81 feet; thence North 63 degrees 59 minutes 59 seconds West, a distance of 262.93 feet; thence North 01 degrees 29 minutes 05 seconds East a distance of 1567.77 feet to the Point of Beginning and containing 39.42 Acres.

FACILITY CORNER COORDINATES		
Point #	Northing	Easting
183	1399298.86	2345303.24
184	1399292.36	2345554.14
185	1399265.83	2346577.60
186	1397605.56	2346558.64
187	1397609.85	2345749.84
188	1397725.11	2345513.52

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ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT

0' 100' 200'

LEGEND
- SECTION LINE
- RESTRICTED USE BOUNDARY
- APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE
- FACILITY BOUNDARY
- N0° 47' 10"E 3100.48' RECORD BOUNDARY DIMENSIONS
- FOUND SURVEY MARKER AS NOTED
- M DENOTES MEASURED DIMENSION

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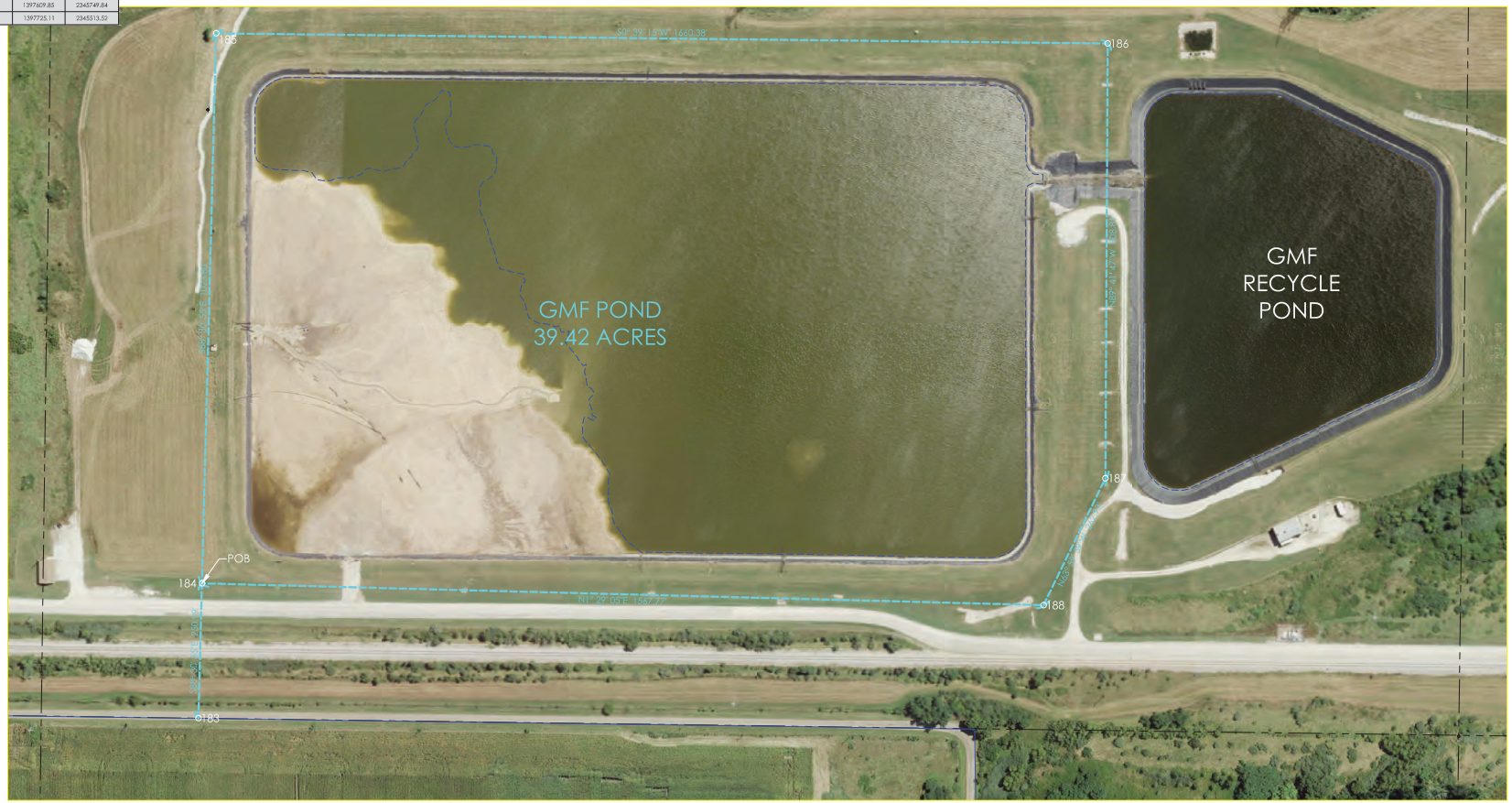

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Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

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Drawing Name:
GMF POND BOUNDARY EXHIBIT

Date:	Project No.
9/21/2021	
Type: SITE	Drawing No. 4
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

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ATTACHMENT B

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AECOM

October 2016

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, IL 61520

RE: History of Construction
USEPA Final CCR Rule, 40 CFR § 257.73(c)
Duck Creek Power Station
Canton, Illinois

On behalf of Illinois Power Resources Generating, LLC, AECOM has prepared the following history of construction for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the Duck Creek Power Station in accordance with 40 CFR § 257.73(c). The Bottom Ash Basin is an incised pond with a storage volume of less than 20 acre-feet. A history of construction is not required for the Bottom Ash Basin as specified in § 257.73(b).

BACKGROUND

40 CFR § 257.73(c)(1) requires the owner or operator of an existing coal combustion residual (CCR) surface impoundment that either (1) has a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) has a height of 20 feet or more to compile a history of construction by October 17, 2016 that contains, to the extent feasible, the information specified in 40 CFR § 257.73(c)(1)(i)–(xii).

The history of construction presented herein was compiled based on existing documentation, as reasonably and readily available (see 80 Fed. Reg. 21302, 21380 [April 17, 2015]), AECOM's site experience, and discussion with plant engineers. AECOM's document review included construction drawings, geotechnical investigations, observation reports, etc. for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the Duck Creek Power Station.

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HISTORY OF CONSTRUCTION

§ 257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

Owner: Illinois Power Resources Generating, LLC

Address: 1500 Eastport Plaza Drive
Collinsville, IL 62234

CCR Units: Ash Pond No. 1
Ash Pond No. 2, IDNR Dam ID No. IL50014
GMF Pond, IDNR Dam ID No. IL50573

Ash Pond No. 1 does not have a state assigned identification number.

§ 257.73(c)(1)(ii): The location of the CCR unit identified on the most recent USGS $7^1/_2$ or 15 minute topographic quadrangle map or a topographic map of equivalent scale if a USGS map is not available.

The locations of the Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond have been identified on an USGS 7-1/2 minute topographic quadrangle map in **Appendix A**.

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

The following captures the purpose of each CCR unit:

- The Ash Pond No. 1 (inactive) was used to store and dispose of fly ash and bottom ash.
- The Ash Pond No. 2 (inactive) was used to store and dispose of fly ash and bottom ash and to clarify CCR contact stormwater prior to discharge in accordance with the station's Water Pollution Control Permit (#2015-EO-59369).
- The GMF Pond is being used to store and dispose of gypsum and to clarify recycled process water for plant operations.

Notice of intent to close Ash Pond No. 1 and Ash Pond No. 2 was provided in November, 2015.[1]

[1] This history of construction report was prepared on a facility-wide basis for CCR surface impoundments at the Duck Creek Power Station. The inclusion of Ash Pond No. 1 and Ash Pond No. 2 in this history of construction report does not concede and should not be construed to concede that Ash Pond No. 1 and Ash Pond No. 2 are subject to the Design Criteria or all Operating Criteria in the CCR Rule.

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§ 257.73(c)(1)(iv): The name and size in acres of the watershed where the CCR unit is located.

Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are located at the western edge of the Rice Lake-Illinois River Watershed with a 12-digit Hydrologic Unit Code (HUC) of 071300030603 and a drainage area of 21,203 acres (USGS, 2016).

§ 257.73(c)(1)(v): A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

Physical properties of the foundation materials for Ash Pond No. 1 and Ash Pond No. 2 are primarily strip-mine spoils with variable thickness overlying shale bedrock. The mine spoils consist of a mixtures of native loess and glacial till and, to a lesser extent, the underlying (primarily shale) bedrock. The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

Physical properties of the foundation materials for the GMF Pond are (from top to bottom) native loess, glacial till, and bedrock (primarily shale). The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

An available summary of foundation material engineering properties for Ash Pond No.1, Ash Pond No. 2, and the GMF Pond is presented in **Table 1** below. The foundation material engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 1. Summary of Foundation Material Engineering Properties

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Loess	116	100	32	1,250	0
Glacial Till	125	200	30	1,900	0
Mine Spoils	120	100	30	250	15
Shale Bedrock	130	300	26	600	13

Ash Pond No.1, Ash Pond No. 2, and the GMF Pond are enclosed impoundments with embankments and do not have abutments.

§ 257.73(c)(1)(vi): A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

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The embankments of the Ash Pond No. 1 and Ash Pond No. 2 were constructed with mine spoils excavated from within the center of the existing pond footprints. The mine spoils consist of a mixtures of native loess and glacial till and, to a lesser extent, the underlying (primarily shale) bedrock. The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

The embankments of the GMF Pond generally consists of silty, low plastic clay and generally had a stiff to very stiff consistency and appeared to be well-compacted material. The liner system within the GMF Pond consists of (from top to bottom) a 60-mil textured high density polyethylene (HDPE) geomembrane, 1-foot-thick layer of “cushion dirt”, 4-ounce geotechnical filter fabric, 1-foot-thick drainage layer, 10-ounce geotextile cushion, 60-mil textured HDPE geomembrane, a Bentomat SDN reinforced geosynthetic clay liner (GCL), and 3-foot-thick layer of compacted clay. A typical cross section profile of the liner system is shown on drawing C180-C102-8 presented in **Appendix B**.

An available summary of construction material engineering properties is presented in **Table 2** below. The construction material engineering properties are based on previous geotechnical investigations and laboratory testing.

Table 2. Summary of Construction Material Engineering Properties

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c’ (psf)	Φ’ (°)	c (psf)	Φ (°)
Liner-Cushion Material	116	0	38	660	0
Liner-Granular Drainage Layer	120	0	33	0	33
Liner-Geotextile /Geomembrane	75	100	25	100	25
Embankment Fill	116	150	32	2,150	0

The methods used for preparation and construction of Ash Pond No. 1 and Ash Pond No. 2 are not reasonably and readily available.

The site preparation work for the GMF Pond included stripping and stockpiling the topsoil. The subsoil was then excavated to approximately 5.4 feet above the proposed foundation grade and stockpiled. Temporary and permanent erosion control measures were also installed. The site was later excavated to the proposed subgrade and proof rolled to inspect for unsuitable soils. Any unsuitable soils were either removed or reworked. A sheepsfoot roller was used to compact suitable backfill material placed in 8-inch lifts. Compaction testing was performed using a nuclear density gauge at a minimum rate of one test per 10,000 cubic yards (minimum one test per lift). Backfill was compacted to at least 95% of standard proctor maximum dry density and with a moisture content of -2% to +2% of optimum. Embankment

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construction was performed using similar compacting and testing techniques as for the subgrade preparation.

Prior to constructing the clay liner for the GMF Pond, two test pad liners were constructed using separate borrow material. Testing of both liners indicated that the construction practice and material used were acceptable. The full scale clay liner was constructed with fill placed in 8-inch lifts and compacted with a sheepsfoot roller. Placed fill was compacted to at least 95% of standard proctor maximum dry density and with a moisture content of optimum to +5%. Compaction testing was performed using a nuclear density gauge at a minimum rate of one test per 1,000 cubic yards (minimum one test per lift). After the minimum clay liner thickness was achieved, the surface was smooth rolled in preparation of the GCL. The GCL and lower geomembrane were then placed sequentially followed by the 10-ounce geotextile cushion. A leak detection/leachate collection and recovery system (LD/LCRS) was then installed which includes a 1-foot-thick sand drainage layer and collection pipes. The sand was graded to minimum thickness using a dozer. The LD/LCRS was completed by placing a 4-ounce geotechnical filter fabric on top of the sand. A 1-foot-thick “cushion dirt” layer was then placed using a dozer to spread general fill. The liner was completed by placing the upper geomembrane on top.

The approximate dates of each successive event stage of construction of Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are provided in **Table 3** below.

Table 3. Approximate dates of construction of each successive stage of construction.

Date	Event
1976	Ash Pond No. 1 was commissioned
1986	Ash Pond No. 2 was commissioned
2007	Surface preparation for GMF Pond began
2008-2009	Construction of GMF Pond

§ 257.73(c)(1)(vii): At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

Drawings that contain items pertaining to the requested information for Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are listed in **Table 4** below. Items marked as "Not Available" are items not found during review of reasonably and readily available record documentation

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Table 4. List of drawings containing items pertaining to the information requested in § 257.73(c)(1)(vii).

	Ash Pond No. 1	Ash Pond No. 2	GMF Pond
Dimensional plan view (all zones)	C180-G1916-3	C180-G1916-4, C180-G1916-6	C180-C102-8 thru -11
Dimensional cross sections	C180-G1916-3	C180-G1916-7	C180-C102-12 thru -14
Foundation Improvements	C180-G1916-3	C180-G1916-7	Not Applicable
Drainage Provisions	Not Applicable	C180-G1916-9 thru -11, M-1001	C180-C102-12 thru -14 C180-C102-30 thru -31
Spillways and Outlets	C180-G1916-3	C180-G1916-8	C180-C102-15, C180-C102-29
Diversion Ditches	Not Applicable	Not Applicable	Not Applicable
Instrument Locations	Figure in Appendix C, Plate 2	Figure in Appendix C, Plate 2	Not Applicable
Slope Protection	C180-G1916-3	Not Available	C180-C102-12
Normal Operating Pool Elevation	Not Available	Not Available	Not Available
Maximum Pool Elevation	C180-G1916	C180-G1916-7	Not Available
Approximate Maximum Depth of CCR in 2016	68 feet	59 feet	25 feet

All drawings referenced in the table above can be found in **Appendix B** and **Appendix C**.

Based on the review of the drawings listed above, no natural or manmade features that could adversely affect operation of these CCR units due to malfunction or mis-operation were identified.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Existing instrumentation at Ash Pond No. 1 and Ash Pond No. 2 consists of open-standpipe piezometers. The purpose of the piezometers is to measure the pore water pressures within and around the CCR units. Two (2) piezometers (B-2 and B-5) were installed in 2010 and the locations are presented on Plate 2 in **Appendix C**. Five (5) additional piezometers were installed in 2010 and the locations are presented in **Appendix C**.

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The GMF Pond does not contain existing instrumentation used for monitoring the operation of the CCR unit.

§ 257.73(c)(1)(ix): Area-capacity curves for the CCR unit.

Area-capacity curves for the Ash Pond No. 1 and Ash Pond No. 2 are not reasonably and readily available. The area-capacity curve for the GMF Pond is presented in **Figure 1** below. "Area-capacity curves", as defined by 40 CFR § 257.53, "means graphic curves which readily show the reservoir water surface area, in acres, at different elevations from the bottom of the reservoir to the maximum water surface, and the capacity or volume, in acre-feet, of the water contained in the reservoir at various elevations."

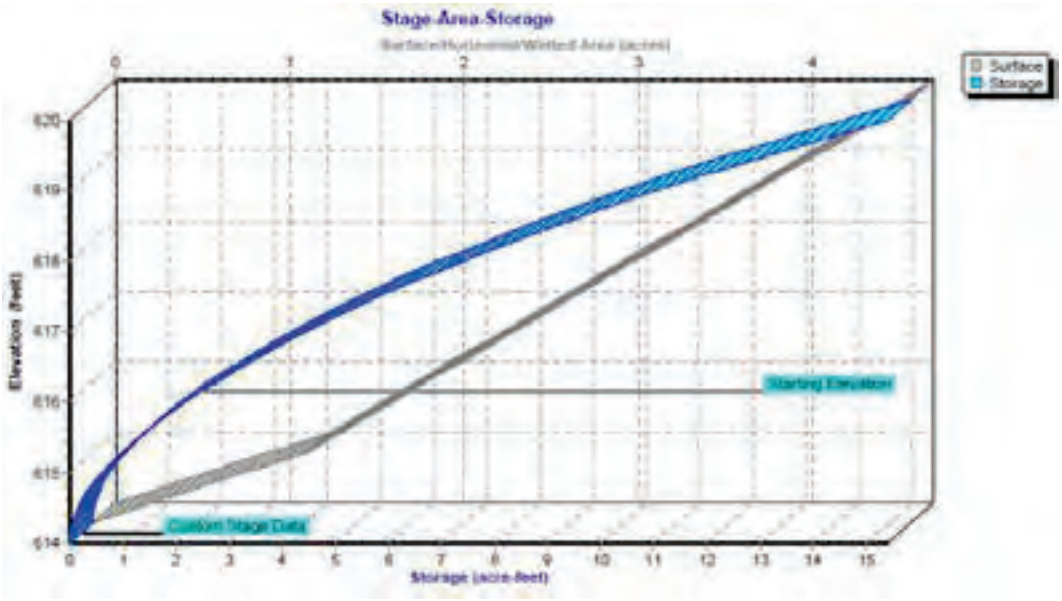

Figure 1. Area-capacity curve for GMF Pond prepared in 2016

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

Ash Pond No. 1 does not contain an active spillway or diversion feature. Stormwater collected in Ash Pond No. 1 is manually pumped to Ash Pond No. 2 at the judgement of plant personnel. Current discharge capacity and calculation information for Ash Pond No. 1 is not reasonably and readily available.

Stormwater collected in Ash Pond No. 2 is drained via a 36-inch diameter (dia.) steel morning glory spillway, formed by 2-foot tall stacked sections, located in the northeast corner of the pond. The spillway transitions to a 36-inch dia. reinforced concrete pipe (RCP) and drains towards the return water pumphouse and discharges in accordance with the station's Water Pollution Control Permit. Current discharge capacity and calculation information for Ash Pond No. 2 is not reasonably and readily available.

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The GMF Pond contains a transfer channel that discharges clear water into the GMF Recycle Pond. The transfer channel is trapezoidal in shape with 3H:1V side slopes. The channel transitions from a 16-foot bottom width at an invert elevation of 616 feet at the upstream end to a 35-foot bottom width at an invert elevation of 609 feet at the downstream end. In 2016 the discharge capacity of the GMF Pond was evaluated using HydroCAD 8.50 software modeling a 1,000-year, 24-hour rainfall event. The results of the HydroCAD 8.50 analysis are presented below in **Table 5**.

Table 5. Results of HydroCAD 8.50 analyses

	GMF Pond
Approximate Minimum Berm Elevation[1] (ft)	620.0
Approximate Emergency Spillway Elevation[1] (ft)	616.0
Starting Pool Elevation[1] (ft)	616.0
Peak Elevation[1] (ft)	618.3
Time to Peak (hr)	12.0
Surface Area (ac)	3.5
Storage[2] (ac-ft)	8.3

Notes: 1. Elevations are based on NAVD88 datum.
2. Storage given is from Starting Pool Elevation to Peak Elevation

§ 257.73(c)(1)(xi): The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

The construction specification for Ash Pond No. 1 is located in Technical Specification Section 21, however the construction specification is not reasonably and readily available. The construction specification for the Ash Pond No. 2 is not reasonably and readily available. The construction specification for the GMF Pond is located in *Project Manual; Specification No's.: C180-C102* (presented in **Appendix D**).

The provisions for surveillance, general maintenance, and repair of the GMF Pond are presented in **Appendix E**.

The operations and maintenance plans for Ash Pond No. 1, Ash Pond No. 2, and GMF Pond are currently either being generated or being revised by Illinois Power Resources Generating,

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LLC. This section will be updated when the new operations and maintenance plans are available.

§ 257.73(c)(1)(xii): Any record or knowledge of structural instability of the CCR unit.

There is no record or knowledge of structural instability of Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond at Duck Creek Power Station.

LIMITATIONS

The signature of AECOM's authorized representative on this document represents that to the best of AECOM's knowledge, information and belief in the exercise of its professional judgment, it is AECOM's professional opinion that the aforementioned information is accurate as of the date of such signature. Any recommendation, opinion or decisions by AECOM are made on the basis of AECOM's experience, qualifications and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data and that actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

Sincerely,

Claudia Prado
Project Manager

Victor Modeer, P.E., D.GE
Senior Project Manager

REFERENCES

United States Environmental Protection Agency (USEPA). (2015). *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.* 40 CFR Parts 257 and 261, 80 Fed. Reg. 21302, 21380 April 17, 2015.

United States Geological Survey (USGS). (2016). The National Map Viewer. http://viewer.nationalmap.gov/viewer/. USGS data first accessed in March of 2016.

APPENDICES

Appendix A: History of Construction Vicinity Map
Appendix B: Duck Creek Power Station Drawings
Appendix C: Duck Creek Power Station Boring and Piezometer Locations
Appendix D: Project Manual; Specification No's.: C180-C102 (excerpt)
Appendix E: Operation and Maintenance Manual, Duck Creek Energy Center, Gypsum Management Facility

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Appendix A: History of Construction Vicinity Map

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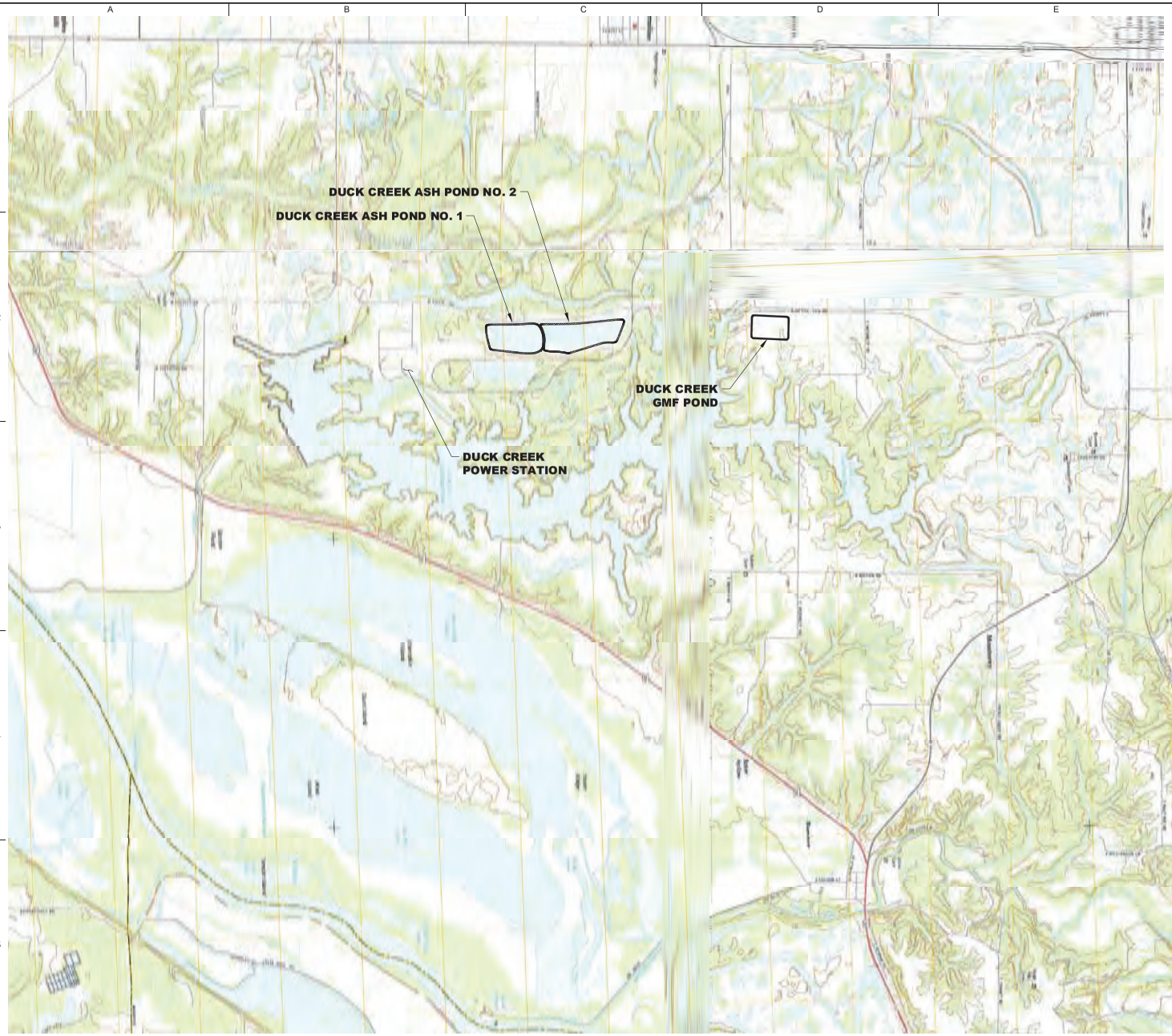

LEGEND

CCR UNITS

SOURCE:
MAP PROVIDED FROM ELECTRONIC USGS DIGITAL RASTER GRAPHIC 7.5 MINUTE TOPOGRAPHIC MAP OF SAINT DAVID ILLINOIS, DUCK CREEK ISLAND ILLINOIS, CANTON ILLINOIS AND BANNOR ILLINOIS, REVISED 2015.



QUADRANGLE LOCATION

N

0 2000 4000 6000

SCALE IN FEET

AECOM
1001 Highlands Plaza Drive, Suite 300
St. Louis, Mo. 63110
314 429-0100 (phone)
314-429-0462 (fax)

ILLINOIS POWER RESOURCES GENERATING, LLC
17751 North CILCO Rd.,
Canton, IL 61520

HISTORY OF CONSTRUCTION

DUCK CREEK
POWER STATION
CANTON, ILLINOIS

ISSUED FOR BIDDING	DATE	BY
ISSUED FOR CONSTRUCTION	DATE	BY

REVISIONS

NO.	DESCRIPTION	DATE
1		
2		
3		
4		
5		

AECOM PROJECT NO:	60489731
DRAWN BY:	DJD
DESIGNED BY:	DJD
CHECKED BY:	MN
DATE CREATED:	2016-04-13
PLOT DATE:	
SCALE:	1" = 2000'
ACAD VER:	2014

SHEET TITLE

HISTORY OF CONSTRUCTION VICINITY MAP

01

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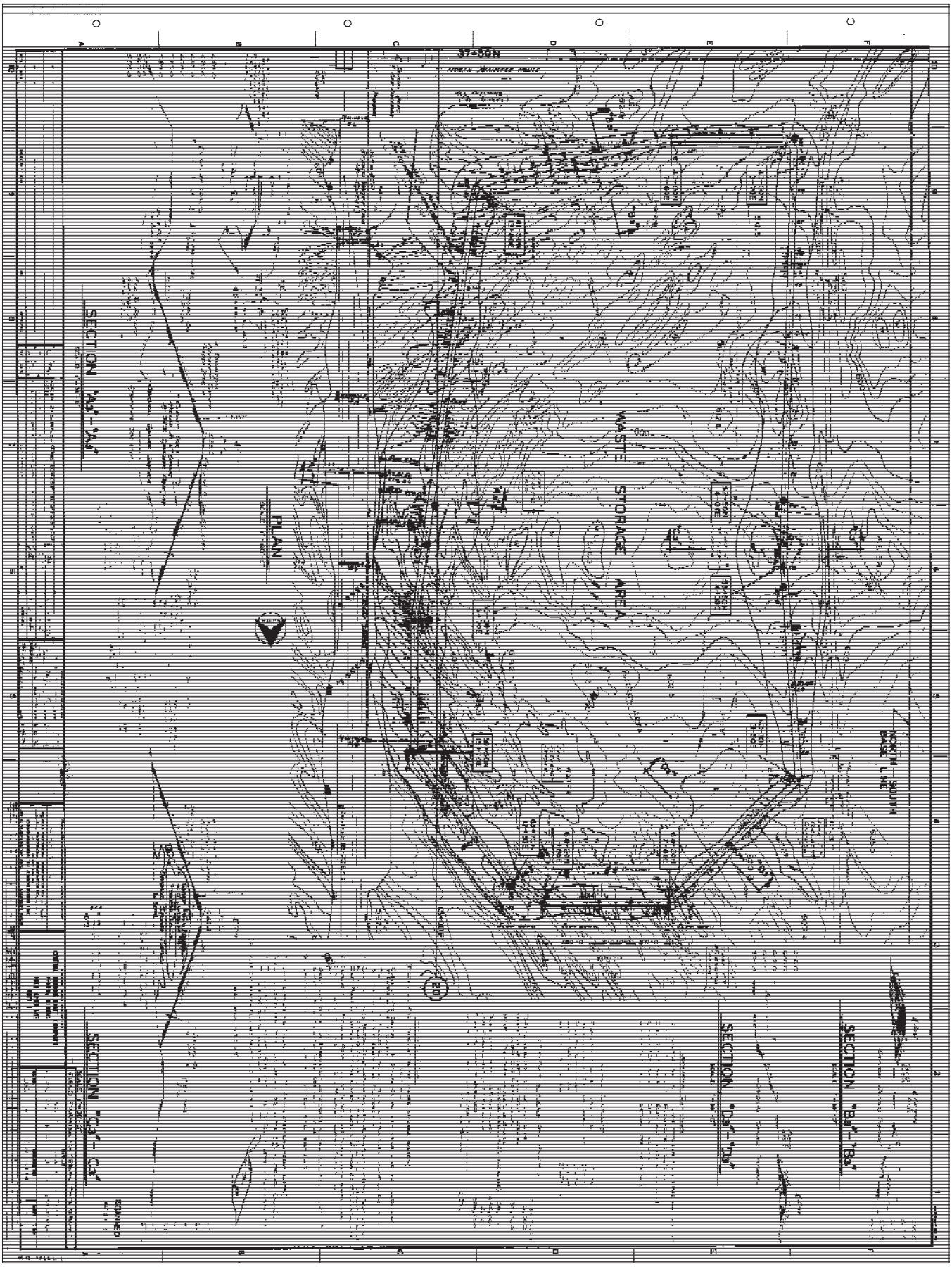
Appendix B: Duck Creek Power Station Drawings

1. “Waste Storage System, Plan and Details of Dike Embankment”, Drawing No. C180-G1916-3, Revision D, 13 February, 1975, Commonwealth Associates Inc.
2. “Waste Disposal System, Site Plan”, Drawing No. C180-G1916-4, Revision C, 16 October, 1984, Commonwealth Associates Inc.
3. “Waste Disposal Area II, Site Plan”, Drawing No. C180-G1916-6, Revision G, 16 October, 1984, Commonwealth Associates Inc.
4. “Waste Disposal System, Dike Sections and Details”, Drawing No. C180-G1916-7, Revision D, 16 October, 1984, Commonwealth Associates Inc.
5. “Waste Disposal System, Inlet and Outlet Details”, Drawing No. C180-G1916-8, Revision E, 16 October, 1984, Commonwealth Associates Inc.
6. “Waste Disposal Area II, Outlet Pipe Plan & Profile”, Drawing No. C180-G1916-9, Revision E, 11 October, 1984, Commonwealth Associates Inc.
7. “Waste Disposal System, Pipe Profile and Details”, Drawing No. C180-G1916-10, Revision E, 10 October, 1984, Commonwealth Associates Inc.
8. “Waste Disposal System, Miscellaneous Details”, Drawing No. C180-G1916-11, Revision E, 10 October, 1984, Commonwealth Associates Inc.
9. “Pipe Plan & Profile, Recycle Pond Bypass”, Drawing No. M-1001, Revision 0, 30 July, 2004, Sargent & Lundy LLC.
10. “Gypsum Stack – Foundation Grade”, Drawing No. C180-C102-8, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
11. “Gypsum Stack – Clay Layer Grade”, Drawing No. C180-C102-9, Revision 4, 5 March, 2009, Hanson Professional Services, Inc.
12. “Gypsum Stack – LD/LCRS Drainage Layer Grade”, Drawing No. C180-C102-10, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
13. “PWRS-Ring Drain System Cushion Dirt Layer Grade”, Drawing No. C180-C102-11, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
14. “PWRS-Ring Drain Details”, Drawing No. C180-C102-12, Revision 5, 5 March, 2009, Hanson Professional Services, Inc.
15. “PWRS-Ring Drain Details”, Drawing No. C180-C102-13, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
16. “LD/LCRS Sections & Details”, Drawing No. C180-C102-14, Revision 3, 5 March, 2009, Hanson Professional Services, Inc.
17. “Recycle Pond Plan”, Drawing No. C180-C102-15, Revision 5, 5 March, 2009, Hanson Professional Services, Inc.
18. “Miscellaneous Details”, Drawing No. C180-C102-29, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
19. “LD/LCRS Underdrain Dewatering System-Seep 1”, Drawing No. C180-C102-30, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
20. “LD/LCRS Underdrain Dewatering System-Seep 2”, Drawing No. C180-C102-31, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.

Electronic Filing: Received, Clerk's Office 06/20/2024



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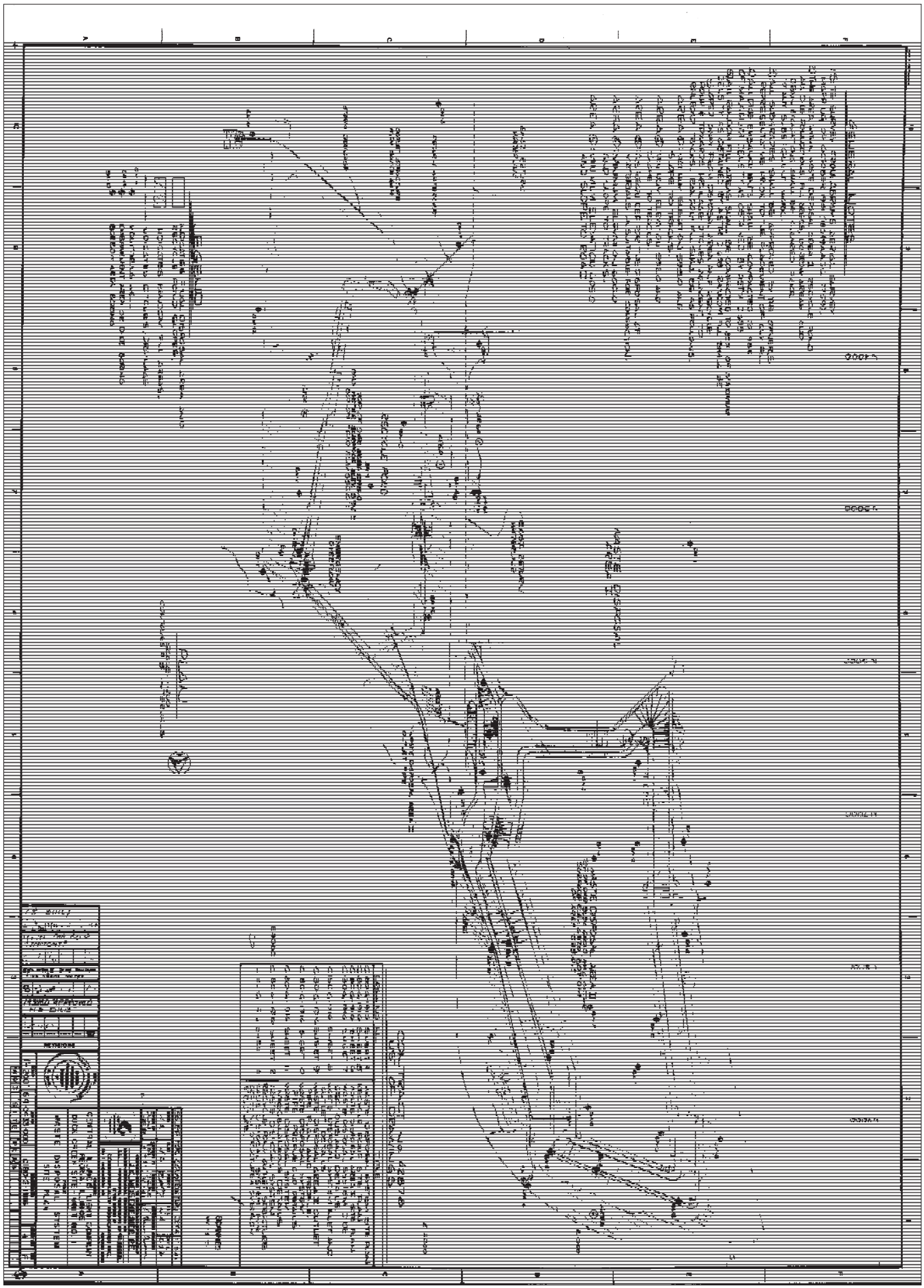

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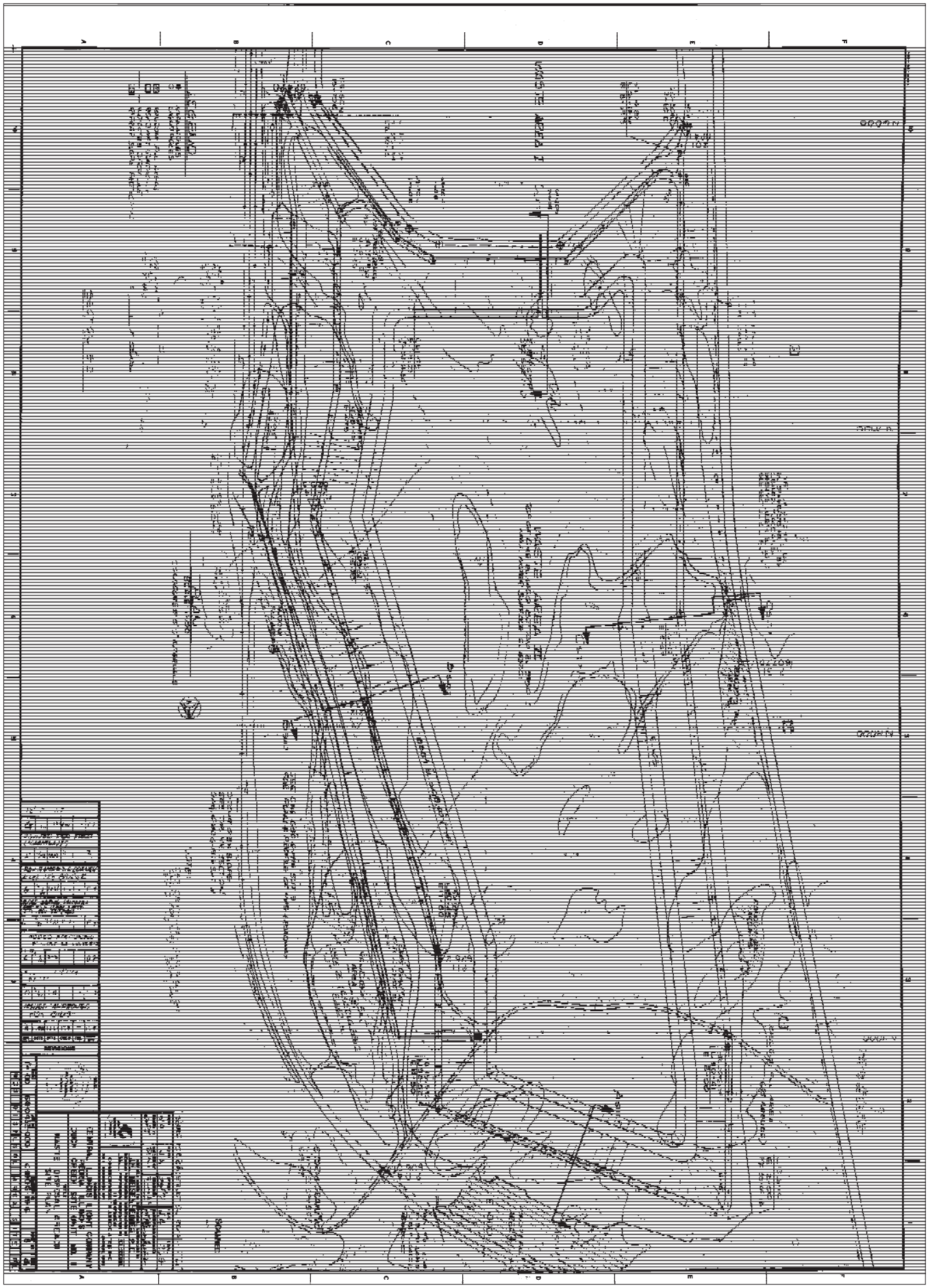

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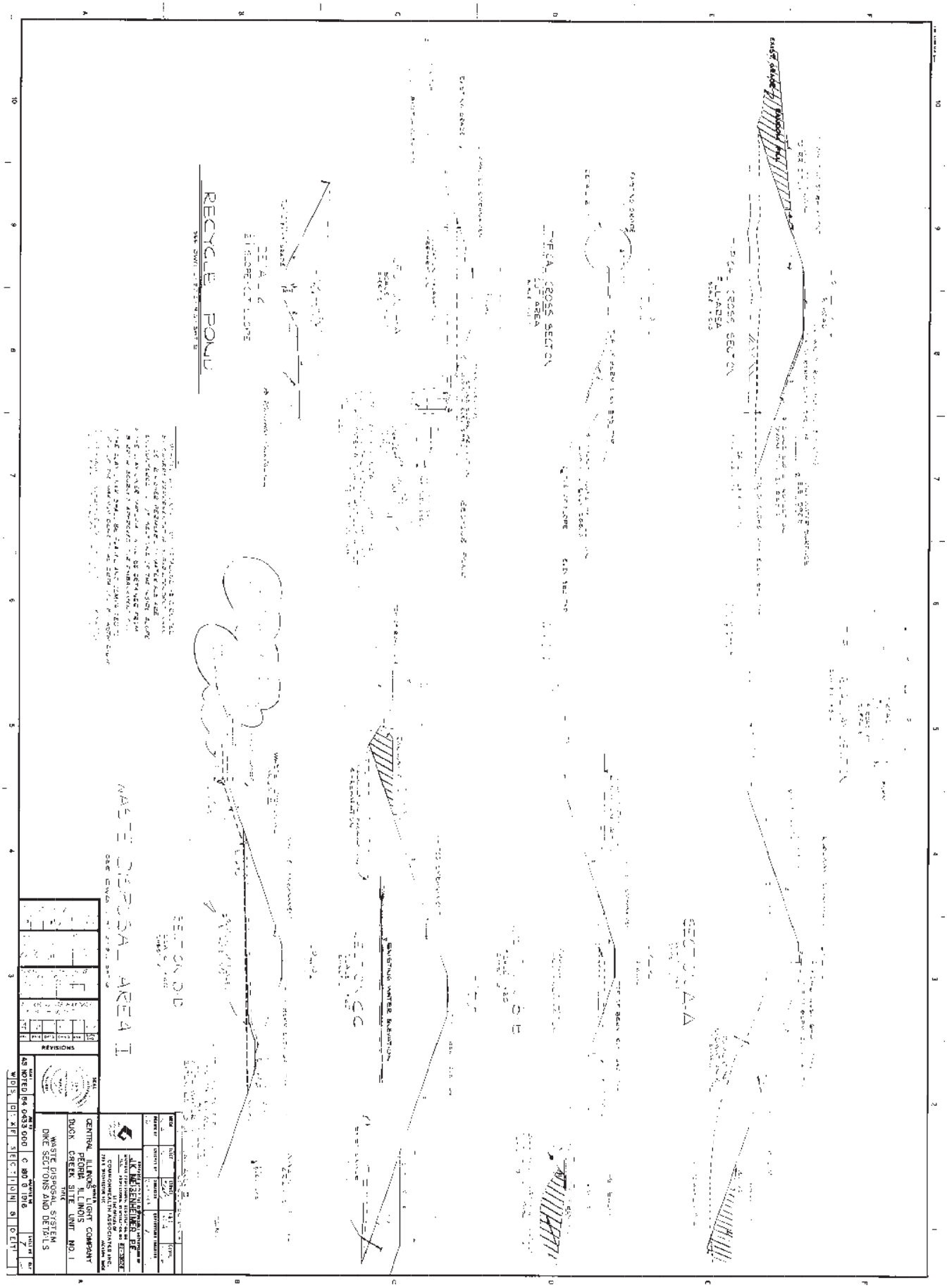

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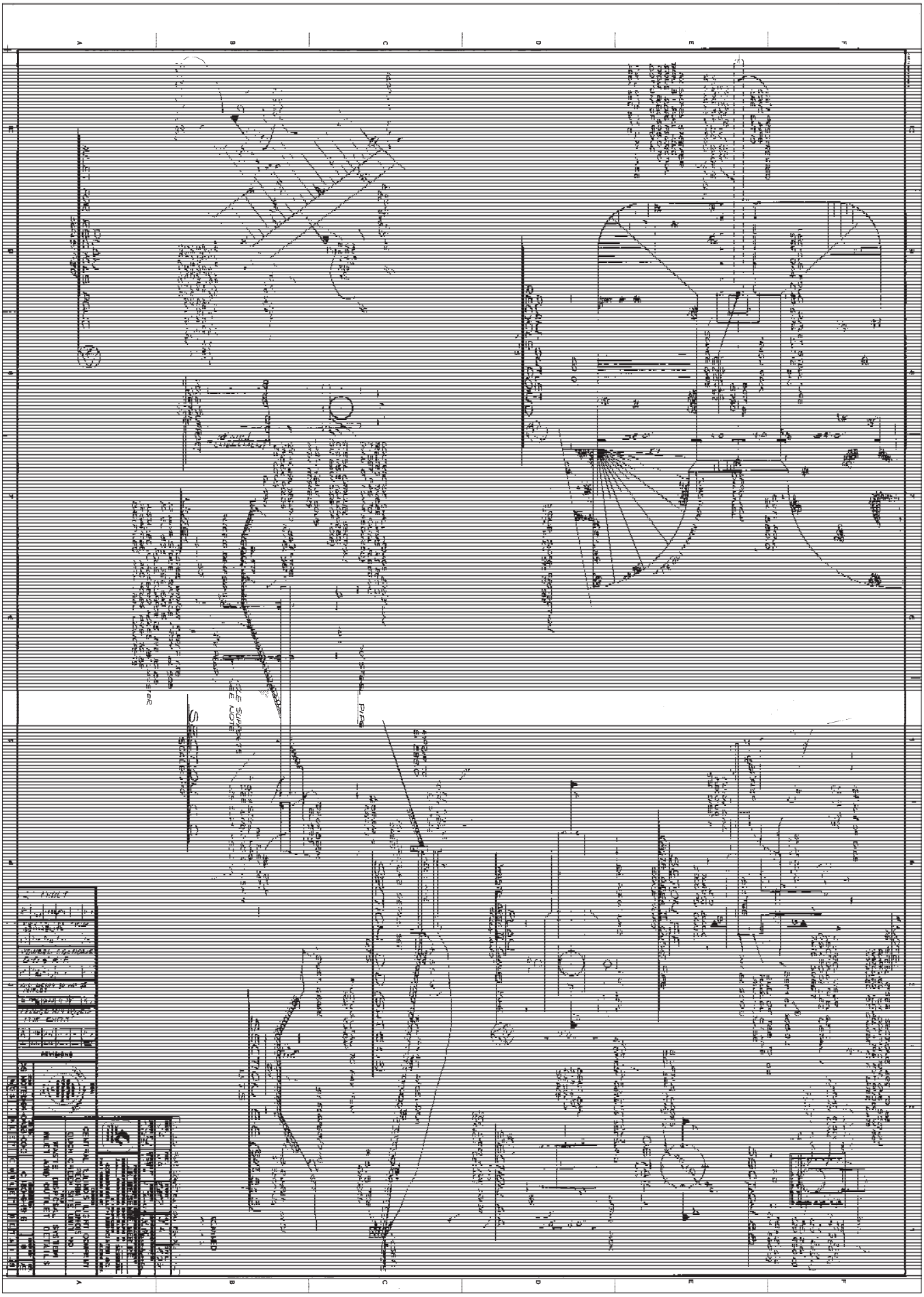

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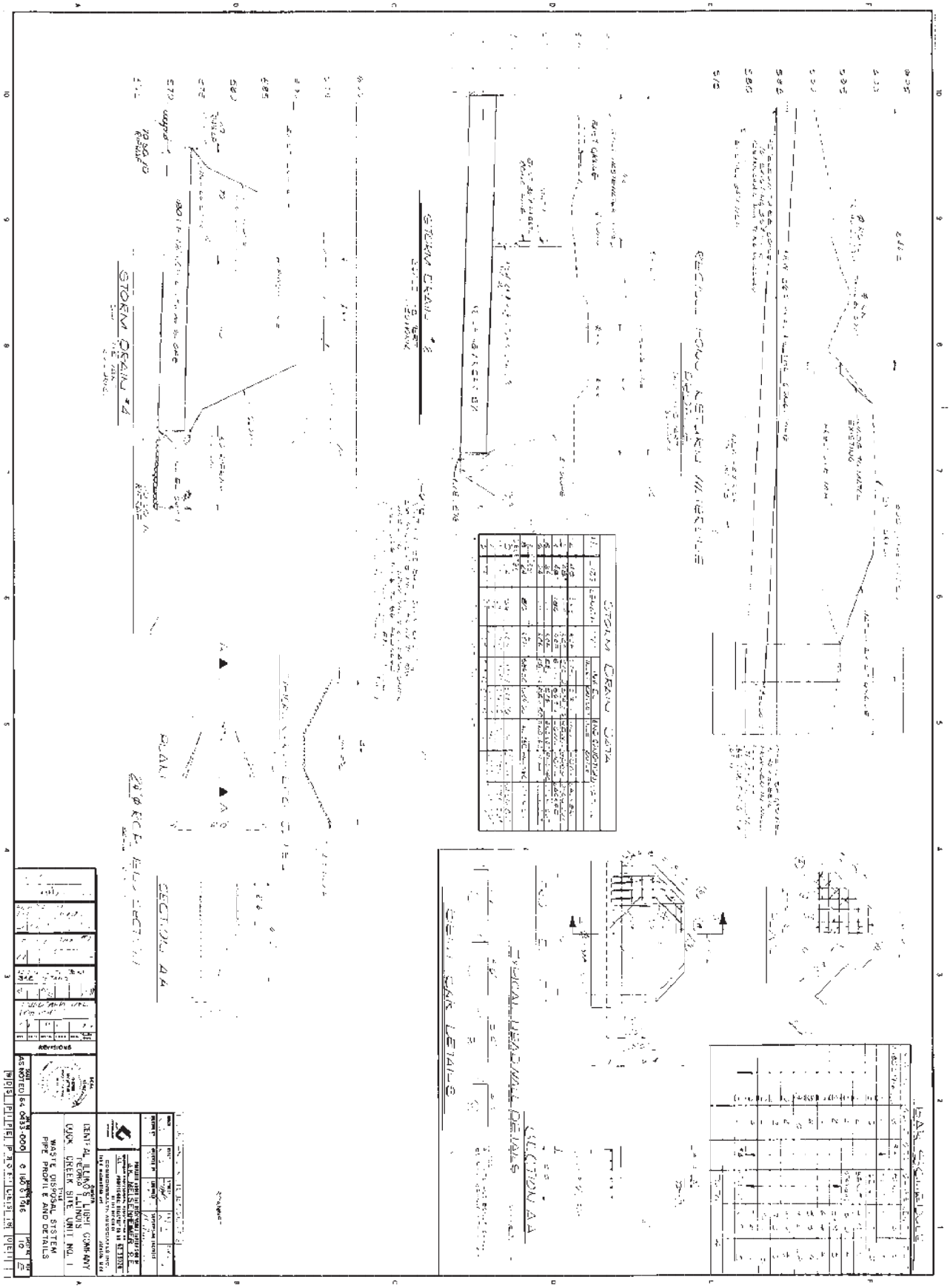

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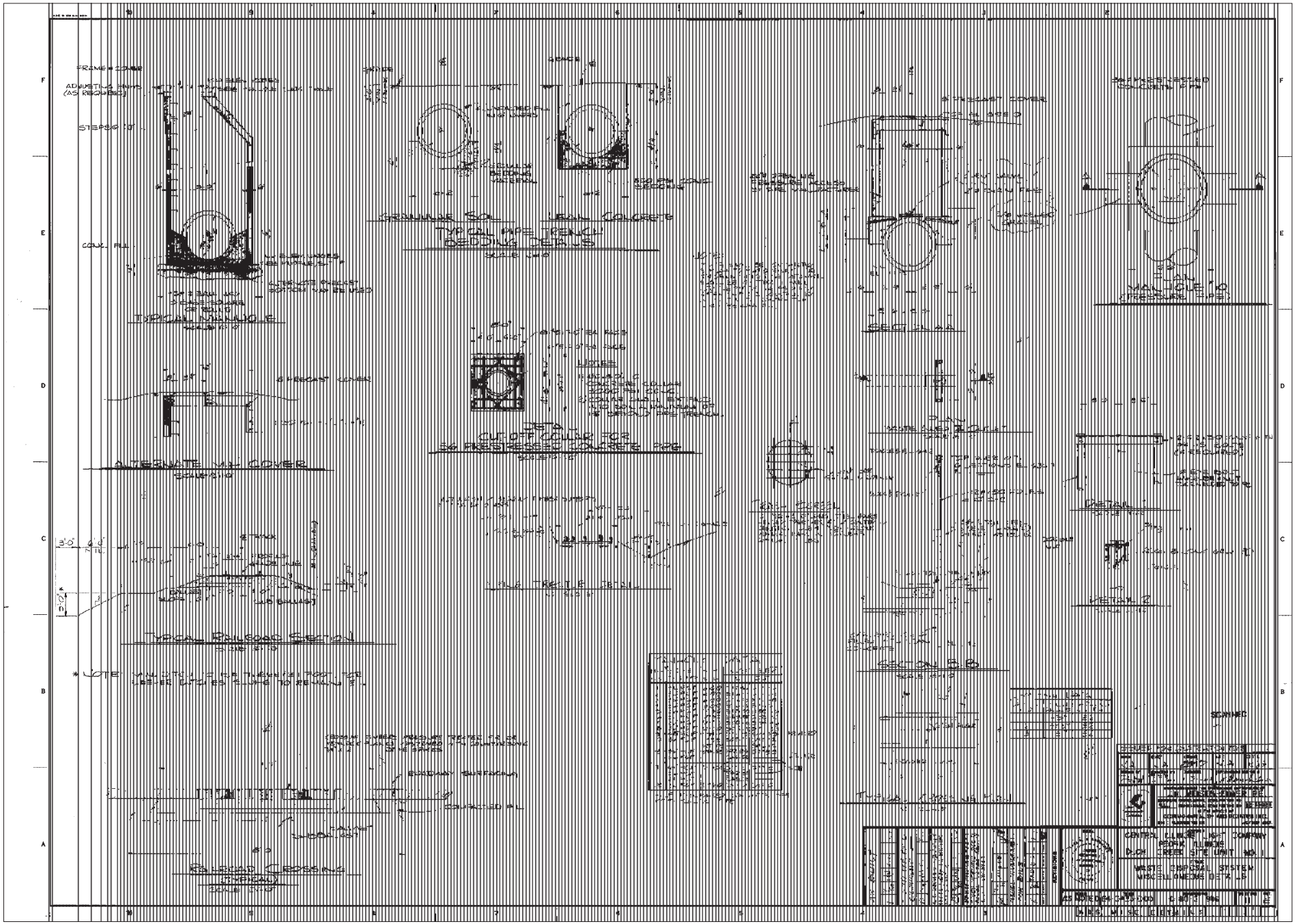

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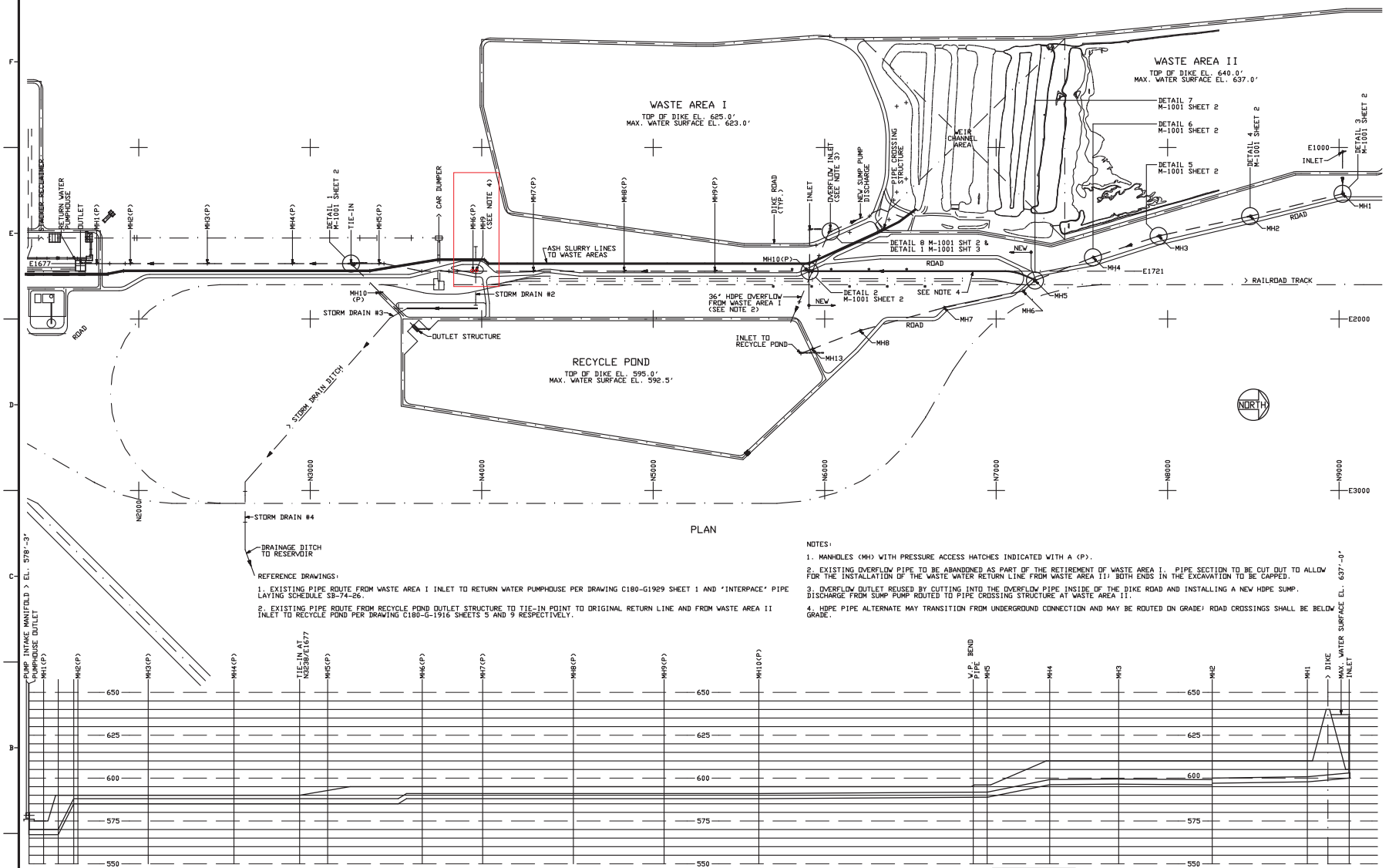

REFERENCE DRAWINGS:

1. EXISTING PIPE ROUTE FROM WASTE AREA I INLET TO RETURN WATER PUMPHOUSE PER DRAWING C180-G1929 SHEET 1 AND 'INTERPACE' PIPE LAYING SCHEDULE SB-74-26.

2. EXISTING PIPE ROUTE FROM RECYCLE POND OUTLET STRUCTURE TO TIE-IN POINT TO ORIGINAL RETURN LINE AND FROM WASTE AREA II INLET TO RECYCLE POND PER DRAWING C180-G-1916 SHEETS 5 AND 9 RESPECTIVELY.

NOTES:

1. MANHOLES (MH) WITH PRESSURE ACCESS HATCHES INDICATED WITH A (P).

2. EXISTING OVERFLOW PIPE TO BE ABANDONED AS PART OF THE RETIREMENT OF WASTE AREA I. PIPE SECTION TO BE CUT OUT TO ALLOW FOR THE INSTALLATION OF THE WASTE WATER RETURN LINE FROM WASTE AREA II; BOTH ENDS IN THE EXCAVATION TO BE CAPPED.

3. OVERFLOW OUTLET REUSED BY CUTTING INTO THE OVERFLOW PIPE INSIDE OF THE DIKE ROAD AND INSTALLING A NEW HDPE SUMP. DISCHARGE FROM SUMP PUMP ROUTED TO PIPE CROSSING STRUCTURE AT WASTE AREA II.

4. HDPE PIPE ALTERNATE MAY TRANSITION FROM UNDERGROUND CONNECTION AND MAY BE ROUTED ON GRADE; ROAD CROSSINGS SHALL BE BELOW GRADE.

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY

FILE I.D.: M1001 01.DGN

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
0	07/30/04	J.ALCANTARA	M.MAZZAFERRO		FOR RECORD/SENT TO CLIENT	

SCALE: 1"=200'

PROJECT NUMBER: 11478-006

PIPE PLAN & PROFILE RECYCLE POND BYPASS

DUCK CREEK SITE
UNIT 1
CANTON, ILLINOIS
AMEREN CILCO

Sargent & Lundy LLC

DRAWING NO. M-1001

REV. 0

SHEET 1 OF

Electronic Filing: Received, Clerk's Office 06/20/2024

C180-C102

PAGE NO. - 08

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F100	16094.44	600.00	591.92	591.92
F101	16122.48	600.00	601.92	601.72
F102	16151.72	600.00	614.00	613.93
F103	16181.80	600.00	618.50	618.41
F104	16181.80	600.00	618.50	618.41
F0105	16181.80	600.00	618.50	618.41
F0106	16207.05	600.00	618.50	618.41
F0107	16212.92	600.00	618.50	617.46
F0200	16093.44	700.00	591.83	591.43
F0202	16128.99	700.00	601.57	601.57
F0203	16171.75	700.00	614.00	613.66
F0204	16181.83	700.00	618.50	613.83
F0205	16181.83	700.00	618.50	618.45
F0206	16207.08	700.00	618.50	618.50
F0207	16214.05	699.99	618.33	618.08
F0300	16092.59	800.00	592.23	592.10
F0302	16130.09	800.00	602.09	601.78
F0303	16171.78	800.00	614.00	613.92
F0304	16181.86	800.00	618.50	618.40
F0305	16207.11	800.00	618.50	618.36
F0307	16231.93	800.00	611.41	613.17
F0401	16097.41	894.79	592.75	592.62
F0402	16131.01	894.69	602.34	601.96
F0403	16171.81	894.69	614.00	613.80
F0404	16181.89	894.67	614.00	613.95
F0405	16181.89	894.67	618.50	618.40
F0406	16207.14	894.67	618.50	618.49
F0407	16233.79	894.62	611.50	611.10
F0501	16094.47	897.40	592.72	592.81
F0502	16084.09	931.08	601.58	601.58
F0503	16093.63	971.56	614.00	613.82
F0504	16093.52	981.58	614.00	613.99
F0505	16093.52	981.58	618.50	618.42
F0506	16093.24	1007.23	618.50	618.27
F0507	16092.98	1032.66	611.24	612.16
F0601	16000.00	894.01	592.01	591.89
F0602	16000.00	931.99	601.71	601.71
F0603	16000.00	970.96	614.00	613.85
F0604	16000.00	981.05	614.00	613.91
F0605	16000.00	981.05	618.50	618.39
F0606	16000.00	1005.86	618.50	618.42
F0607	15999.99	1027.33	612.30	614.31
F0701	15950.00	885.98	591.18	591.13
F0702	15900.00	926.34	601.97	601.53
F0703	15900.00	931.08	614.00	613.72
F0704	15900.00	979.93	614.00	613.92
F0705	15900.00	979.93	618.50	618.32
F0706	15900.00	979.93	618.50	618.28
F0707	15900.00	1030.84	594.03	610.36
F0801	15850.00	885.98	590.35	590.35
F0802	15800.00	923.77	601.15	601.09
F0803	15800.00	926.73	613.71	613.71
F0804	15800.00	978.81	614.00	613.82
F0805	15800.00	978.81	618.50	618.32
F0806	15800.00	1004.06	618.50	618.35
F0807	15799.99	1028.73	614.00	611.55
F0901	15700.00	881.93	589.52	589.33
F0902	15750.00	921.00	600.74	600.52
F0903	15700.00	967.62	614.00	613.65
F0904	15700.00	977.70	614.00	613.92
F0905	15700.00	977.70	618.50	618.32
F0906	15700.00	1002.05	618.50	618.42
F0907	15700.00	1027.61	615.50	615.36
F1001	15600.00	874.33	587.67	587.28
F1002	15600.00	920.32	600.74	600.52
F1003	15600.00	966.50	614.00	613.79
F1004	15600.00	976.58	614.00	613.91
F1005	15600.00	976.58	618.50	618.43
F1006	15600.00	1001.83	618.50	618.42
F1007	15600.00	1020.34	613.15	613.94
F1101	15500.00	866.73	585.81	585.66
F1102	15500.00	916.58	599.91	599.75
F1103	15500.00	965.58	614.00	613.70
F1104	15500.00	975.46	614.00	613.81
F1105	15500.00	975.46	618.50	618.40
F1106	15500.00	1000.72	618.50	618.37
F1107	15500.00	1020.41	612.87	613.37
F1201	15450.00	866.73	584.81	584.67
F1202	15400.00	913.48	599.49	599.29
F1203	15400.00	964.27	614.00	613.73
F1204	15400.00	974.35	614.00	613.76
F1205	15400.00	974.35	618.50	618.32
F1206	15400.00	999.60	618.50	618.32
F1207	15399.99	1018.82	614.00	613.70
F1301	15300.00	858.87	584.15	583.89
F1302	15300.00	908.58	599.07	598.91
F1303	15300.00	963.15	614.00	613.76
F1304	15300.00	973.23	614.00	613.88
F1305	15300.00	973.23	618.50	618.38
F1306	15300.00	998.48	618.50	618.32
F1307	15300.00	1018.07	610.62	611.00
F1401	15200.00	854.65	583.32	583.20
F1402	15200.00	904.34	598.24	598.12
F1403	15200.00	962.03	614.00	613.76
F1404	15200.00	972.12	614.00	613.82
F1405	15200.00	972.12	618.50	618.27
F1406	15200.00	997.37	618.50	618.39
F1407	15199.99	1026.89	610.12	611.00
F1501	15100.00	850.02	582.49	582.33
F1502	15100.00	905.77	598.24	598.08
F1503	15100.00	960.92	614.00	613.80
F1504	15100.00	971.00	614.00	613.79
F1505	15100.00	971.00	618.50	618.43
F1506	15100.00	996.25	618.50	618.39
F1507	15099.99	1029.67	608.86	611.29
F1601	15000.00	845.59	581.66	581.50
F1602	15000.00	903.20	597.83	597.75
F1603	15000.00	958.80	614.00	613.83
F1604	15000.00	969.88	614.00	613.88
F1605	15000.00	969.88	618.50	618.37
F1606	15000.00	995.13	618.50	618.28
F1607	15000.00	1043.53	604.97	608.10
F1701	14900.00	842.57	580.83	580.78
F1702	14900.00	900.63	597.41	597.32
F1703	14900.00	958.69	614.00	613.84
F1704	14900.00	968.77	614.00	613.92
F1705	14900.00	968.77	618.50	618.38

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F0108	16207.05	600.00	618.50	618.41
F0109	16212.92	600.00	618.50	617.46
F0201	16093.44	700.00	591.83	591.43
F0202	16128.99	700.00	601.57	601.57
F0203	16171.75	700.00	614.00	613.66
F0204	16181.83	700.00	618.50	613.83
F0205	16181.83	700.00	618.50	618.45
F0208	16207.08	700.00	618.50	618.50
F0209	16214.05	699.99	618.33	618.08
F0301	16092.59	800.00	592.23	592.10
F0302	16130.09	800.00	602.09	601.78
F0303	16171.78	800.00	614.00	613.92
F0304	16181.86	800.00	618.50	618.40
F0305	16207.11	800.00	618.50	618.36
F0307	16231.93	800.00	611.41	613.17
F0401	16097.41	894.79	592.75	592.62
F0402	16131.01	894.69	602.34	601.96
F0403	16171.81	894.69	614.00	613.80
F0404	16181.89	894.67	614.00	613.95
F0405	16181.89	894.67	618.50	618.40
F0406	16207.14	894.67	618.50	618.49
F0407	16233.79	894.62	611.50	611.10
F0501	16094.47	897.40	592.72	592.81
F0502	16084.09	931.08	601.58	601.58
F0503	16093.63	971.56	614.00	613.82
F0504	16093.52	981.58	614.00	613.99
F0505	16093.52	981.58	618.50	618.42
F0506	16093.24	1007.23	618.50	618.27
F0507	16092.98	1032.66	611.24	612.16
F0601	16000.00	894.01	592.01	591.89
F0602	16000.00	931.99	601.71	601.71
F0603	16000.00	970.96	614.00	613.85
F0604	16000.00	981.05	614.00	613.91
F0605	16000.00	981.05	618.50	618.39
F0606	16000.00	1005.86	618.50	618.42
F0607	15999.99	1027.33	612.30	614.31
F0701	15950.00	885.98	591.18	591.13
F0702	15900.00	926.34	601.97	601.53
F0703	15900.00	931.08	614.00	613.72
F0704	15900.00	979.93	614.00	613.92
F0705	15900.00	979.93	618.50	618.32
F0706	15900.00	979.93	618.50	618.28
F0707	15900.00	1030.84	594.03	610.36
F0801	15850.00	885.98	590.35	590.35
F0802	15800.00	923.77	601.15	601.09
F0803	15800.00	926.73	613.71	613.71
F0804	15800.00	978.81	614.00	613.82
F0805	15800.00	978.81	618.50	618.32
F0806	15800.00	1004.06	618.50	618.35
F0807	15799.99	1028.73	614.00	611.55
F0901	15700.00	881.93	589.52	589.33
F0902	15750.00	921.00	600.74	600.52
F0903	15700.00	967.62	614.00	613.65
F0904	15700.00	977.70	614.00	613.92
F0905	15700.00	977.70	618.50	618.32
F0906	15700.00	1002.05	618.50	618.42
F0907	15700.00	1027.61	615.50	615.36
F1001	15600.00	874.33	587.67	587.28
F1002	15600.00	920.32	600.74	600.52
F1003	15600.00	966.50	614.00	613.79
F1004	15600.00	976.58	614.00	613.91
F1005	15600.00	976.58	618.50	618.43
F1006	15600.00	1001.83	618.50	618.42
F1007	15600.00	1020.34	613.15	613.94
F1101	15500.00	866.73	585.81	585.66
F1102	15500.00	916.58	599.91	599.75
F1103	15500.00	965.58	614.00	613.70
F1104	15500.00	975.46	614.00	613.81
F1105	15500.00	975.46	618.50	618.40
F1106	15500.00	1000.72	618.50	618.37
F1107	15500.00	1020.41	612.87	613.37
F1201	15450.00	866.73	584.81	584.67
F1202	15400.00	913.48	599.49	599.29
F1203	15400.00	964.27	614.00	613.73
F1204	15400.00	974.35	614.00	613.76
F1205	15400.00	974.35	618.50	618.32
F1206	15400.00	999.60	618.50	618.32
F1207	15399.99	1018.82	614.00	613.70
F1301	15300.00	858.87	584.15	583.89
F1302	15300.00	908.58	599.07	598.91
F1303	15300.00	963.15	614.00	613.76
F1304	15300.00	973.23	614.00	613.88
F1305	15300.00	973.23	618.50	618.38
F1306	15300.00	998.48	618.50	618.32
F1307	15300.00	1018.07	610.62	611.00
F1401	15200.00	854.65	583.32	583.20
F1402	15200.00	904.34	598.24	598.12
F1403	15200.00	962.03	614.00	613.76
F1404	15200.00	972.12	614.00	613.82
F1405	15200.00	972.12	618.50	618.27
F1406	15200.00	997.37	618.50	618.39
F1407	15199.99	1026.89	610.12	611.00
F1501	15100.00	850.02	582.49	582.33
F1502	15100.00	905.77	598.24	598.08
F1503	15100.00	960.92	614.00	613.80
F1504	15100.00	971.00	614.00	613.79
F1505	15100.00	971.00	618.50	618.43
F1506	15100.00	996.25	618.50	618.39
F1507	15099.99	1029.67	608.86	611.29
F1601	15000.00	845.59	581.66	581.50
F1602	15000.00	903.20	597.83	597.75
F1603	15000.00	958.80	614.00	613.83
F1604	15000.00	969.88	614.00	613.88
F1605	15000.00	969.88	618.50	618.37
F1606	15000.00	995.13	618.50	618.28
F1607	15000.00	1043.53	604.97	608.10
F1701	14900.00	842.57	580.83	580.78
F1702	14900.00	900.63	597.41	597.32
F1703	14900.00	958.69	614.00	613.84
F1704	14900.00	968.77	614.00	613.92
F1705	14900.00	968.77	618.50	618.38

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F0109	16207.05	600.00	618.50	618.41
F0110	16212.92	600.00	618.50	617.46
F0202	16093.44	700.00	591.83	591.43
F0204	16128.99	700.00	601.57	601.57
F0205	16171.75	700.00	614.00	613.66
F0206	16181.83	700.00	618.50	613.83
F0207	16181.83	700.00	618.50	618.45
F0210	16207.08	700.00	618.50	618.50
F0211	16214.05	699.99	618.33	618.08
F0303	16092.59	800.00	592.23	592.10
F0304	16130.09	800.00	602.09	601.78
F0305	16171.78	800.00	614.00	613.92
F0306	16181.86	800.00	618.50	618.40
F0307	16207.11	800.00	618.50	618.36
F0309	16231.93	800.00	611.41	613.17
F0403	16097.41	894.79	592.75	592.62
F0404	16131.01	894.69	602.34	601.96
F0405	16171.81	894.69	614.00	613.80
F0406	16181.89	894.67	614.00	613.95
F0407	16181.89	894.67	618.50	618.40
F0408	16207.14	894.67	618.50	618.49
F0409	16233.79	894.62	611.50	611.10
F0503	16094.47	897.40	592.72	592.81
F0504	16084.09	931.08	601.58	601.58
F0505	16093.63	971.56	614.00	613.82
F0506	16093.52	981.58	614.00	613.99
F0507	16093.52	981.58	618.50	618.42
F0508	16093.24	1007.23	618.50	618.27
F0509	16092.98	1032.66	611.24	612.16
F0603	16000.00	894.01	592.01	591.89
F0604	16000.00	931.99	601.71	601.71
F0605	16000.00	970.96	614.00	613.85
F0606	16000.00	981.05	614.00	613.91
F0607	16000.00	981.05	618.50	618.39
F0608	16000.00	1005.86	618.50	618.42
F0609	15999.99	1027.33	612.30	614.31
F0703	15950.00	885.98	591.18	591.13
F0704	15900.00	926.34	601.97	601.53
F0705	15900.00	931.08	614.00	613.72
F0706	15900.00	979.93	614.00	613.92
F0707	15900.00	979.93	618.50	618.32
F0708	15900.00	979.93	618.50	618.28
F0709	15900.00	1030.84	594.03	610.36
F0803	15850.00	885.98	590.35	590.35
F0804	15800.00	923.77	601.15	601.09
F0805	15800.00	926.73	613.71	613.71
F0806	15800.00	978.81	614.00	613.82
F0807	15800.00	978.81	618.50	618.32
F0808	15800.00	1004.06	618.50	618.35
F0809	15799.99	1028.73	614.00	611.55
F0903	15700.00	881.93	589.52	589.33
F0904	15750.00	921.00	600.74	600.52
F0905	15700.00	967.62	614.00	613.65
F0906	15700.00	977.70	614.00	613.92
F0907	15700.00	977.70	618.50	618.32
F0908	15700.00	1002.05	618.50	618.42
F0909	15700.00	1027.61	615.50	615.36
F1003	15600.00	874.33	587.67	587.28
F1004	15600.00	920.32	600.74	600.52
F1005	15600.00	966.50	614.00	613.79
F1006	15600.00	976.58	614.00	613.91
F1007	15600.00	976.58	618.50	618.43
F1008	15600.00	1001.83	618.50	618.42
F1009	15600.00	1020.34	613.15	613.94
F1103	15500.00	866.73	585.81	585.66
F1104	15500.00	916.58	599.91	599.75
F1105	15500.00	965.58	614.00	613.70
F1106	15500.00	975.46	614.00	613.81
F1107	15500.00	975.46	618.50	618.40
F1108	15500.00	1000.72	618.50	618.37
F1109	15500.00	1020.41	612.87	613.37
F1203	15450.00	866.73	584.81	584.67
F1204	15400.00	913.48	599.49	599.29
F1205	15400.00	964.27	614.00	613.73
F1206	15400.00	974.35	614.00	613.76
F1207	15400.00	974.35	618.50	618.32
F1208	15400.00	999.60	618.50	618.32
F1209	15399.99	1018.82	614.00	613.70
F1303	15300.00	858.87	584.15	583.89
F1304	15300.00	908.58	599.07	598.91
F1305	15300.00	963.15	614.00	613.76
F1306	15300.00	973.23	614.00	613.88
F1307	15300.00	973.23	618.50	618.38
F1308	15300.00	998.48	618.50	618.32
F1309	15300.00	1018.07	610.62	611.00
F1403	15200.00	854.65	583.32	583.20
F1404	15200.00	904.34	598.24	598.12
F1405	15200.00	962.03	614.00	613.76
F1406	15200.00	972.12	614.00	613.82
F1407	15200.00	972.12	618.50	618.27
F1408	15200.00	997.37	618.50	618.39
F1409	15199.99	1026.89	610.12	611.00
F1503	15100.00	850.02	582.49	582.33
F1504	15100.00	905.77	598.24	598.08
F1505	15100.00	960.92	614.00	613.80
F1506	15100.00	971.00	614.00	613.79
F1507	15100.00	971.00	618.50	618.43
F1508	15100.00	996.25	618.50	618.39
F1509	15099.99	1029.67	608.86	611.29
F1603	15000.00	845.59	581.66	581.50
F1604	15000.00	903.20	597.83	597.75
F1605	15000.00	958.80	614.00	613.83
F1606	15000.00	969.88	614.00	613.88
F1607	15000.00	969.88	618.50	618.37
F1608	15000.00	995.13	618.50	618.28
F1609	15000.00	1043.53	604.97	608.10
F1703	14900.00	842.57	580.83	580.78
F1704	14900.00	900.63	597.41	597.32
F1705	14900.00	958.69	614.00	613.84
F1706	14900.00	968.77	614.00	613.92
F1707	14900.00	968.77	618.50	618.38

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F2400	15400.00	35.86	614.00	613.89
F2401	15400.00	35.86	618.50	618.35
F2402	15500.00	35.86	618.50	618.35
F2403	15299.99	-4.81	614.10	615.48
F2501	15500.00	145.64	585.80	585.79
F2502	15500.00	96.46	599.98	599.88
F2503	15500.00	47.28	614.00	613.88
F2504	15500.00	37.19	614.00	613.95
F2505	15500.00	37.19	618.50	618.35
F2506	15500.00	11.94	618.50	618.28
F2507	15399.99	-3.09	614.22	616.40
F2601	15600.00	140.54	587.74	587.67
F2602	15600.00	96.36	600.36	600.28
F2603	15600.00	48.61	614.00	613.87
F2604	15600.00	38.53	614.00	613.95
F2605	15600.00	38.53	618.50	618.43
F2606	15600.00	13.09	618.50	618.13
F2607	15600.00	0.68	614.96	617.26
F2701	15700.00	126.44	589.57	589.38
F2702	15700.00	96.27	600.77	600.75
F2703	15700.00	49.94	614.00	613.94
F2704	15700.00	39.86	614.00	613.84
F2705	15700.00	39.86	618.50	618.31
F2706	15700.00	14.61	618.50	618.16
F2707	15699.99	6.05	616.08	618.25
F2801	15800.00	133.30	590.35	590.28
F2802	15800.00	96.17	601.17	600.92
F2803	15800.00	96.36	600.36	600.28
F2804	15800.00	41.20	614.00	613.78
F2805	15800.00	41.20	618.50	618.30
F2806	15800.00	15.94	618.50	618.48
F2807	15799.99	13.41	617.77	619.70
F2901	15900.00	132.16	591.27	591.17
F2902	15900.00	96.07	601.58	601.40
F2903	15900.00	42.53	614.00	613.83
F2904	15900.00	42.53	614.00	613.99
F2905	15900.00	42.53	618.50	618.41
F2906	15900.00	17.26	618.50	618.27
F2907	15899.99	14.53	619.26	620.26
F3001	16000.00	130.87	592.09	591.82
F3002	16000.00	95.78	601.89	601.73
F3003	16000.00	53.94	614.00	613.93
F3004	16000.00	43.86	614.00	613.91
F3005	16000.00	43.86	618.50	618.37
F3006	16000.00	18.61	618.50	618.28
F3007	15999.99	15.77	620.08	620.37
F4101	16084.55	129.59	592.71	592.70
F4102	16085.05	95.91	602.34	602.23
F4103	16085.54	55.08	614.00	613.89
F4104	16085.68	45.00	614.00	613.81
F4105	16085.68	45.00	618.50	618.34
F4106	16086.02	19.76	618.50	618.11
F4107	16086.68	13.77	620.21	620.54
F4201	16085.68	45.00	614.00	613.81
F4202	16130.77	142.25	602.34	602.02
F4203	16131.26	142.25	602.34	602.02
F4204	16161.66	142.25	614.00	613.89
F4205	16161.66	142.25	618.50	618.46
F4206	16206.91	142.24	618.50	618.30
F4207	16214.67	142.24	616.28	619.50
F4301	16130.18	200.00	602.17	601.94
F4302	16130.18	200.00	602.17	601.94
F4303	16171.65	200.00	614.00	613.91
F4304	16181.68	200.00	614.00	613.93
F4305	16181.68	200.00	618.50	618.41
F4306	16206.93	200.00	618.50	618.44
F4307	16214.54	199.97	613.14	616.16
F4401	16203.88	300.00	591.79	591.57
F4402	16205.68	300.00	614.00	613.87
F4403	16171.63	300.00	614.00	613.88
F4404	16171.71	300.00	614.00	613.92
F4405	16181.71	300.00	618.50	618.42
F4406	16206.96	300.00	618.50	618.45
F4407	16222.86	300.00	613.66	618.31
F4501	16093.81	400.00	591.76	591.75
F4502	16126.13	400.00	601.66	601.64
F4503	16171.66	400.00	614.00	613.61
F4504	16181.74	400.00	614.00	613.62
F4505	16181.74	400.00	618.50	618.41
F4506	16206.96	400.00	618.50	618.43
F4507	16219.15	400.02	615.01	618.75
F4601	16095.90	500.00	592.17	592.15
F4602	16130.22	500.00	602.15	601.93
F4603	16171.66	500.00	614.00	613.86
F4604	16181.77	500.00	614.00	613.86
F4605	16181.77	500.00	618.50	618.42
F4606	16207.02	500.00	618.50	618.42
F4607	16214.91	499.98	613.98	616.91
F801	14960.00	352.42	579.83	579.59
F802	14960.00	352.42	580.83	580.58
F803	15000.00	352.42	581.45	581.24
F804	15200.00	352.42	582.26	582.22
F805	15300.00	352.42	583.06	583.06
F806	15400.00	352.42	583.87	583.69
F807	15500.00	352.42	584.68	584.44
F808	15600.00	352.42	586.49	586.24
F809	15700.00	352.42	588.30	588.08
F810	15800.00	352.42	589.10	588.95
F811	15900.00	352.42	589.91	589.69
F812	16000.00	352.42	590.72	590.64
F813	16100.00	352.42	591.53	591.36
F814	15500.00	513.35	581.66	581.35
F815	15100.00	513.35	582.40	582.32
F816	15200.00	513.35	582.81	582.78
F817	15300.00	513.35	583.61	583.61
F818	15400.00	513.35	584.01	584.00
F819	15500.00	513.35	584.82	584.76
F820	15600.00	513.35	585.63	585.53
F821	15700.00	513.35	586.43	586.31
F822	15800.00	513.35	587.24	587.09
F823	15900.00	513.35	588.04	587.86
F824	16000.00	513.35	588.85	588.64
F825	14900.00	674.29	579.63	579.69
F826	15000.00	674.29	580.63	580.47
F827	15100.00	674.29	581.45	581.42
F828	15200.00	674.29	582.26	582.26
F829	15300.00	674.29	583.07	582.93

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F2500	15400.00	674.29	583.87	583.66
F2501	15500.00	674.29	584.68	584.50
F2502	15600.00	674.29	585.48	585.38
F2503	15700.00	674.29	586.30	586.25
F2504	15800.00	674.29	587.10	586.95
F2505	15900.00	674.29	587.91	587.74
F2506	16000.00	674.29	588.71	588.51
F2507	16100.00	674.29	589.52	589.36
F2601	15000.00	834.29	581.26	581.11
F2602	15100.00	834.29	582.07	581.90
F2603	15200.00	834.29	582.87	582.82
F2604	15300.00	834.29	583.68	583.61
F2605	15400.00	834.29	584.48	584.39
F2606	15500.00	834.29	585.29	585.18
F2607	15600.00	834.29	586.09	585.97
F2608	15700.00	834.29	586.90	586.75
F2609	15800.00	834.29	587.70	587.54
F2610	15900.00	834.29	588.51	588.33
F2611	16000.00	834.29	589.31	589.12
F2701	15000.00	1000.00	581.07	580.92
F2702	15100.00	1000.00	581.88	581.71
F2703	15200.00	1000.00	582.68	582.63
F2704	15300.00	1000.00	583.49	583.42
F2705	15400.00	1000.00	584.

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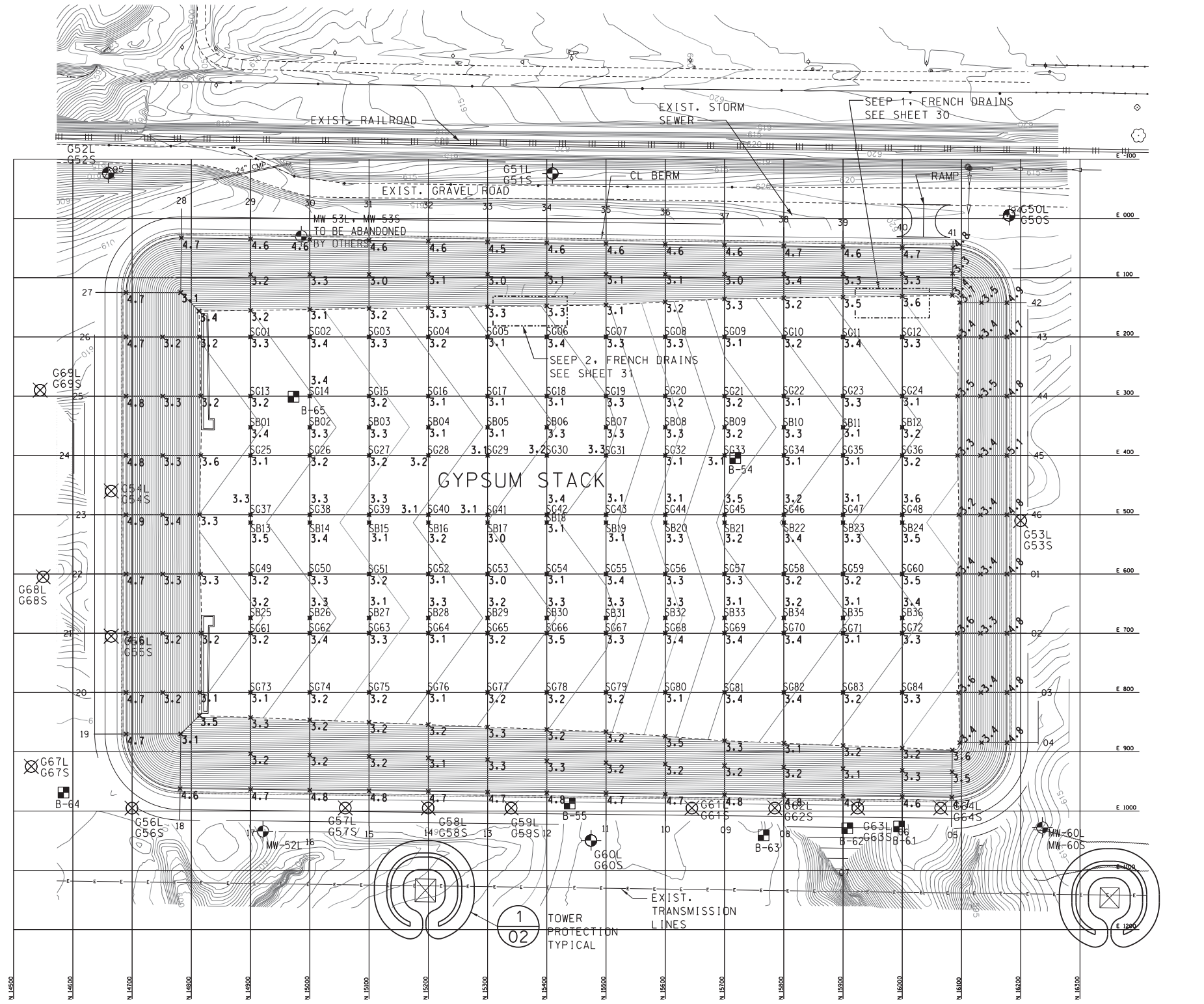
CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS
S0101	16094.01	600.00	594.92	595.29	3.4
S0102	16131.93	600.00	605.75	605.94	3.4
S0103	16176.55	600.00	618.50	618.66	4.8
S0201	16093.01	700.00	594.62	595.01	3.6
S0202	16131.96	700.00	605.75	605.83	3.3
S0203	16176.58	700.00	618.50	618.59	4.8
S0301	16095.16	800.00	595.23	595.72	3.6
S0302	16132.64	800.00	605.94	606.02	3.4
S0303	16176.61	800.00	618.50	618.68	4.8
S0401	16096.98	884.70	595.74	596.05	3.4
S0402	16133.97	884.69	606.31	606.33	3.4
S0403	16176.64	884.68	618.50	618.70	4.8
S0501	16084.47	896.97	595.71	596.24	3.6
S0502	16084.06	934.06	606.31	606.41	3.5
S0503	16083.58	976.73	618.50	618.65	4.7
S0601	16000.00	893.58	595.01	595.08	3.2
S0602	16000.00	931.11	605.73	605.74	3.3
S0603	16000.00	975.79	618.50	618.51	4.6
S0701	15900.00	889.55	594.18	594.28	3.2
S0702	15900.00	928.54	605.32	605.41	3.1
S0703	15900.00	974.68	618.50	618.50	4.7
S0801	15800.00	885.53	593.35	593.44	3.1
S0802	15800.00	925.97	604.90	604.98	3.2
S0803	15800.00	973.56	618.50	618.55	4.8
S0901	15700.00	881.50	592.52	592.61	3.3
S0902	15700.00	923.40	604.49	604.57	3.2
S0903	15700.00	972.45	618.50	618.57	4.8
S1001	15600.00	873.90	590.66	590.75	3.5
S1002	15600.00	920.83	604.07	604.16	3.2
S1003	15600.00	971.33	618.50	618.51	4.7
S1101	15500.00	866.30	588.81	588.90	3.2
S1102	15500.00	918.26	603.66	603.72	3.2
S1103	15500.00	970.21	618.50	618.50	4.7
S1201	15400.00	862.27	587.98	588.08	3.2
S1202	15400.00	915.68	603.24	603.30	3.3
S1203	15400.00	969.10	618.50	618.51	4.8
S1301	15300.00	858.25	587.15	587.19	3.3
S1302	15300.00	913.11	602.82	602.89	3.3
S1303	15300.00	967.98	618.50	618.51	4.7
S1401	15200.00	854.22	586.32	586.41	3.2
S1402	15200.00	910.54	602.41	602.41	3.1
S1403	15200.00	966.87	618.50	618.51	4.7
S1501	15100.00	850.19	585.49	585.59	3.2
S1502	15100.00	907.97	601.99	602.01	3.2
S1503	15100.00	965.75	618.50	618.52	4.8
S1601	15000.00	846.17	584.65	584.73	3.2
S1602	15000.00	905.40	601.58	601.65	3.2
S1603	15000.00	964.63	618.50	618.57	4.8
S1701	14900.00	842.14	583.82	584.08	3.3
S1702	14900.00	903.35	601.31	601.39	3.2
S1703	14900.00	963.52	618.50	618.50	4.7
S1801	14813.86	838.67	583.11	583.51	3.5
S1802	14782.32	869.87	592.12	592.18	3.1
S1803	14781.09	962.19	618.50	618.54	4.6
S1901	14813.86	838.67	583.11	583.51	3.5
S1902	14782.32	869.87	592.12	592.16	3.1
S1903	14689.99	870.07	618.50	618.52	4.7
S2001	14814.62	800.00	582.89	582.98	3.1
S2002	14752.10	800.00	600.75	600.82	3.2
S2003	14689.97	800.00	618.50	618.58	4.7
S2101	14816.61	700.00	582.31	582.51	3.2
S2102	14752.08	700.00	600.75	600.80	3.2
S2103	14689.95	700.00	618.50	618.50	4.6
S2201	14815.61	600.00	582.59	582.75	3.3
S2202	14752.06	600.00	600.75	600.76	3.3
S2203	14689.93	600.00	618.50	618.50	4.7
S2301	14814.16	500.00	583.00	583.15	3.3
S2302	14752.03	500.00	600.75	600.78	3.4
S2303	14689.91	500.00	618.50	618.52	4.9
S2401	14816.11	400.00	582.44	582.87	3.6
S2402	14752.01	400.00	600.75	600.77	3.3
S2403	14689.89	400.00	618.50	618.51	4.8
S2501	14815.99	300.00	582.46	582.58	3.2
S2502	14751.99	300.00	600.75	600.78	3.3
S2503	14689.87	300.00	618.50	618.52	4.8
S2601	14813.97	200.00	583.04	583.13	3.2
S2602	14751.57	200.00	600.86	600.86	3.2
S2603	14689.85	200.00	618.50	618.53	4.7
S2701	14813.09	156.55	583.29	583.56	3.4
S2702	14782.16	125.21	592.12	592.22	3.1
S2703	14689.83	125.03	618.50	618.52	4.7
S2801	14813.09	156.55	583.29	583.54	3.4
S2802	14782.16	125.21	592.12	592.20	3.1
S2803	14783.19	32.89	618.50	618.51	4.7
S2901	14900.00	155.22	583.99	584.23	3.2
S2902	14900.00	94.62	601.31	601.36	3.2
S2903	14900.00	34.44	618.50	618.51	4.6
S3001	15000.00	153.70	584.81	584.85	3.1
S3002	15000.00	94.74	601.66	601.72	3.3
S3003	15000.00	35.78	618.50	618.55	4.6
S3101	15100.00	152.17	585.63	585.72	3.2
S3102	15100.00	94.64	602.06	602.09	3.0
S3103	15100.00	37.11	618.50	618.51	4.6
S3201	15200.00	150.65	586.45	586.54	3.3
S3202	15200.00	94.55	602.47	602.47	3.1
S3203	15200.00	38.44	618.50	618.57	4.6
S3301	15300.00	149.12	587.26	587.46	3.3
S3302	15300.00	94.45	602.88	602.93	3.0
S3303	15300.00	39.78	618.50	618.51	4.5
S3401	15400.00	147.60	588.08	588.26	3.3
S3402	15400.00	94.35	603.29	603.37	3.1
S3403	15400.00	41.11	618.50	618.51	4.6
S3501	15500.00	146.07	588.90	588.93	3.1
S3502	15500.00	94.26	603.70	603.69	3.1
S3503	15500.00	42.45	618.50	618.49	4.6
S3601	15600.00	140.97	590.73	590.85	3.2
S3602	15600.00	94.16	604.11	604.16	3.1
S3603	15600.00	43.78	618.50	618.50	4.6
S3701	15700.00	135.87	592.57	592.65	3.3
S3702	15700.00	94.07	604.51	604.53	3.0
S3703	15700.00	45.11	618.50	618.49	4.6
S3801	15800.00	134.35	593.39	593.44	3.2
S3802	15800.00	93.97	604.92	604.99	3.4
S3803	15800.00	46.45	618.50	618.50	4.7
S3901	15900.00	132.82	594.20	594.71	3.5
S3902	15900.00	93.87	605.33	605.43	3.3
S3903	15900.00	47.78	618.50	618.54	4.6

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS
S4001	16000.00	131.30	595.02	595.38	3.6
S4002	16000.00	93.78	605.74	605.83	3.3
S4003	16000.00	49.11	618.50	618.58	4.7
S4101	16084.55	130.01	595.71	596.11	3.4
S4102	16085.04	92.92	606.31	606.49	3.3
S4103	16085.61	50.25	618.50	618.66	4.8
S4201	16096.74	142.27	595.74	596.24	3.7
S4202	16133.75	142.26	606.31	606.47	3.5
S4203	16176.41	142.25	618.50	618.70	4.9
S4301	16095.54	200.00	595.39	595.74	3.4
S4302	16132.87	200.00	606.05	606.20	3.4
S4303	16176.43	200.00	618.50	618.61	4.7
S4401	16093.45	300.00	594.78	595.08	3.5
S4402	16131.83	300.00	605.75	605.94	3.5
S4403	16176.46	300.00	618.50	618.64	4.8
S4501	16093.38	400.00	594.75	595.01	3.3
S4502	16131.87	400.00	605.75	605.91	3.4
S4503	16176.49	400.00	618.50	618.68	5.1
S4601	16095.53	500.00	595.36	595.55	3.2
S4602	16131.90	500.00	605.75	605.92	3.4
S4603	16176.52	500.00	618.50	618.59	4.8
SB01	14900.00	352.42	582.83	582.85	3.4
SB02	15000.00	352.42	583.64	583.71	3.3
SB03	15100.00	352.42	584.45	584.49	3.3
SB04	15200.00	352.42	585.26	585.32	3.1
SB05	15300.00	352.42	586.06	586.06	3.1
SB06	15400.00	352.42	586.87	586.97	3.3
SB07	15500.00	352.42	587.68	587.76	3.3
SB08	15600.00	352.42	589.49	589.54	3.3
SB09	15700.00	352.42	591.30	591.31	3.2
SB10	15800.00	352.42	592.10	592.20	3.3
SB11	15900.00	352.42	592.91	593.03	3.1
SB12	16000.00	352.42	593.72	593.88	3.2
SB13	14900.00	513.35	583.78	583.86	3.5
SB14	15000.00	513.35	584.59	584.66	3.4
SB15	15100.00	513.35	585.40	585.41	3.1
SB16	15200.00	513.35	586.21	586.26	3.2
SB17	15300.00	513.35	587.01	587.04	3.0
SB18	15400.00	513.35	587.82	587.86	3.1
SB19	15500.00	513.35	588.63	588.65	3.1
SB20	15600.00	513.35	590.44	590.55	3.3
SB21	15700.00	513.35	592.24	592.26	3.2
SB22	15800.00	513.35	593.05	593.14	3.4
SB23	15900.00	513.35	593.86	593.91	3.3
SB24	16000.00	513.35	594.67	594.85	3.5
SB25	14900.00	674.29	582.83	582.91	3.2
SB26	15000.00	674.29	583.64	583.72	3.3
SB27	15100.00	674.29	584.45	584.47	3.1
SB28	15200.00	674.29	585.26	585.35	3.3
SB29	15300.00	674.29	586.07	586.09	3.2
SB30	15400.00	674.29	586.87	586.95	3.3
SB31	15500.00	674.29	587.68	587.75	3.3
SB32	15600.00	674.29	589.49	589.59	3.3
SB33	15700.00	674.29	591.30	591.34	3.1
SB34	15800.00	674.29	592.10	592.19	3.2
SB35	15900.00	674.29	592.91	592.92	3.1
SB36	16000.00	674.29	593.72	593.94	3.4
SG01	14900.00	200.00	583.73	583.84	3.3
SG02	15000.00	200.00	584.54	584.56	3.4
SG03	15100.00	200.00	585.35	585.42	3.3
SG04	15200.00	200.00	586.15	586.21	3.2
SG05	15300.00	200.00	586.96	587.04	3.1
SG06	15400.00	200.00	587.77	587.81	3.4
SG07	15500.00	200.00	588.58	588.66	3.3
SG08	15600.00	200.00	590.39	590.43	3.3
SG09	15700.00	200.00	592.19	592.26	3.1
SG10	15800.00	200.00	593.00	593.07	3.2
SG11	15900.00	200.00	593.81	594.03	3.4
SG12	16000.00	200.00	594.62	594.69	3.3
SG13	14900.00	300.00	583.14	583.21	3.2
SG14	15000.00	300.00	583.95	584.05	3.4
SG15	15100.00	300.00	584.76	584.77	3.2
SG16	15200.00	300.00	585.57	585.67	3.1
SG17	15300.00	300.00	586.37	586.41	3.1
SG18	15400.00	300.00	587.18	587.22	3.1
SG19	15500.00	300.00	587.99	588.09	3.3
SG20	15600.00	300.00	589.80	589.81	3.2
SG21	15700.00	300.00	591.60	591.65	3.2
SG22	15800.00	300.00	592.41	592.45	3.1
SG23	15900.00	300.00	593.22	593.41	3.3
SG24	16000.00	300.00	594.03	594.10	3.1
SG25	14900.00	400.00	583.11	583.23	3.1
SG26	15000.00	400.00	583.92	584.00	3.2
SG27	15100.00	400.00	584.73	584.75	3.2
SG28	15200.00	400.00	585.54	585.61	3.2
SG29	15300.00	400.00	586.34	586.35	3.1
SG30	15400.00	400.00	587.15	587.23	3.2
SG31	15500.00	400.00	587.96	588.05	3.3
SG32	15600.00	400.00	589.77	589.80	3.1
SG33	15700.00	400.00	591.58	591.64	3.1
SG34	15800.00	400.00	592.38	592.45	3.1
SG35	15900.00	400.00	593.19	593.26	3.1
SG36	16000.00	400.00	594.00	594.07	3.2
SG37	14900.00	500.00	583.70	583.77	3.3
SG38	15000.00	500.00	584.51	584.58	3.3
SG39	15100.00	500.00	585.32	585.36	3.3
SG40	15200.00	500.00	586.13	586.19	3.1
SG41	15300.00	500.00	586.93	586.95	3.1
SG42	15400.00	500.00	587.74	587.82	3.4
SG43	15500.00	500.00	588.55	588.60	3.1
SG44	15600.00	500.00	590.36	590.43	3.1
SG45	15700.00	500.00	592.17	592.23	3.5
SG46	15800.00	500.00	592.97	593.05	3.2
SG47	15900.00	500.00	593.78	593.79	3.1
SG48	16000.00	500.00	594.59	594.83	3.6
SG49	14900.00	600.00	583.27	583.37	3.2
SG50	15000.00	600.00	584.08	584.17	3.3
SG51	15100.00	600.00	584.89	584.95	3.2
SG52	15200.00	600.00	585.70	585.70	3.1
SG53	15300.00	600.00	586.50	586.50	3.0
SG54	15400.00	600.00	587.31	587.39	3.1
SG55	15500.00	600.00	588.12	588.18	3.4
SG56	15600.00	600.00	589.93	590.03	3.3
SG57	15700.00	600.00	591.73	591.81	3.3
SG58	15800.00	600.00	592.54	592.57	3.2
SG59	15900.00	600.00	593.35	593.44	3.2
SG60	16000.00	600.00	594.16	594.43	3.5

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS
SG61	14900.00	700.00	582.99	582.99	3.2
SG62	15000.00	700.00	583.79	583.88	3.4
SG63	15100.00	700.00	584.60	584.62	3.3
SG64	15200.00	700.00	585.41	585.45	3.1
SG65	15300.00	700.00	586.22	586.24	3.2
SG66	15400.00	700.00	587.02	587.09	3.5
SG67	15500.00	700.00	587.83	587.92	3.3
SG68	15600.00	700.00	589.64	589.73	3.4
SG69	15700.00	700.00	591.45	591.50	3.4
SG70	15800.00	700.00	592.26	592.34	3.4
SG71	15900.00	700.00	593.06	593.07	3.1
SG72	16000.00	700.00	593.87	594.03	3.3
SG73	14900.00	800.00	583.57	583.57	3.1
SG74	15000.00	800.00	584.38	584.45	3.2
SG75	15100.00	800.00	585.19	585.20	3.2
SG76	15200.00	800.00	586.00	586.00	3.1
SG77	15300.00	800.00	586.81	586.82	3.2
SG78	15400.00	800.00	587.61	587.70	3.2
SG79	15500.00	800.00	588.42	588.52	3.2
SG80	15600.00	800.00	590.23	590.29	3.1
SG81	15700.00	800.00	592.04	592.13	3.4
SG82	15800.00	800.00	592.84	592.90	3.4
SG83	15900.00	800.00	593.65	593.69	3.2
SG84	16000.00	800.00	594.46	594.76	3.3



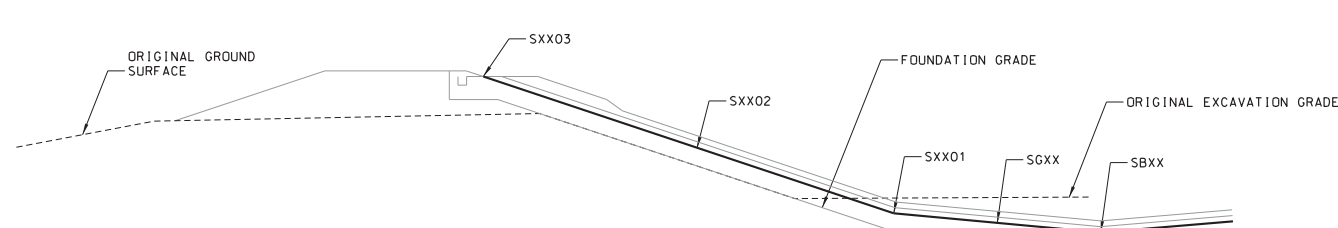
NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.

TYPICAL POINT NUMBER LOCATION

SB 00 — GRID POINT NUMBER; CLAY LAYER GRADE (BREAK POINT)

SG 00 — GRID POINT NUMBER; CLAY LAYER GRADE

S 00 00 — POINT NUMBER (SEE POINT NUMBERING DETAIL); CONTROL LINE NUMBER; CLAY LAYER GRADE



POINT NUMBERING DETAIL

STANDARD LEGEND

(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- 3.1 CLAY LAYER THICKNESS (IN FEET)

0' 100' 200'
SCALE: 1" = 100'

RECORD DRAWING

FILE NO. -C180-C102-09.dgn

Brans00939
09\4\2009
I:\03 jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-09.dgn

AEG CAD GENERATED
DO NOT REVISE MANUALLY

LAYOUT	SMB	05/08/07
DRAWN	SKB	03-05-08
REVIEWED		

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-21-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED POINT NO. DETAIL - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	08-29-08	DBH	SMB	SMB	RAISE BOTTOM ELEV. OF NORTH 400' OF CELL-UPDATE CONTOURS & POINT TABLE
4	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084
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SCALE -
DRAFTER -
DATE 03-26-09

DRAWING TITLE

GYPSUM STACK - CLAY LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

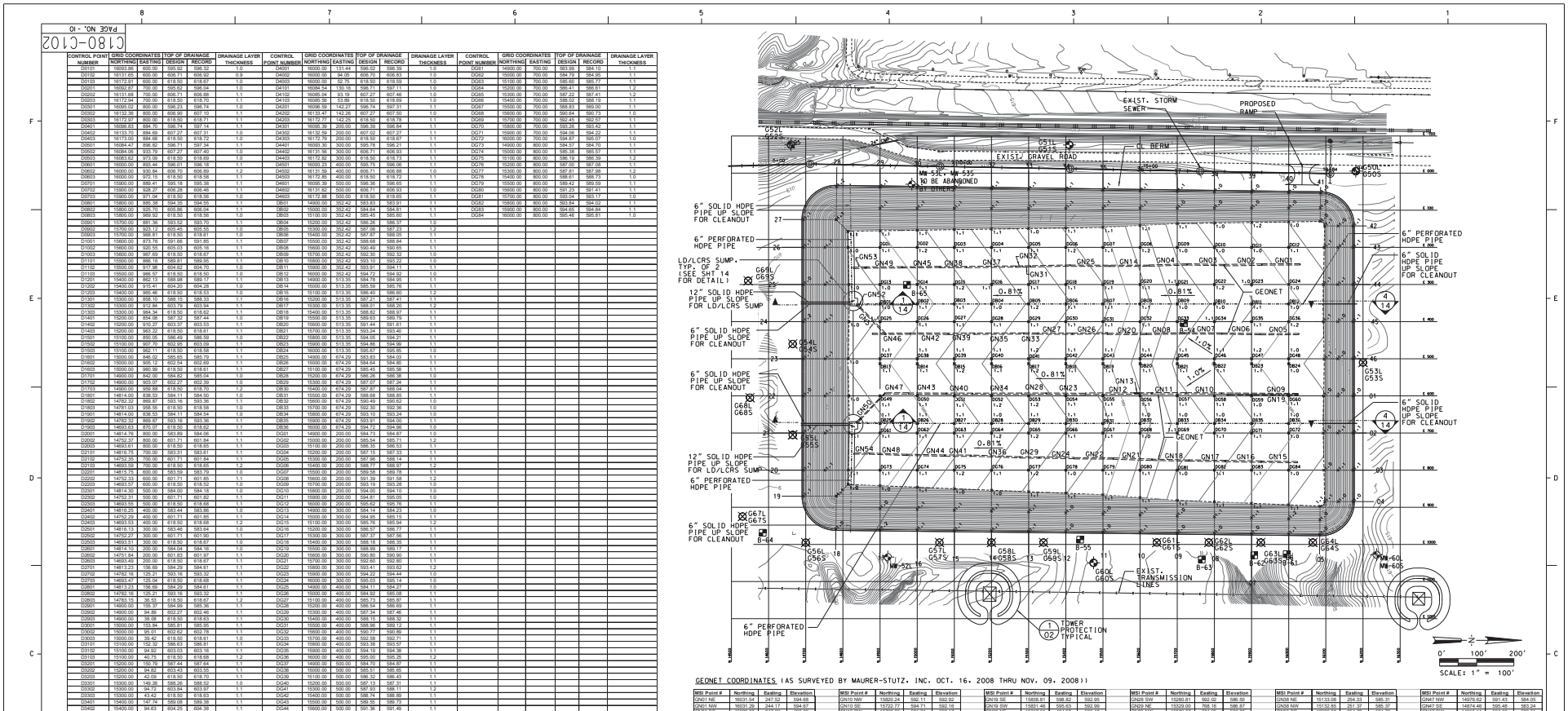
Ameren Energy
Resources Generating

DRAWING NUMBER C180-C102 REV. 4

SHEET NO. 09 OF 33

30x42

Electronic Filing: Received, Clerk's Office 06/20/2024



CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
D0101	16093.86	600.00	595.92	596.32	1.0
D0102	16131.65	600.00	609.71	609.92	0.9
D0103	16172.91	600.00	618.50	618.67	1.0
D0201	16092.87	700.00	595.62	596.04	1.0
D0202	16131.68	700.00	606.71	606.88	1.1
D0203	16172.94	700.00	618.50	618.74	1.1
D0301	16095.02	800.00	596.23	596.74	1.0
D0302	16132.36	800.00	606.90	607.10	1.1
D0303	16172.97	800.00	618.50	618.71	1.1
D0401	16096.83	884.70	596.74	597.14	1.1
D0402	16133.70	884.69	607.27	607.31	1.0
D0403	16173.09	884.68	618.50	618.72	1.0
D0501	16094.47	896.82	596.71	597.34	1.1
D0502	16094.08	933.79	607.27	607.40	1.0
D0503	16083.62	973.58	618.50	618.69	1.0
D0601	16099.92	993.44	596.01	596.18	1.1
D0602	16000.00	930.84	606.70	606.89	1.2
D0603	16000.00	972.15	618.50	618.50	1.1
D0701	15900.00	889.41	595.18	595.38	1.1
D0702	15900.00	928.27	606.48	606.68	1.1
D0703	15900.00	971.04	618.50	618.56	1.0
D0801	15900.00	885.38	594.35	594.55	1.1
D0802	15800.00	925.70	605.86	606.04	1.1
D0803	15800.00	969.92	618.50	618.56	1.0
D0901	15700.00	881.36	593.52	593.70	1.1
D0902	15700.00	923.12	605.45	605.58	1.0
D0903	15700.00	968.81	618.50	618.56	1.0
D1001	15600.00	873.76	591.66	591.85	1.1
D1002	15600.00	920.55	605.13	605.16	1.1
D1003	15600.00	967.69	618.50	618.67	1.1
D1101	15500.00	866.18	589.81	589.95	1.1
D1102	15500.00	917.98	604.62	604.70	1.1
D1103	15500.00	966.57	618.50	618.50	1.0
D1201	15400.00	862.13	589.98	589.17	1.1
D1202	15400.00	915.41	604.20	604.28	1.0
D1203	15400.00	965.46	618.50	618.53	1.0
D1301	15300.00	858.10	588.15	588.33	1.1
D1302	15300.00	912.84	603.79	603.94	1.1
D1303	15300.00	964.34	618.50	618.62	1.1
D1401	15200.00	854.08	587.32	587.44	1.0
D1402	15200.00	910.27	603.37	603.51	1.1
D1403	15200.00	963.22	618.50	618.61	1.1
D1501	15100.00	850.05	586.49	586.59	1.1
D1502	15100.00	907.70	602.95	603.09	1.1
D1503	15100.00	962.10	618.50	618.58	1.1
D1601	15000.00	846.02	585.65	585.79	1.1
D1602	15000.00	905.12	602.64	602.69	1.1
D1603	15000.00	960.99	618.50	618.61	1.1
D1701	14900.00	842.00	584.82	585.04	1.0
D1702	14900.00	903.07	602.27	602.39	1.0
D1703	14900.00	959.88	618.50	618.70	1.2
D1801	14814.00	838.53	584.10	584.50	1.1
D1802	14782.32	869.87	593.18	593.36	1.1
D1803	14781.13	958.55	618.50	618.58	1.0
D1901	14814.00	838.53	584.11	584.54	1.0
D1902	14782.32	869.87	593.16	593.36	1.1
D1903	14693.83	870.67	618.50	618.62	1.0
D2001	14814.76	800.00	583.89	584.06	1.1
D2002	14752.37	800.00	601.71	601.84	1.1
D2003	14693.61	800.00	618.50	618.65	1.1
D2101	14816.75	700.00	583.31	583.50	1.1
D2102	14752.35	700.00	601.71	601.84	1.1
D2103	14693.39	700.00	618.50	618.65	1.2
D2201	14815.75	600.00	583.59	583.76	1.0
D2202	14752.33	600.00	601.71	601.85	1.3
D2203	14693.37	600.00	618.50	618.52	1.2
D2301	14814.30	500.00	584.00	584.18	1.0
D2302	14752.31	500.00	601.71	601.82	1.1
D2303	14693.35	500.00	618.50	618.68	1.1
D2401	14816.25	400.00	583.44	583.38	1.0
D2402	14752.22	400.00	601.71	601.85	1.1
D2403	14693.53	400.00	618.50	618.68	1.2
D2501	14816.13	300.00	583.46	583.64	1.0
D2502	14752.27	300.00	601.71	601.90	1.1
D2503	14693.51	300.00	618.50	618.67	1.1
D2601	14814.10	200.00	584.04	584.16	1.0
D2602	14751.84	200.00	601.83	601.97	1.1
D2603	14693.49	200.00	618.50	618.67	1.1
D2701	14813.23	156.69	584.29	584.51	1.1
D2702	14752.16	125.21	593.16	593.32	1.1
D2703	14693.47	125.04	618.50	618.68	1.1
D2801	14813.23	156.68	584.29	584.51	1.1
D2802	14752.16	125.21	593.16	593.32	1.1
D2803	14783.15	36.53	618.50	618.62	1.2
D2901	14900.00	155.37	584.99	585.36	1.1
D2902	14900.00	94.89	602.27	602.46	1.0
D2903	14900.00	38.98	618.50	618.63	1.1
D3001	15000.00	153.94	585.81	585.95	1.1
D3002	15000.00	95.01	602.62	602.78	1.1
D3003	15000.00	39.42	618.50	618.61	1.0
D3101	15100.00	152.52	586.63	586.81	1.1
D3102	15100.00	94.92	603.03	603.16	1.1
D3103	15100.00	40.75	618.50	618.56	1.2
D3201	15200.00	150.79	587.44	587.64	1.1
D3202	15200.00	94.52	603.43	603.61	1.1
D3203	15200.00	42.09	618.50	618.70	1.1
D3301	15300.00	149.20	588.52	588.50	1.2
D3302	15300.00	94.72	603.94	603.97	1.1
D3303	15300.00	43.42	618.50	618.63	1.1
D3401	15400.00	147.61	589.60	589.78	1.1
D3402	15400.00	94.63	604.25	604.38	1.1
D3403	15400.00	44.75	618.50	618.66	1.1
D3501	15500.00	146.21	589.89	590.06	1.1
D3502	15500.00	94.56	604.56	604.73	1.1
D3503	15500.00	46.09	618.50	618.61	1.1
D3601	15600.00	147.13	590.18	590.35	1.1
D3602	15600.00	94.44	605.07	605.18	1.1
D3603	15600.00	47.42	618.50	618.64	1.1
D3701	15700.00	138.03	593.97	594.15	1.1
D3702	15700.00	94.34	605.48	605.53	1.0
D3703	15700.00	48.75	618.50	618.56	1.0
D3801	15800.00	134.49	594.39	594.47	1.0
D3802	15800.00	94.25	605.88	605.98	1.1
D3803	15800.00	50.09	618.50	618.56	1.0
D3901	15900.00	132.96	595.20	595.94	1.2
D3902	15900.00	94.15	606.29	606.33	1.0
D3903	15900.00	51.42	618.50	618.54	1.0

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
D4001	16000.00	131.44	596.02	596.39	1.0
D4002	16000.00	94.05	606.70	606.83	1.0
D4003	16000.00	52.75	618.50	618.59	1.0
D4101	16084.54	130.18	596.71	597.11	1.0
D4102	16085.04	93.19	607.27	607.46	1.0
D4103	16085.56	53.89	618.50	618.69	1.0
D4201	16096.39	142.27	596.74	597.31	1.1
D4202	16133.47	142.26	607.27	607.50	1.0
D4203	16172.77	142.25	618.50	618.78	1.1
D4301	16095.39	200.00	596.39	596.84	1.1
D4302	16132.58	200.00	607.02	607.27	1.1
D4303	16172.79	200.00	618.50	618.67	1.1
D4401	16093.33	300.00	595.78	596.21	1.1
D4402	16131.56	300.00	606.71	606.93	1.1
D4403	16172.82	300.00	618.50	618.73	1.1
D4501	16093.23	400.00	595.75	596.08	1.1
D4502	16131.55	400.00	606.71	606.88	1.0
D4503	16172.85	400.00	618.50	618.72	1.1
D4601	16095.39	500.00	596.36	596.65	1.1
D4602	16131.62	500.00	606.73	606.93	1.0
D4603	16172.88	500.00	618.50	618.65	1.1
D4701	16092.88	600.00	596.71	597.09	1.1
D4702	16132.58	600.00	607.27	607.50	1.1
D4703	16172.92	600.00	618.50	618.65	1.1
D4801	16092.88	700.00	596.71	597.09	1.1
D4802	16131.62	700.00	606.73	606.93	1.0
D4803	16172.88	700.00	618.50	618.65	1.1
D4901	16092.88	800.00	596.71	597.09	1.1
D4902	16132.58	800.00	607.27	607.50	1.1
D4903	16172.92	800.00	618.50	618.65	1.1
D5001	16092.88	900.00	596.71	597.09	1.1
D5002	16132.58	900.00	607.27	607.50	1.1
D5003	16172.92	900.00	618.50	618.65	1.1
D5101	16092.88	1000.00	596.71	597.09	1.1
D5102	16132.58	1000.00	607.27	607.50	1.1
D5103	16172.92	1000.00	618.50	618.65	1.1
D5201	16092.88	1100.00	596.71	597.09	1.1
D5202	16132.58	1100.00	607.27	607.50	1.1
D5203	16172.92	1100.00	618.50	618.65	1.1
D5301	16092.88	1200.00	596.71	597.09	1.1
D5302	16132.58	1200.00	607.27	607.50	1.1
D5303	16172.92	1200.00	618.50	618.65	1.1
D5401	16092.88	1300.00	596.71	597.09	1.1
D5402	16132.58	1300.00	607.27	607.50	1.1
D5403	16172.92	1300.00	618.50	618.65	1.1
D5501	16092.88	1400.00	596.71	597.09	1.1
D5502	16132.58	1400.00	607.27	607.50	1.1
D5503	16172.92	1400.00	618.50	618.65	1.1
D5601	16092.88	1500.00	596.71	597.09	1.1
D5602	16132.58	1500.00	607.27	607.50	1.1
D5603	16172.92	1500.00	618.50	618.65	1.1
D5701	16092.88	1600.00	596.71	597.09	1.1
D5702	16132.58	1600.00	607.27	607.50	1.1
D5703	16172.92	1600.00	618.50	618.65	1.1
D5801	16092.88	1700.00	596.71	597.09	1.1
D5802	16132.58	1700.00	607.27	607.50	1.1
D5803	16172.92	1700.00	618.50	618.65	1.1
D5901	16092.88	1800.00	596.71	597.09	1.1
D5902	16132.58	1800.00	607.27	607.50	1.1
D5903	16172.92	1800.00	618.50	618.65	1.1
D6001	16092.88	1900.00	596.71	597.09	1.1
D6002	16132.58	1900.00	607.27	607.50	1.1
D6003	16172.92	1900.00	618.50	618.65	1.1
D6101	16092.88	2000.00	596.71	597.09	1.1
D6102	16132.58	2000.00	607.27	607.50	1.1
D6103	16172.92	2000.00	618.50	618.65	1.1
D6201	16092.88	2100.00	596.71	597.09	1.1
D6202	16132.58	2100.00	607.27	607.50	1.1
D6203	16172.92	2100.00	618.50	618.65	1.1
D6301	16092.88	2200.00	596.71	597.09	1.1
D6302	16132.58	2200.00	607.27	607.50	1.1
D6303	16172.92	2200.00	618.50	618.65	1.1
D6401	16092.88	2300.00	596.71	597.09	1.1
D6402	16132.58	2300.00	607.27	607.50	1.1
D6403	16172.92	2300.00	618.50	618.65	1.1
D6501	16092.88	2400.00	596.71	597.09	1.1
D6502	16132.58	2400.00	607.27	607.50	1.1
D6503	16172.92	2400.00	618.50	618.65	1.1
D6601	16092.88	2500.00	596.71	597.09	1.1
D6602	16132.58	2500.00	607.27	607.50	1.1
D6603	16172.92	2500.00	618.50	618.65	1.1
D6701	16092.88	2600.00	596.71	597.09	1.1
D6702	16132.58	2600.00	607.27	607.50	1.1
D6703	16172.92	2600.00	618.50	618.65	1.1
D6801	16092.88	2700.00	596.71	597.09	1.1
D6802	16132.58	2700.00	607.27	607.50	1.1
D6803	16172.92	2700.00	618.50	618.65	1.1
D6901	16092.88	2800.00	596.71	597.09	1.1
D6902	16132.58	2800.00	607.27	607.50	1.1
D6903	16172.92	2800.00	618.50	618.65	1.1
D7001	16092.88	2900.00	596.71	597.09	1.1
D7002	16132.58	2900.00	607.27	607.50	1.1
D7003	16172.92	2900.00	618.50	618.65	1.1
D7101	16092.88	3000.00	596.71	597.09	1.1
D7102	16132.58	3000.00	607.27	607.50	1.1
D7103	16172.92	3000.00	618.50	618.65	1.1
D7201	16092.88	3100.00	596.71	597.09	1.1
D7202	16132.58	3100.00	607.27	607.50	1.1
D7203	16172.92	3100.00	618.50	618.65	1.1
D7301	16092.88	3200.00	596.71	597.09	1.1
D7302	16132.58	3200.00	607.27	607.50	1.1
D7303	16172.92	3200.00	618.50	618.65	1.1
D7401	16092.88	3300.00	596.71	597.09	1.1
D7402	16132.58	3300.00	607.27	607.50	1.1
D7403	16172.92	3300.00	618.50	618.65	1.1
D7501	16092.88	3400.00	596.71	597.09	1.1
D7502	16132.58	3400.00	607.27	607.50	1.1
D7503	16172.92	3400.00	618.50	618.65	1.1
D7601	16092.88	3500.00	596.71	597.09	1.1
D7602	16132.58	3500.00	607.27	607.50	1.1
D7603	16172.92	3500.00	618.50	618.65	1.1
D7701	16092.88	3600.00	596.71	597.09	1.1
D7702	16132.58	3600.00	607.27	607.50	1.1
D7703	16172.92	3600.00	618.50	618.65	1.1
D7801	16092.88	3700.00	596.71	597.09	1.1
D7802	16132.58	3700.00	607.27	607.50	1.1
D7803	16172.92	3700.00	618.50	618.65	1.1
D7901	16092.88	3800.00	596.71	597.09	1.1
D7902	16132.58	3800.00	607.27	607.50	1.1
D7903	16172.92	3800.00	618.50	618.65	1.1
D8001	16092.88	3900.00	596.71	597.09	1.1
D8002	16132.58	3900.00	607.27	607.50	1.1
D8003	16172.92	3900.00	618.50	618.65	1.1
D8101	16092.88	4000.00	596.71	597.09	1.1
D8102	16132.58	4000.00	607.27	607.50	1.1
D8103	16172.92	4000.00	618.50	618.65	1.1
D8201	16092.88	4100.00	596.71	597.09	1.1
D8202	16132.58	4100.00	607.27	607.50	1.1
D8203	16172.92	4100.00	618.50	618.65	1.1
D8301	16092.88	4200.00	596.71	597.09	1.1
D8302	16132.58	4200.00	607.27	607.50	1.1
D8303	16172.92	4200.00	618.50	618.65	1.1
D8401	16092.88	4300.00	596.71	597.09	1.1
D8402	16132.58	4300.00	607.27	607.50	1.1
D8403	16172.92	4300.00	618.50	618.65	1.1
D8501	16092.88	4400.00	596.71	597.09	1.1
D8502	16132.58	4400.00	607.27	607.50	1.1
D8503	16172.92	4400.00	618.50	618.65	1.1
D8601	16092.88	4500.00	596.71	597.09	1.1
D8602	16132.58	4500.00	607.27	607.50	1.1
D8603	16172.92	4500.00	618.50	618.65	1.1
D8701	16092.88	4600.00	596.71	597.09	1.1
D8702	16132.58	4600.00	607.27	607.50	1.1
D8703	16172.92	4600.00	618.50	618.65	1.1
D8801	16092.88	4700.00	596.71	597.09	1.1
D8802	16132.58	4700.00	607.27	607.50	1.1
D8803	16172.92	4700.00	618.50	618.65	1.1
D8901	16092.88	4800.00	596.71	597.09	1.1
D8902	16132.58	4800.00	607.27	607.50	1.1
D8903	16172.92	4800.00	618.50	618.65	1.1
D9001	16092.88	4900.00	596.71	597.09	1.1
D9002	16132.58	4900.00	607.27	607.50	1.1
D9003	16172.92	4900.00	618.50	618.65	1.1
D9101	16092.88	5000.00	596.71	597.09	1.1
D9102	16132.58	5000.00	607.27	607.50	1.1
D9103	16172.92	5000.00	618.50	618.65	1.1
D9201	16092.88	5100.00	596.71	597.09	1.1
D9202	16132.58	5100.00	607.27	607.50	1.1
D9203	16172.92	5100.00	618.50	618.65	1.1
D9301	16092.88	5200.00	596.71	597.09	1.1
D9302	16132.58	5200.00	607.27	607.50	1.1
D9303	16172.92	5200.00	618.50	618.65	1.1
D9401	16092.88	5300.00	596.71	597.09	1.1
D9402	16132.58	5300.00	607.27	607.50	1.1
D9403	16172.92	5300.00	618.50	618.65	1.1
D9501	16092.88	5400.00	596.71	597.09	1.1
D9502	16132.58	5400.00	607.27	607.50	1.1
D9503	16172.92	5400.00	618.50	618.65	1.1
D9601	16092.88	5500.00	596.71	597.09	1.1
D9602	16132.58	5500.00	607.27	607.50	1.1
D9603	16172.92	5500.00	618.50	618.65	1.1
D9701	16092.88	5600.00	596.71	597.09	1.1
D9702	16132.58	5600.00	607.27	607.50	1.1
D9703	16172.92	5600.00	618.50	618.65	1.1
D9801	16092.88	5700.00	596.71	597.09	1.1
D9802	16132.58	5700.00	607.27	607.50	1.1
D9803	16172.92	5700.00	618.50	618.65	1.1
D9901	16092.88	5800.00	596.71	597.09	1.1
D9902	16132.58	5800.00	607.27	607.50	1.1
D9903	16172.92	5800.00	618.50	618.65	1.1
D10001	16092.88	5900.00	596.71	597.09	1.1
D10002	16132.58	5900.00	607.27	607.50	1.1
D10003	16172.92	5900.00	618.50	618.65	1.1
D10101	16092.88	6000.00	596.71	597.09	1.1
D10102	16132.58	6000.00	607.27	607.50	1.1
D10103	16172.92	6000.00	618.50	618.65	1.1

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
D0601	14900.00	700.00	583.99	584.10	1.1
D0602	15000.00	700.00	584.79	584.95	1.1
D0603	15100.00	700.00	585.60	585.77	1.1
D0604	15200.00	700.00	586.41	586.61	1.2
D0605	15300.00	700.00	587.22	587.41	1.2
D0606	15400.00	700.00	588.02	588.19	1.1
D0607	15500.00	700.00	588.83	589.00	1.1
D0608	15600.00	700.00	590.64	590.73	1.0
D0609	15700.00	700.00	592.45	592.37	1.1
D0701	15800.00	700.00	593.26	593.42	1.1
D0702	15900.00	700.00	594.06	594.22	1.1
D0703	16000.00	700.00	594.87	595.07	1.1
D0704	16100.00	700.00	595.68	595.92	1.2
D0705	16200.00	700.00	596.49	596.77	1.2
D0706	16300.00	700.00	597.30	597.62	1.2
D0707	16400.00	700.00	598.10	598.47	1.2
D0708	16500.00	700.00	598.91	599.32	1.2
D0709	16600.00	700.00	599.72	600.17	1.2
D0710	16700.00	700.00	600.53	601.02	1.2
D0711	16800.00	700.00	601.34	601.87	1.2
D0712	16900.00	700.00	602.14	602.72	1.2
D0713	17000.00	700.00	602.95	603.57	1.2
D0714	17100.00	700.00	603.76	604.42	1.2
D0715	17200.00	700.00	604.57	605.27	1.2
D0716	17300.00	700.00	605.38	606.12	1.2
D0717	17400.00	700.00	606.18	606.97	1.2
D0718	17500.00	700.00	606.99	607.82	1.2
D0719	17600.00	700.00	607.80	608.67	1.2
D0720	17700.00	700.00	608.61	609.52	1.2
D0721	17800.00	700.00	609.42	610.37	1.2
D0722	17900.00	700.00	610.22	611.22	1.2
D0723	18000.00	700.00	611.03	612.07	1.2
D0724	18100.00	700.00	611.84	612.92	1.2
D0725	18200.00	700.00	612.65	613.77	1.2
D0726	18300.00	700.00	613.46	614.62	1.2
D0727	18400.00	700.00	614.26	615.47	1.2
D0728	18500.00	700.00	615.07	616.32	1.2
D0729	18600.00	700.00	615.88	617.17	1.2
D0730	18700.00	700.00	616.69	618.02	1.2
D0731	18800.00	700.00	617.50	618.87	1.2
D0732	18900.00	700.00	618.30	619.72	1.2
D0733	19000.00	700.00	619.11	620.57	1.2
D0734	19100.00	700.00	619.92	621.42	1.2
D0735	19200.00	700.00	620.73	622.27	1.2
D0736	19300.00	700.00	621.54	623.12	1.2
D0737	19400.00	700.00	622.34	623.97	1.2
D0738	19500.00	700.00	623.15	624.82	1.2
D0739	19600.00	700.00	623.96	625.67	1.2
D0740	19700.00	700.00	624.77	626.52	1.2
D0741	19800.00	700.00	625.58	627.37	1.2
D0742	19900.00	700.00	626.38	628.22	1.2
D0743	20000.00	700.00	627.19	629.07	1.2
D0744	20100.00	700.00	628.00	629.92	1.2
D0745	20200.00	700.00	628.81	630.77	1.2
D0746	20300.00	700.00	629.62	631.62	1.2
D0747	20400.00	700.00	630.42	632.47	1.2
D0748	20500.00	700.00	631.23	633.32	1.2
D0749	20600.00	700.00	632.04	634.17	1.2
D0750	20700.00	700.00	632.85	635.02	1.2
D0751	20800.00	700.00	633.66	635.87	1.2
D0752	20900.00	700.00	634.46	636.72	1.2
D0753	21000.00	700.00	635.27	637.57	1.2
D0754	21100.00	700.00	636.08	638.42	1.2
D0755	21200.00	700.00	636.89	639.27	1.2
D0756	21300.00	700.00	637.70	640.12	1.2
D0757	21400.00	700.00	638.50	640.97	1.2
D0758	21500.00	700.00	639.31	641.82	1.2
D0759	21600.00	700.00	640.12	642.67	1.2
D0760	21700.00	700.00	640.93	643.52	1.2
D0761	21800.00	700.00	641.74	644.37	1.2
D0762	21900.00	700.00	642.54	645.22	1.2
D0763	22000.00	700.00	643.35	646.07	1.2
D0764	22100.00	700.00	644.16	646.92	1.2
D0765	22200.00	700.00	644.97	647.77	1.2
D0766	22300.00	700.00	645.78	648.62	1.2
D0767	22400.00	700.00	646.58	649.47	1.2
D0768	22500.00	700.00	647.39	650.32	1.2
D0769	22600.00	700.00	648.20	651.17	1.2
D0770	22700.00	700.00	649.01	652.02	1.2
D0771	22800.00	700.00	649.82	652.87	1.2
D0772	22900.00	700.00	650.62	653.72	1.2
D0773	23000.00	700.00	651.43	654.57	1.2
D0774	23100.00	700.00	652.24	655.42	1.2
D0775	23200.00	700.00	653.05	656.27	1.2
D0776	23300.00	700.00	653.86	657.12	1.2
D0777	23400.00	700.00	654.66	657.97	1.2
D0778	23500.00	700.00	655.47	658.82	1.2
D0779	23600.00	700.00	656.28	659.67	1.2
D0780	23700.00	700.00	657.09	660.52	1.2
D0781	23800.00	700.00	657.90	661.37	1.2
D0782	23900.00	700.00	658.70	662.22	1.2
D0783	24000.00	700.00	659.51	663.07	1.2
D0784	24100.00	700.00	660.32	663.92	1.2
D0785	24200.00	700.00	661.13	664.77	1.2
D0786

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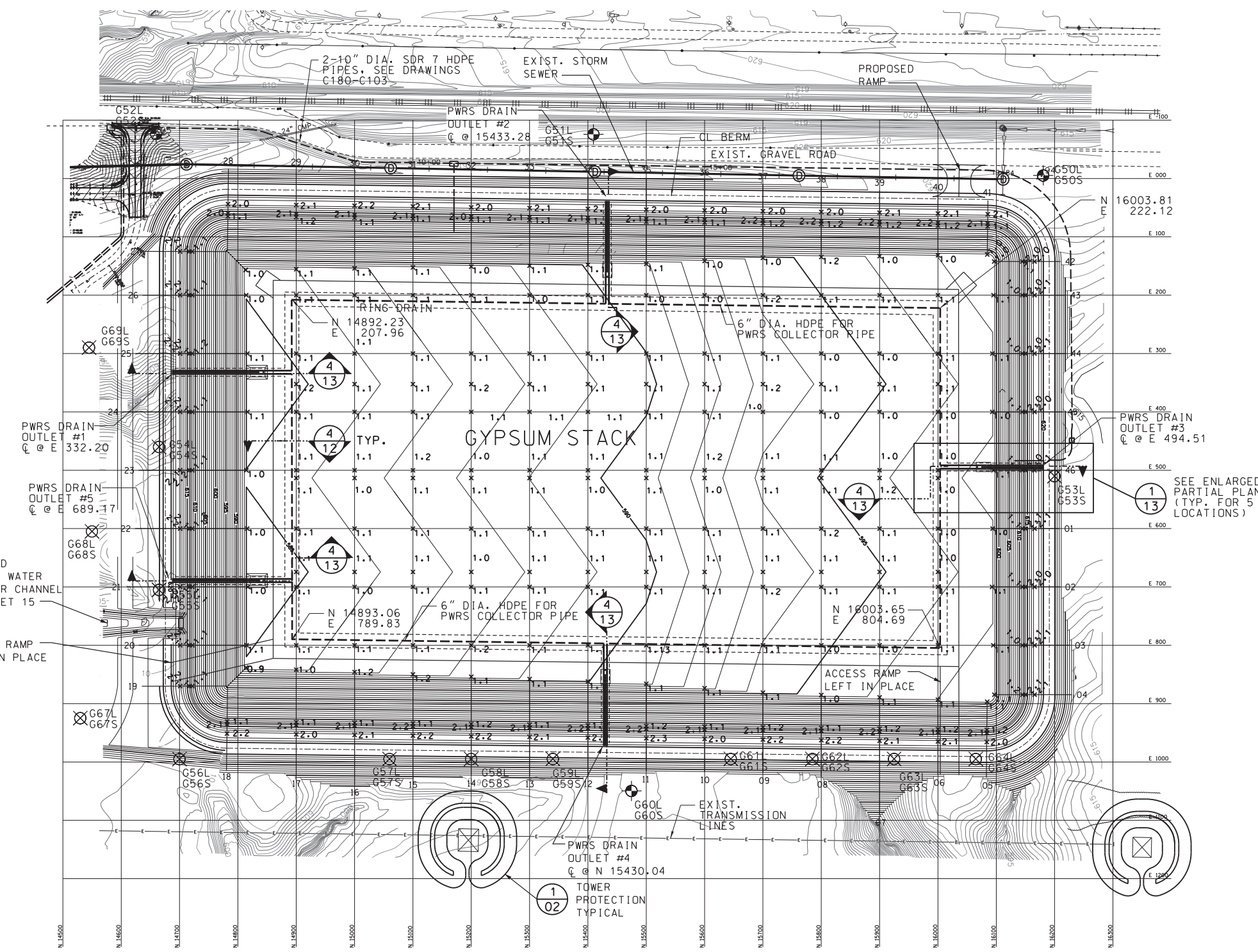
CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CUSHION DIRT DESIGN	TOP OF CUSHION DIRT RECORD	CUSHION DIRT
C0101	16093.72	600.00	596.91	597.36	1.0
C0102	16144.88	600.00	611.53	611.82	1.1
C0103	16149.88	600.00	614.00	614.30	2.1
C0104	16165.63	600.00	618.50	618.74	2.1
C0201	16092.72	700.00	596.62	597.10	1.1
C0202	16144.91	700.00	611.53	611.82	1.1
C0203	16149.91	700.00	614.00	614.24	2.0
C0204	16165.66	700.00	618.50	618.74	2.0
C0301	16094.87	800.00	597.23	597.82	1.1
C0302	16144.94	800.00	611.53	611.75	1.0
C0303	16149.94	800.00	614.00	614.29	2.1
C0304	16165.69	800.00	618.50	618.78	2.1
C0401	16096.68	884.70	597.74	598.24	1.1
C0402	16144.96	884.71	611.53	611.79	1.2
C0403	16149.96	884.70	614.00	614.23	2.1
C0404	16165.72	884.69	618.50	618.74	2.1
C0501	16084.47	896.68	597.71	598.41	1.1
C0502	16083.93	945.11	611.56	611.85	1.2
C0503	16083.88	950.06	614.00	614.25	2.1
C0504	16083.70	965.81	618.50	618.69	2.0
C0601	16000.00	893.29	597.01	597.27	1.1
C0602	16000.00	944.12	611.53	611.82	1.2
C0603	16000.00	949.12	614.00	614.24	2.1
C0604	16000.00	964.87	618.50	618.72	2.1
C0701	15900.00	889.27	596.18	596.47	1.1
C0702	15900.00	943.00	611.53	611.82	1.2
C0703	15900.00	948.01	614.00	614.29	2.2
C0704	15900.00	963.76	618.50	618.70	2.1
C0801	15800.00	885.24	595.35	595.60	1.0
C0802	15800.00	941.89	611.53	611.80	1.1
C0803	15800.00	946.89	614.00	614.26	2.1
C0804	15800.00	962.64	618.50	618.78	2.2
C0901	15700.00	881.21	594.52	594.81	1.1
C0902	15700.00	940.77	611.53	611.82	1.2
C0903	15700.00	945.77	614.00	614.26	2.1
C0904	15700.00	961.53	618.50	618.80	2.2
C1001	15600.00	873.61	592.66	592.94	1.1
C1002	15600.00	939.66	611.53	611.76	1.1
C1003	15600.00	944.66	614.00	614.25	2.1
C1004	15600.00	960.41	618.50	618.73	2.0
C1101	15500.00	866.01	590.81	591.07	1.1
C1102	15500.00	938.54	611.53	611.82	1.2
C1103	15500.00	943.54	614.00	614.26	2.2
C1104	15500.00	959.29	618.50	618.78	2.3
C1201	15400.00	861.99	589.98	590.25	1.1
C1202	15400.00	937.42	611.53	611.82	1.2
C1203	15400.00	942.42	614.00	614.29	2.2
C1204	15400.00	958.18	618.50	618.73	2.2
C1301	15300.00	857.96	589.15	589.38	1.1
C1302	15300.00	936.31	611.53	611.79	1.1
C1303	15300.00	941.31	614.00	614.23	2.1
C1304	15300.00	957.06	618.50	618.75	2.1
C1401	15200.00	853.93	588.32	588.57	1.1
C1402	15200.00	935.19	611.53	611.82	1.2
C1403	15200.00	940.19	614.00	614.25	2.1
C1404	15200.00	955.94	618.50	618.76	2.2
C1501	15100.00	849.91	587.48	587.77	1.2
C1502	15100.00	934.07	611.53	611.81	1.1
C1503	15100.00	939.07	614.00	614.27	2.2
C1504	15100.00	954.83	618.50	618.78	2.2
C1601	15000.00	845.88	586.65	586.96	1.2
C1602	15000.00	932.96	611.53	611.81	1.1
C1603	15000.00	937.96	614.00	614.26	2.1
C1604	15000.00	953.71	618.50	618.72	2.1
C1701	14900.00	841.85	585.82	586.02	1.0
C1702	14900.00	931.84	611.53	611.82	1.1
C1703	14900.00	936.84	614.00	614.29	2.1
C1704	14900.00	952.60	618.50	618.71	2.0
C1801	14814.14	838.40	585.11	585.38	0.9
C1802	14781.51	930.52	611.53	611.79	1.1
C1803	14781.45	935.52	614.00	614.20	2.1
C1804	14781.24	951.27	618.50	618.77	2.2
C1901	14814.14	838.40	585.11	585.40	0.9
C1902	14721.66	870.00	611.53	611.75	1.1
C1903	14716.66	870.01	614.00	614.25	2.1
C1904	14700.91	870.05	618.50	618.76	2.1
C2001	14814.90	800.00	584.89	585.18	1.1
C2002	14721.64	800.00	611.53	611.82	1.1
C2003	14716.64	800.00	614.00	614.25	2.1
C2004	14700.89	800.00	618.50	618.71	2.1
C2101	14816.88	700.00	584.31	584.59	1.0
C2102	14721.62	700.00	611.53	611.80	1.1
C2103	14716.62	700.00	614.00	614.21	2.1
C2104	14700.87	700.00	618.50	618.72	2.0
C2201	14815.89	600.00	584.59	584.83	1.0
C2202	14721.60	600.00	611.53	611.81	1.2
C2203	14716.60	600.00	614.00	614.20	2.1
C2204	14700.85	600.00	618.50	618.70	2.2
C2301	14814.43	500.00	585.00	585.22	1.0
C2302	14721.58	500.00	611.53	611.81	1.1
C2303	14716.58	500.00	614.00	614.29	2.2
C2304	14700.83	500.00	618.50	618.76	2.1
C2401	14816.38	400.00	584.44	584.96	1.1
C2402	14721.56	400.00	611.53	611.77	1.1
C2403	14716.56	400.00	614.00	614.23	2.1
C2404	14700.81	400.00	618.50	618.71	2.1
C2501	14816.27	300.00	584.47	584.76	1.1
C2502	14721.54	300.00	611.53	611.78	1.2
C2503	14716.54	300.00	614.00	614.23	2.1
C2504	14700.79	300.00	618.50	618.74	2.2
C2601	14814.24	200.00	585.04	585.25	1.0
C2602	14721.52	200.00	611.53	611.78	1.1
C2603	14716.52	200.00	614.00	614.25	2.1
C2604	14700.77	200.00	618.50	618.72	2.1
C2701	14813.37	156.83	585.29	585.66	1.0
C2702	14721.50	125.09	611.53	611.75	1.1
C2703	14716.50	125.09	614.00	614.24	2.1
C2704	14700.75	125.05	618.50	618.70	2.1
C2801	14813.37	156.83	585.29	585.68	1.0
C2802	14782.84	64.56	611.53	611.79	1.1
C2803	14782.89	59.56	614.00	614.21	2.0
C2804	14783.07	43.81	618.50	618.68	2.0
C2901	14900.00	155.51	585.99	586.42	1.1
C2902	14900.00	66.12	611.53	611.82	1.2
C2903	14900.00	61.12	614.00	614.23	2.1
C2904	14900.00	45.37	618.50	618.74	2.1
C3001	15000.00	153.98	586.81	587.08	1.1

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CUSHION DIRT DESIGN	TOP OF CUSHION DIRT RECORD	CUSHION DIRT
C3002	15000.00	67.45	611.53	611.75	1.1
C3003	15000.00	62.45	614.00	614.23	2.1
C3004	15000.00	46.70	618.50	618.78	2.2
C3101	15100.00	152.46	587.63	587.91	1.1
C3102	15100.00	68.79	611.53	611.81	1.1
C3103	15100.00	63.79	614.00	614.25	2.1
C3104	15100.00	48.03	618.50	618.77	2.1
C3201	15200.00	150.93	588.44	588.66	1.0
C3202	15200.00	70.12	611.53	611.81	1.1
C3203	15200.00	65.12	614.00	614.23	2.0
C3204	15200.00	49.37	618.50	618.71	2.0
C3301	15300.00	149.41	589.26	589.61	1.1
C3302	15300.00	71.45	611.53	611.77	1.1
C3303	15300.00	66.45	614.00	614.25	2.1
C3304	15300.00	50.70	618.50	618.74	2.1
C3401	15400.00	147.88	590.08	590.46	1.1
C3402	15400.00	72.79	611.53	611.79	1.1
C3403	15400.00	67.79	614.00	614.22	2.1
C3404	15400.00	52.03	618.50	618.66	2.0
C3501	15500.00	146.36	590.89	591.14	1.1
C3502	15500.00	74.12	611.53	611.77	1.1
C3503	15500.00	69.12	614.00	614.24	2.1
C3504	15500.00	53.37	618.50	618.62	2.0
C3601	15600.00	141.26	592.73	592.98	1.0
C3602	15600.00	75.45	611.53	611.78	1.1
C3603	15600.00	70.45	614.00	614.25	2.1
C3604	15600.00	54.70	618.50	618.68	2.0
C3701	15700.00	136.16	594.57	594.81	1.0
C3702	15700.00	76.79	611.53	611.77	1.2
C3703	15700.00	71.79	614.00	614.27	2.2
C3704	15700.00	56.03	618.50	618.61	2.0
C3801	15800.00	134.63	595.39	595.65	1.2
C3802	15800.00	78.12	611.53	611.80	1.2
C3803	15800.00	73.12	614.00	614.26	2.2
C3804	15800.00	57.37	618.50	618.61	2.0
C3901	15900.00	133.11	596.20	596.94	1.0
C3902	15900.00	79.45	611.53	611.81	1.2
C3903	15900.00	74.45	614.00	614.25	2.2
C3904	15900.00	58.70	618.50	618.67	2.1
C4001	16000.00	131.58	597.02	597.43	1.0
C4002	16000.00	80.79	611.53	611.83	1.2
C4003	16000.00	75.79	614.00	614.30	2.2
C4004	16000.00	60.03	618.50	618.71	2.1
C4101	16084.54	130.31	597.71	598.14	1.0
C4102	16085.19	81.93	611.53	611.80	1.1
C4103	16085.25	76.93	614.00	614.24	2.1
C4104	16085.46	61.17	618.50	618.76	2.1
C4201	16096.44	142.27	597.74	598.33	1.0
C4202	16144.74	142.26	611.53	611.83	1.1
C4203	16149.74	142.26	614.00	614.26	2.0
C4204	16165.49	142.25	618.50	618.81	2.0
C4301	16095.25	200.00	597.39	597.91	1.1
C4302	16144.76	200.00	611.53	611.78	1.0
C4303	16149.76	200.00	614.00	614.26	2.0
C4304	16165.51	200.00	618.50	618.77	2.1
C4401	16093.16	300.00	596.78	597.28	1.1
C4402	16144.79	300.00	611.53	611.80	1.0
C4403	16149.79	300.00	614.00	614.21	2.0
C4404	16165.54	300.00	618.50	618.79	2.1
C4501	16093.09	400.00	596.75	597.07	1.0
C4502	16144.82	400.00	611.53	611.79	1.1
C4503	16149.82	400.00	614.00	614.25	2.0
C4504	16165.57	400.00	618.50	618.78	2.0
C4601	16095.24	500.00	597.36	597.71	1.1
C4602	16144.85	500.00	611.53	611.80	1.1
C4603	16149.85	500.00	614.00	614.22	2.0
C4604	16165.60	500.00	618.50	618.76	2.1
CB01	14900.00	352.42	584.83	585.07	1.2
CB02	15000.00	352.42	585.64	585.91	1.1
CB03	15100.00	352.42	586.45	586.72	1.1
CB04	15200.00	352.42	587.26	587.53	1.2
CB05	15300.00	352.42	588.06	588.29	1.1
CB06	15400.00	352.42	588.87	589.10	1.1
CB07	15500.00	352.42	589.68	589.97	1.1
CB08	15600.00	352.42	591.49	591.72	1.1
CB09	15700.00	352.42	593.30	593.51	1.2
CB10	15800.00	352.42	594.10	594.35	1.1
CB11	15900.00	352.42	594.91	595.17	1.1
CB12	16000.00	352.42	595.72	596.00	1.1
CB13	14900.00	513.35	585.78	586.01	1.1
CB14	15000.00	513.35	586.59	586.80	1.0
CB15	15100.00	513.35	587.40	587.68	1.1
CB16	15200.00	513.35	588.21	588.46	1.1
CB17	15300.00	513.35	589.01	589.30	1.1
CB18	15400.00	513.35	589.82	589.99	1.0
CB19	15500.00	513.35	590.63	590.92	1.1
CB20	15600.00	513.35	592.44	592.65	1.0
CB21	15700.00	513.35	594.24	594.54	1.1
CB22	15800.00	513.35	595.05	595.28	1.1
CB23	15900.00	513.35	595.86	596.16	1.2
CB24	16000.00	513.35	596.67	596.84	1.0
CB25	14900.00	674.29	584.83	585.12	1.1
CB26	15000.00	674.29	585.64	585.88	1.1
CB27	15100.00	674.29	586.45	586.73	1.1
CB28	15200.00	674.29	587.26	587.43	1.0
CB29	15300.00	674.29	588.07	588.35	1.1
CB30	15400.00	674.29	588.87	589.18	1.1
CB31	15500.00	674.29	589.68	589.93	1.1
CB32	15600.00	674.29	591.49	591.74	1.1
CB33	15700.00	674.29	593.30	593.51	1.1
CB34	15800.00	674.29	594.10	594.32	1.1
CB35	15900.00	674.29	594.91	595.15	1.1
CB36	16000.00	674.29	595.72	596.01	1.0
CG01	14900.00	200.00	585.73	585.97	1.1
CG02	15000.00	200.00	586.54	586.80	1.1
CG03	15100.00	200.00	587.35	587.59	1.1
CG04	15200.00	200.00	588.15	588.45	1.1
CG05	15300.00	200.00	588.96	589.15	1.0
CG06	15400.00	200.00	589.77	590.03	1.1
CG07	15500.00	200.00	590.58	590.79	1.0
CG08	15600.00	200.00	592.39	592.62	1.0
CG09	15700.00	200.00	594.19	594.49	1.2
CG10	15800.00	200.00	595.00	595.25	1.1
CG11	15900.00	200.00	595.81	596.13	1.1
CG12	16000.00	200.00	596.62	596.82	1.1
CG13	14900.00	300.00	585.14	585.35	1.1
CG14	15000.00	300.00	585.95	586.21	1.1

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CUSHION DIRT DESIGN	TOP OF CUSHION DIRT RECORD	CUSHION DIRT
CG15	15100.00	300.00	586.76	587.03	1.1
CG16	15200.00	300.00	587.57	587.86	1.1
CG17	15300.00	300.00	588.37	588.67	1.1
CG18	15400.00	300.00	589.18	589.41	1.1
CG19	15500.00	300.00	589.99	590.25	1.1
CG20	15600.00	300.00	591.80	592.04	1.1
CG21	15700.00	300.00	593.60	593.86	1.1
CG22	15800.00	300.00	594.41	594.67	1.0
CG23	15900.00	300.00	595.22	595.45	1.0
CG24	16000.00	300.00	596.03	596.27	1.1
CG25	14900.00	400.00	585.11	585.36	1.1
CG26	15000.00	400.00	585.92	586.15	1.1
CG27	15100.00	400.00	586.73	587.01	1.1
CG28	15200.00	400.00	587.54	587.78	1.1
CG29	15300.00	400.00	588.34	588.58	1.1
CG30	15400.00	400.00	589.15	589.40	1.1
CG31	15500.00	400.00	589.96	590.20	1.1
CG32	15600.00	400.00	591.77	592.03	1.1
CG33	15700.00	400.00	593.58	593.74	1.0
CG34	15800.00	400.00	594.38	594.62	1.0
CG35	15900.00	400.00	595.19	595.41	1.0
CG36	16000.00	400.00	596.00	596.27	1.0
CG37	14900.00	500.00	585.70	586.00	1.1
CG38	15000.00	500.00	586.51	586.75	1.1
CG39	15100.00	500.00	587.32	587.59	1.2
CG40	15200.00	500.00	588.13	588.34	1.0
CG41	15300.00	500.00	588.93	589.21	1.1
CG42	15400.00	500.00	589.74	590.01	1.1
CG43	15500.00	500.00	590.55	590.81	1.1
CG44	15600.00	500.00	592.36	592.65	1.2.
CG45	15700.00	500.00	594.17	594.43	1.1
CG46	15800.00	500.00	594.97	595.22	1.1
CG47	15900.00	500.00	595.78	595.97	1.0
CG48	16000.00	500.00	596.59	596.89	1.0
CG49	14900.00	600.00	585.27	585.53	1.1
CG50	15000.00	600.00	586.08	586.34	1.1
CG51	15100.00	600.00	586.89	587.16	1.1
CG52	15200.00	600.00	587.70	587.97	1.1
CG53	15300.00	600.00	588.50	588.78	1.1
CG54	15400.00	600.00	589.31	589.59	1.1
CG55	15500.00	600.00	590.12	590.35	1.0
CG56	15600.00	600.00	591.93	592.23	1.0
CG57	15700.00	600.00	593.73	593.98	1.1
CG58	15800.00	600.00	594.54	594.82	1.2
CG59	15900.00	600.00	595.35	595.59	1.1
CG60	16000.00	600.00	596.16	596.52	1.0
CG61	14900.00	700.00	584.99	585.21	1.1
CG62	15000.00	700.00	585.79	585.98	1.0
CG63	15100.00	700.00	586.60	586.86	1.1
CG64	15200.00	700.00	587.41	587.68	1.1
CG65	15300.00	700.00	588.22	588.48	1.1
CG66	15400.00	700.00	589.02	589.30	1.1
CG67	15500.00	700.00	589.83	590.12	1.1
CG68	15600.00	700.00	591.64	591.85	1.1
CG69	15700.00	700.00	593.45	593.72	1.1
CG70	15800.00	700.00	594.26	594.52	1.1
CG71	15900.00	700.00	595.06	595.32	1.1
CG72	16000.00	700.00	595.87	596.17	1.1
CG73	14900.00	800.00	585.57	585.81	1.1
CG74	15000.00	800.00	586.38	586.66	1.1
CG75	15100.00	800.00	587.19	587.44	1.1
CG76	15200.00	800.00	588.00	588.27	1.2
CG77	15300.00	800.00	588.81	589.10	1.1
CG78	15400.00	800.00	589.61	589.80	1.1
CG79	15500.00	800.00	590.42	590.72	1.1
CG80	15600.00	800.00	592.23	592.52	1.1
CG81	15700.00	800.00	594.04	594.31	1.1
CG82	15800.00	800.00	594.84	595.06	1.0
CG83	15900.00	800.00	595.65	595.88	1.0
CG84	16000.00	800.00	596.46	596.87	1.1

NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.



STANDARD LEGEND

(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- CUSHION DIRT LAYER THICKNESS (IN FEET)
- RING DRAIN SAND LIMITS
- CONSTRUCTION ROAD LIMITS

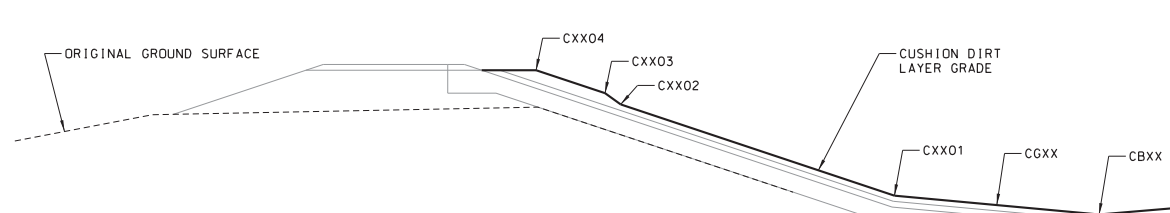
0' 100' 200'
SCALE: 1" = 100'

TYPICAL POINT NUMBER LOCATION

CB 00
- GRID POINT NUMBER
- CUSHION LAYER GRADE (BREAK POINT)

CG 00
- GRID POINT NUMBER
- CUSHION LAYER GRADE

C 00 00
- POINT NUMBER (SEE POINT NUMBERING DETAIL)
- CONTROL LINE NUMBER
- CUSHION LAYER GRADE



POINT NUMBERING DETAIL

Brans00939
09\4\2009
I:\03 jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-II.dgn

AEG CAD GENERATED
DO NOT REVISE MANUALLY

LAYOUT	KNK	05/10/07
DRAWN	SKB	03-05-08
REVIEWED		

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED CONTOURS / TABLE - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	10-14-08	TJL	DBH	SMB	REVISED GRADING TABLE AND CONTOURS FOR 2 FT. FOUNDATION GRADE RAISE FOR THE NORTH 400' OF THE GYPSUM STACK FLOOR
4	11-17-08	DBH	DBH	SMB	ADDED CENTERLINE COORDINATES FOR PWRS DRAIN LOCATIONS
5	02-09-09	DBH	SKB	SMB	RELOCATE SOUTH RING DRAIN ALIGNMENT 30' NORTH
6	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	

30x42

RECORD DRAWING

FILE NO. -C180-C102-II.dgn

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SCALE -
DRAFTER -
DATE 03-26-09

DRAWING TITLE

PWRS-RING DRAIN SYSTEM CUSHION DIRT LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy
Resources Generating

DRAWING NUMBER C180-C102 REV. 6

SHEET NO. 11 OF 33

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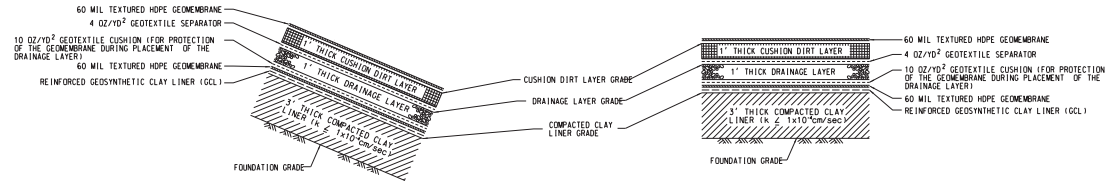
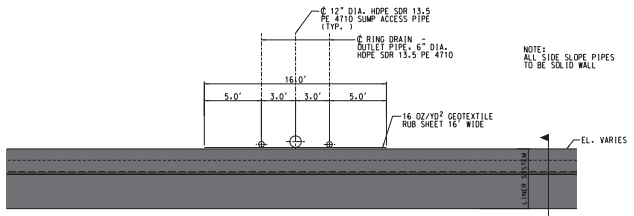
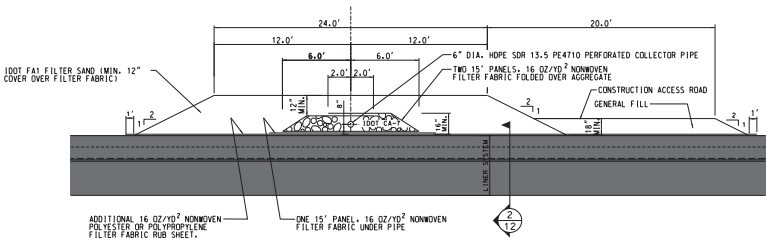


1/12 SIDE SLOPE LINER SYSTEM
NTS
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

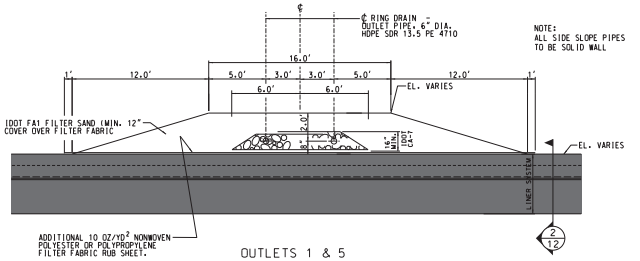
2/12 BOTTOM LINER SYSTEM
NTS
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN



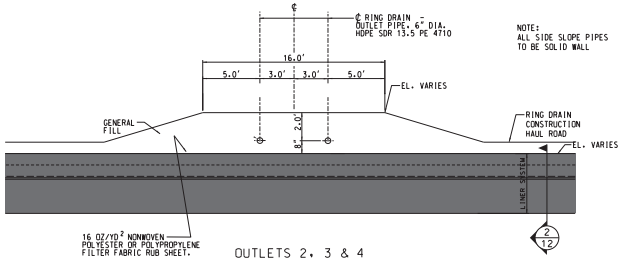
3/12 RING DRAIN RISER CROSS SECTION (3-PIPES) FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN



4/12 RING DRAIN COLLECTOR CROSS SECTION FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

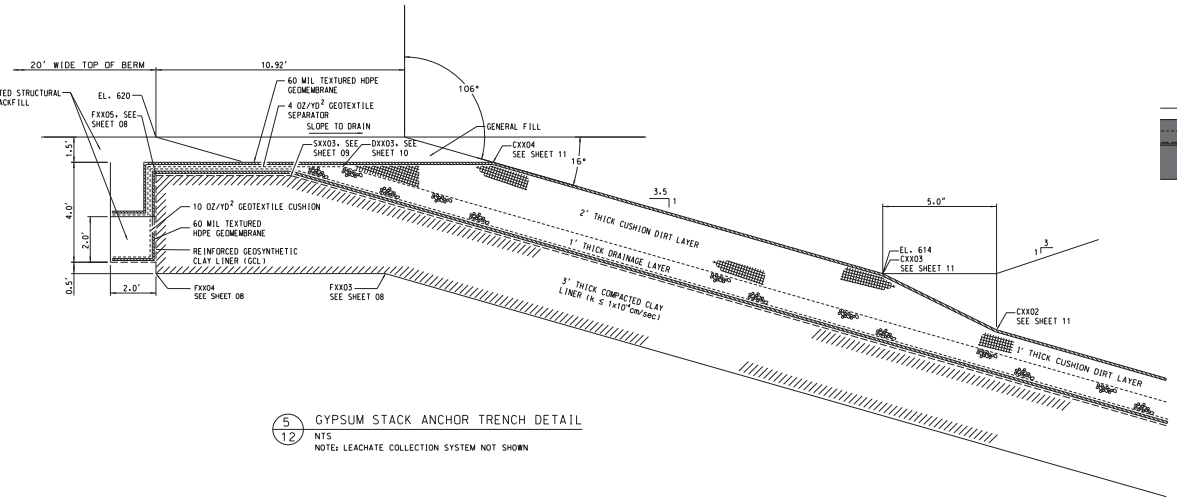


OUTLETS 1 & 5



OUTLETS 2, 3 & 4

6/12 PIPES BETWEEN RING DRAIN AND RISERS FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN



5/12 GYPSUM STACK ANCHOR TRENCH DETAIL
NTS
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

RECORD DRAWING

FILE NO. -C180-C102-12.dgn

DRAWING TITLE

PWRS - RING DRAIN DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

DRAWING NUMBER C180-C102 REV. 5
SHEET NO. 12 OF 33

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DATE 03-26-09

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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED DETAIL 5 - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	9-19-08	TCJ	RWH	RWH	ADDED LEACHATE COLLECTION NOTE TO ALL DETAILS
4	02-12-09	SKB	SMB	SMB	REVISED DETAIL 6
5	03-05-09	SKB	JWM	-	ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

ENTRY	INK	10/15/07
DATA	SKB	03-05-08
REVIEWED		

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Brand0039
06/14/2009
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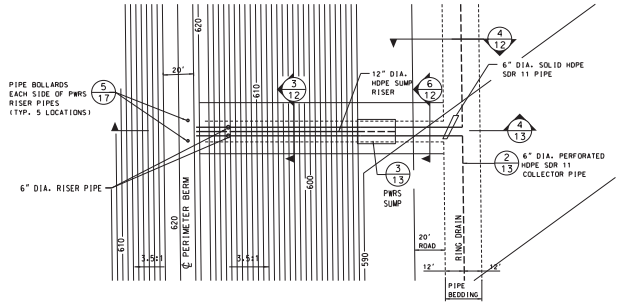
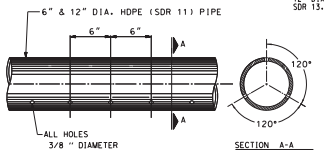
C180-C102

PERFORATED PIPE

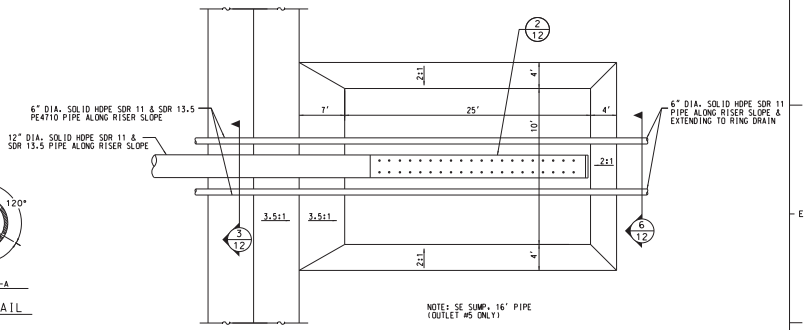
SOLID PIPE



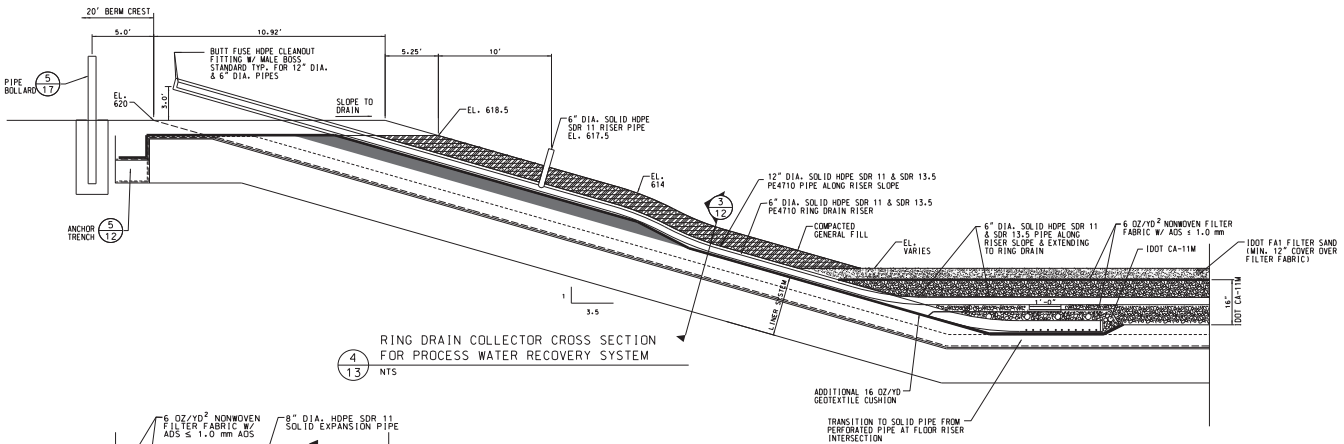
1/13 PROCESS WATER RECOVERY SYSTEM – PARTIAL PLAN (TYP. 5 LOCATIONS)
SCALE: 1"=30'



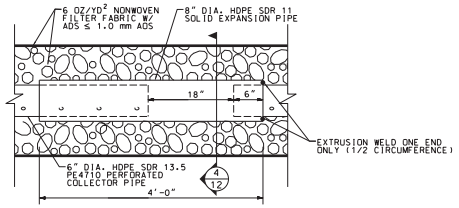
2/13 RING DRAIN COLLECTOR PIPE DETAIL
NTS



3/13 PWRS SUMP PLAN
NTS



4/13 RING DRAIN COLLECTOR CROSS SECTION FOR PROCESS WATER RECOVERY SYSTEM
NTS



5/13 RING DRAIN COLLECTOR PIPE EXPANSION UNION
NTS

NOTE:
INSTALL EXPANSION UNION EVERY 100 FT OF 6" DIA. PERFORATED COLLECTOR PIPE

NOTE:
RING DRAIN COLLECTOR PIPES ARE PERFORATED.
RING DRAIN RISER PIPES ARE NOT PERFORATED.

RECORD DRAWING

FILE NO. C180-C102-13.dgn

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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
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1	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
2	-	SKB	JDM	-	ISSUED FOR RECORD DRAWING

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

ENTRY	INK	10/15/07
DATE	JDM	04-15-08
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DRAWING TITLE

PWRS – RING DRAIN DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

SCALE -

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DATE 03-26-09

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 2

SHEET NO. 13 OF 33

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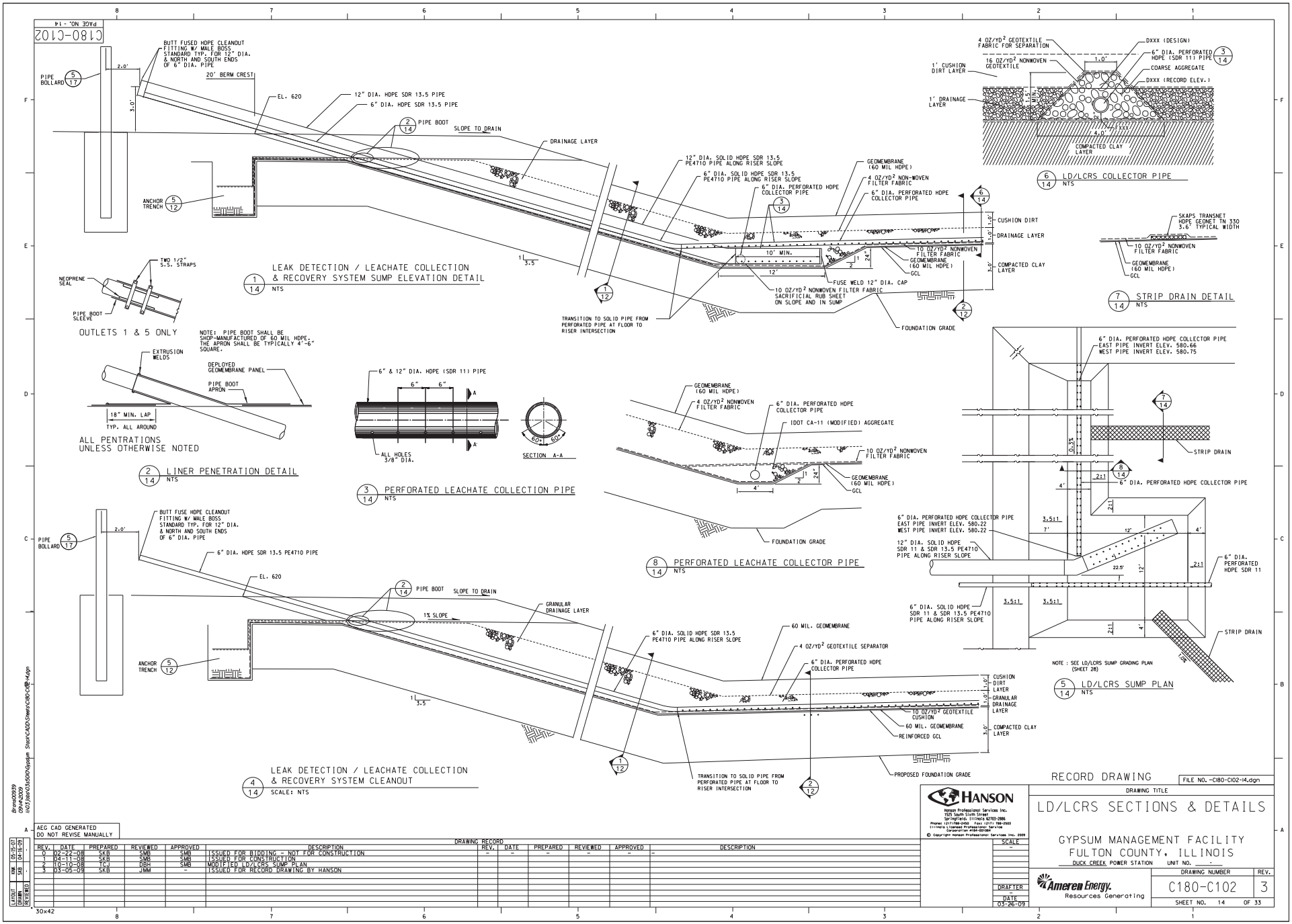
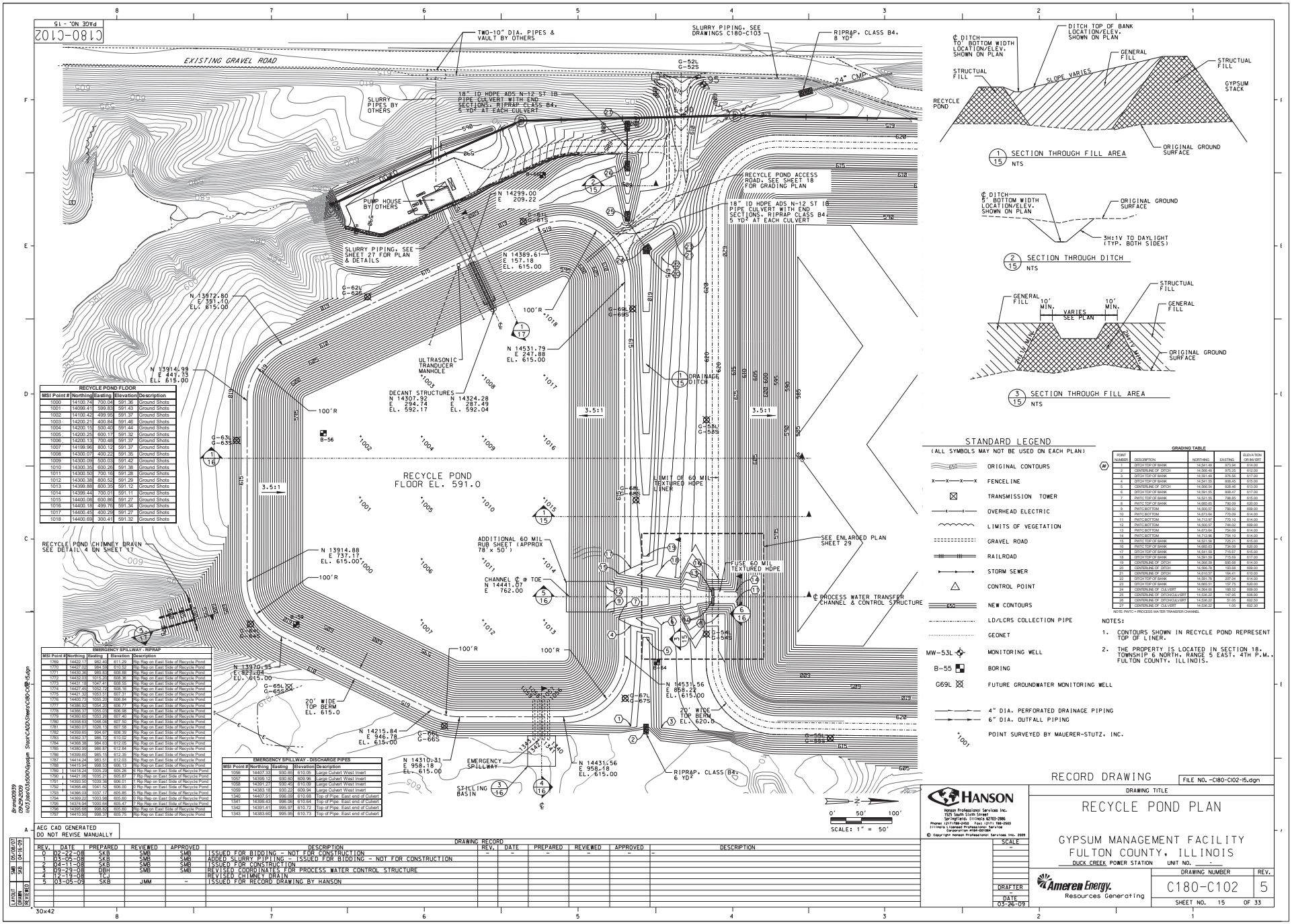


Electronic Filing: Received, Clerk's Office 06/20/2024



RECYCLE POND FLOOR

MSI Point #	Northing	Easting	Elevation	Description
1000	14100.74	700.04	591.36	Ground Shots
1001	14099.41	599.83	591.43	Ground Shots
1002	14100.42	499.95	591.37	Ground Shots
1003	14200.21	400.84	591.46	Ground Shots
1004	14200.15	500.40	591.44	Ground Shots
1005	14200.25	600.17	591.32	Ground Shots
1006	14200.13	700.48	591.37	Ground Shots
1007	14199.98	800.12	591.37	Ground Shots
1008	14300.07	400.22	591.35	Ground Shots
1009	14300.09	500.03	591.42	Ground Shots
1010	14300.35	600.26	591.38	Ground Shots
1011	14300.50	700.16	591.28	Ground Shots
1012	14300.38	800.52	591.29	Ground Shots
1013	14399.88	800.35	591.12	Ground Shots
1014	14399.44	700.91	591.11	Ground Shots
1015	14400.08	600.86	591.27	Ground Shots
1016	14400.18	499.76	591.34	Ground Shots
1017	14400.45	400.29	591.27	Ground Shots
1018	14400.69	300.41	591.32	Ground Shots

EMERGENCY SPILLWAY - RIPRAP

MSI Point #	Northing	Easting	Elevation	Description
1769	14402.17	992.40	611.29	Rip Rap on East Side of Recycle Pond
1770	14427.02	984.56	610.52	Rip Rap on East Side of Recycle Pond
1771	14430.39	989.83	608.88	Rip Rap on East Side of Recycle Pond
1772	14432.03	1019.26	608.36	Rip Rap on East Side of Recycle Pond
1773	14431.18	1047.41	608.55	Rip Rap on East Side of Recycle Pond
1774	14427.46	1052.72	608.18	Rip Rap on East Side of Recycle Pond
1775	14421.32	1053.51	607.31	Rip Rap on East Side of Recycle Pond
1776	14400.73	1055.26	606.84	Rip Rap on East Side of Recycle Pond
1777	14386.92	1054.26	606.77	Rip Rap on East Side of Recycle Pond
1778	14368.37	1055.03	606.98	Rip Rap on East Side of Recycle Pond
1779	14360.85	1063.28	607.40	Rip Rap on East Side of Recycle Pond
1780	14358.63	1048.58	607.50	Rip Rap on East Side of Recycle Pond
1781	14360.07	1026.13	607.58	Rip Rap on East Side of Recycle Pond
1782	14359.65	994.83	608.30	Rip Rap on East Side of Recycle Pond
1783	14362.37	986.73	610.02	Rip Rap on East Side of Recycle Pond
1784	14368.38	984.63	612.05	Rip Rap on East Side of Recycle Pond
1785	14380.99	986.87	612.84	Rip Rap on East Side of Recycle Pond
1786	14399.60	985.15	612.35	Rip Rap on East Side of Recycle Pond
1787	14414.24	983.51	612.05	Rip Rap on East Side of Recycle Pond
1788	14415.94	998.53	606.13	Rip Rap on East Side of Recycle Pond
1789	14418.24	1005.29	605.26	Rip Rap on East Side of Recycle Pond
1790	14421.06	1035.21	605.87	Rip Rap on East Side of Recycle Pond
1791	14393.50	1039.36	606.01	Rip Rap on East Side of Recycle Pond
1792	14368.46	1041.52	606.00	Rip Rap on East Side of Recycle Pond
1793	14366.03	1037.17	605.85	Rip Rap on East Side of Recycle Pond
1794	14369.22	1003.99	605.60	Rip Rap on East Side of Recycle Pond
1795	14374.94	1000.64	605.47	Rip Rap on East Side of Recycle Pond
1796	14395.68	998.82	605.60	Rip Rap on East Side of Recycle Pond
1797	14410.95	998.37	605.75	Rip Rap on East Side of Recycle Pond

EMERGENCY SPILLWAY - DISCHARGE PIPES

MSI Point #	Northing	Easting	Elevation	Description
1056	14407.33	930.85	610.05	Large Culvert West Invert
1057	14399.12	930.60	609.96	Large Culvert West Invert
1058	14391.27	930.45	610.09	Large Culvert West Invert
1059	14383.18	930.22	609.94	Large Culvert West Invert
1340	14407.51	996.09	610.68	Top of Pipe: East end of Culvert
1341	14399.43	996.06	610.64	Top of Pipe: East end of Culvert
1342	14391.41	995.97	610.72	Top of Pipe: East end of Culvert
1343	14383.40	995.95	610.73	Top of Pipe: East end of Culvert

STANDARD LEGEND

(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- POINT SURVEYED BY MAUERER-STUTZ, INC.

GRADING TABLE

POINT NUMBER	DESCRIPTION	NORTHING	EASTING	ELEVATION OR INVERT
1	DITCH TOP OF BANK	14,541.48	373.94	614.00
2	CENTERLINE OF DITCH	14,356.49	375.25	612.00
3	DITCH TOP OF BANK	14,591.49	376.56	617.00
4	DITCH TOP OF BANK	14,541.55	838.45	615.00
5	CENTERLINE OF DITCH	14,356.54	838.46	613.00
6	DITCH TOP OF BANK	14,591.55	838.47	617.00
7	PWTC TOP OF BANK	14,521.50	798.85	615.00
8	PWTC TOP OF BANK	14,685.85	780.00	620.00
9	PWTC BOTTOM	14,300.57	780.02	609.00
10	PWTC BOTTOM	14,673.94	770.00	614.00
11	PWTC BOTTOM	14,712.87	770.10	614.00
12	PWTC BOTTOM	14,300.57	744.02	609.00
13	PWTC BOTTOM	14,673.84	754.09	614.00
14	PWTC BOTTOM	14,712.96	754.19	614.00
15	PWTC TOP OF BANK	14,521.58	725.21	615.00
16	PWTC TOP OF BANK	14,685.83	734.09	620.00
17	DITCH TOP OF BANK	14,541.59	735.87	615.00
18	DITCH TOP OF BANK	14,591.59	715.69	617.00
19	CENTERLINE OF DITCH	14,356.59	695.69	614.00
20	CENTERLINE OF DITCH	14,356.78	189.89	609.00
21	CENTERLINE OF DITCH	14,810.57	184.41	610.00
22	DITCH TOP OF BANK	14,591.79	207.04	614.00
23	DITCH TOP OF BANK	14,665.51	157.75	620.00
24	CENTERLINE OF CULVERT	14,564.90	139.12	609.00
25	CENTERLINE OF DITCH/CULVERT	14,336.22	147.95	608.90
26	CENTERLINE OF DITCH/CULVERT	14,336.62	51.05	602.00
27	CENTERLINE OF CULVERT	14,336.23	1.05	602.30

NOTE: PWTC = PROCESS WATER TRANSFER CHANNEL

NOTES:

1. CONTOURS SHOWN IN RECYCLE POND REPRESENT TOP OF LINER.
2. THE PROPERTY IS LOCATED IN SECTION 18, TOWNSHIP 6 NORTH, RANGE 5 EAST, 4TH P.M., FULTON COUNTY, ILLINOIS.

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DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	ADDED SLURRY PIPING - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	03-29-08	DBH	SMB	SMB	REVISED COORDINATES FOR PROCESS WATER CONTROL STRUCTURE
4	12-19-08	TCJ			REVISED CHIMNEY DRAIN
5	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

RECORD DRAWING

FILE NO. -C180-C102-r5.dgn

HANSON

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Corporation #184.001352

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DRAWING TITLE

RECYCLE POND PLAN

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 5

SHEET NO. 15 OF 33

SCALE -

DRAFTER

DATE 03-26-09

30x42

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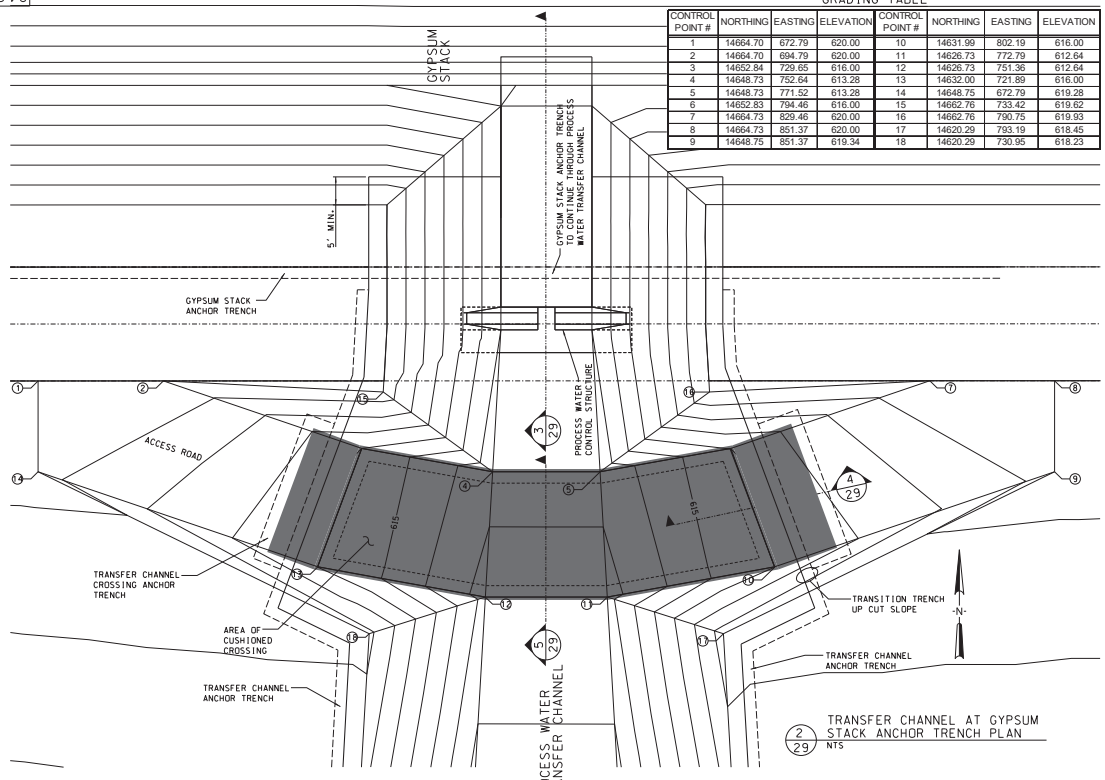
C180-C102

PAGE NO. - 29

GRADING TABLE

CONTROL POINT #	NORTHING	EASTING	ELEVATION	CONTROL POINT #	NORTHING	EASTING	ELEVATION
1	14664.70	672.79	620.00	10	14631.99	802.19	616.00
2	14664.70	694.79	620.00	11	14626.73	772.79	612.64
3	14652.84	729.65	616.00	12	14626.73	751.36	612.64
4	14648.73	752.64	613.28	13	14632.00	721.89	616.00
5	14648.73	771.52	613.28	14	14648.75	672.79	619.28
6	14652.83	794.46	616.00	15	14662.76	733.42	619.62
7	14664.73	829.46	620.00	16	14662.76	790.75	619.93
8	14664.73	851.37	620.00	17	14620.29	793.19	618.45
9	14648.75	851.37	619.34	18	14620.29	730.95	618.23

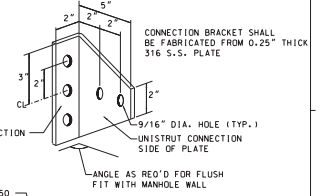


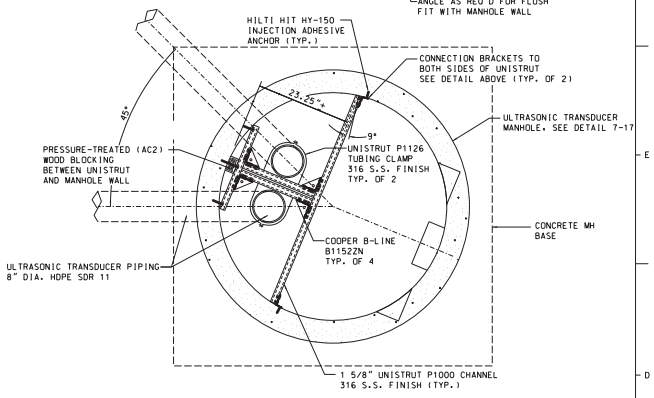
2 29 TRANSFER CHANNEL AT GYPSUM STACK ANCHOR TRENCH PLAN
NTS

NOTE:

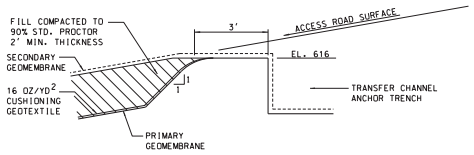
ALL ANCHORS IN MANHOLE WALLS SHALL BE HILTI HIT HY-150 MAX INJECTION ADHESIVE ANCHORS SET TO A DEPTH OF 3".

ALL FASTENER HARDWARE AND UNISTRUT CHANNEL NUTS (PART P1010) SHALL BE 316 S.S. WITH 1/2"x13 BOLT SIZE

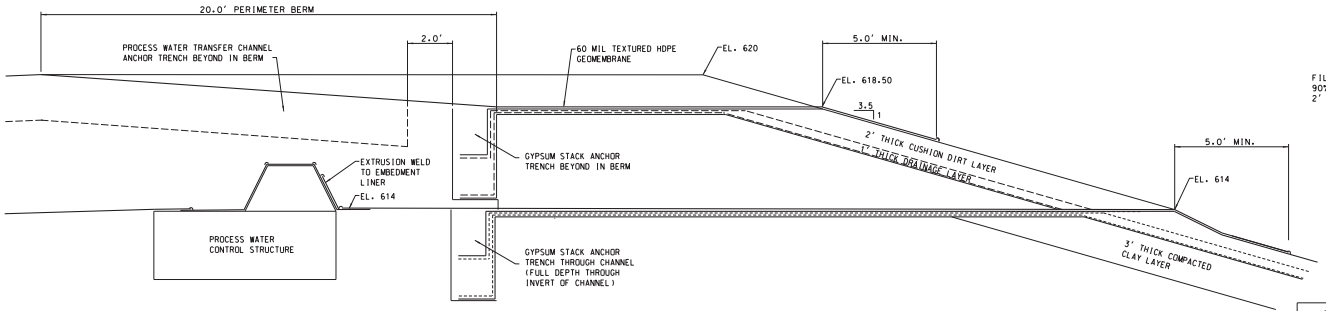




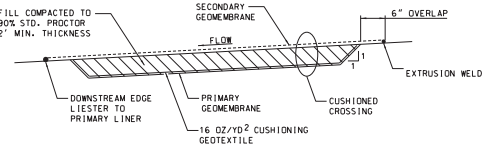
1 29 ULTRASONIC TRANSDUCER PIPE SUPPORT DETAIL
1"=1'



4 29 ACCESS ROAD AT TRANSFER CHANNEL TRENCH
NTS



3 29 TRANSFER CHANNEL AT GYPSUM STACK ANCHOR TRENCH SECTION
NTS



5 29 ACCESS ROAD THRU PROCESS WATER TRANSFER CHANNEL TRENCH
NTS

AWING

FILE NO. -C180-C102-29.dgn

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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-07-08	TCJ	DBH	SMB	ISSUED FOR CONSTRUCTION
1	01-08-09	TCJ	DBH	DBH	ADDED ACCESS ROAD CROSSING AND DETAILS
2	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION

DRAWN SKB 11-21-08
CHECKED JMM 11-21-08
APPROVED - -/-/-

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DRAWING TITLE

MISCELLANEOUS DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

SCALE -
DRAFTER
DATE 03-26-09

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 2

SHEET NO. 29 OF 33

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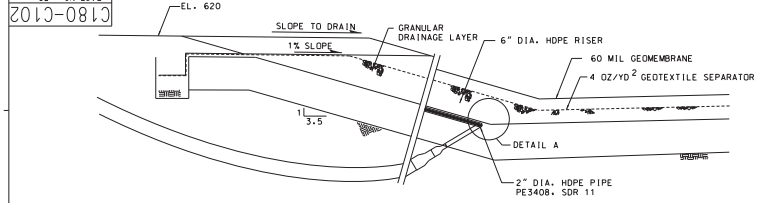
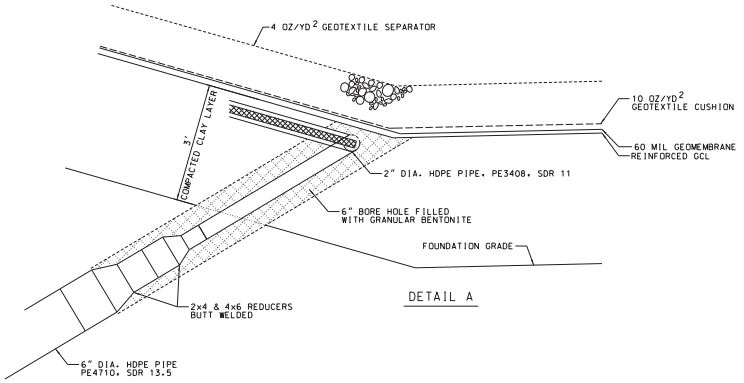


1/30 RISER DETAIL
SCALE: NTS



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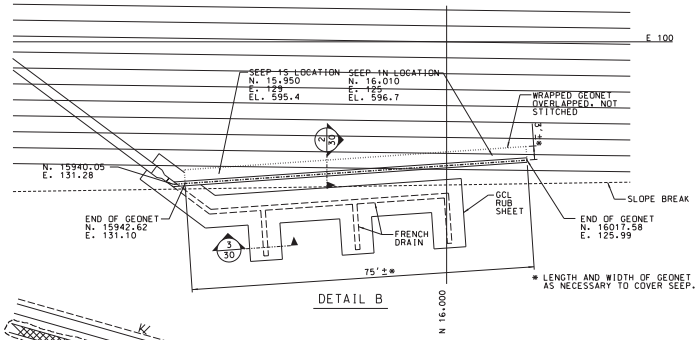

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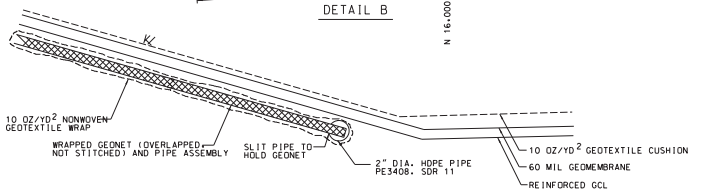
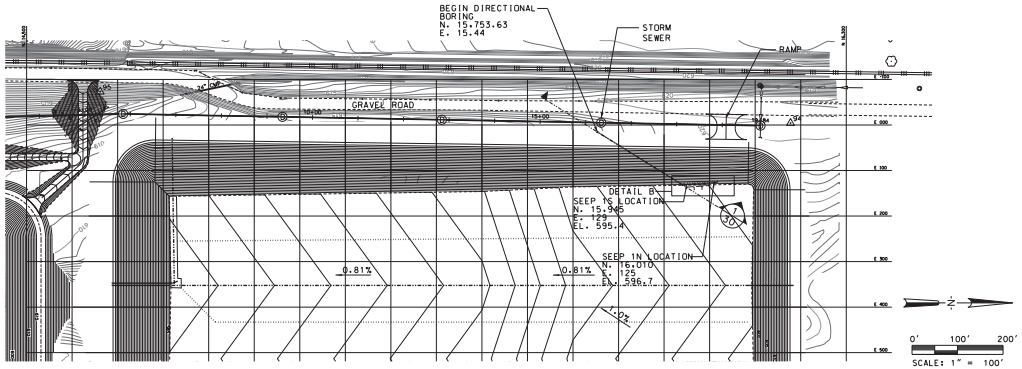
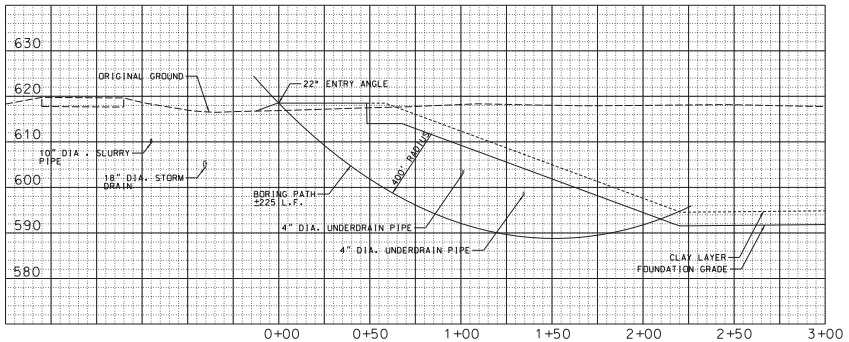


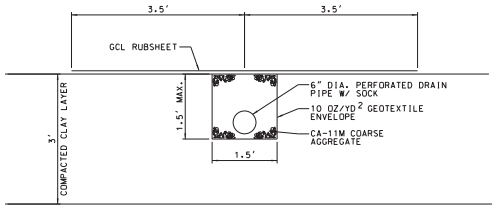
2/30 GEONET DETAIL
SCALE: NTS





BORING PROFILE

STATION	CLAY LAYER ELEVATION	BORING PATH ELEVATION
0+00	618.50	618.50
0+10	618.50	614.57
0+20	618.50	610.94
0+30	618.50	607.62
0+40	618.50	604.58
0+50	618.50	601.82
0+60	618.26	599.34
0+70	616.79	597.14
0+80	615.31	595.19
0+90	613.84	593.51
1+00	612.36	592.09
1+10	610.89	590.93
1+20	609.41	590.02
1+30	607.94	589.36
1+40	606.46	588.95
1+50	604.98	588.80
1+60	603.51	588.89
1+70	602.03	589.23
1+80	600.56	589.83
1+90	599.08	590.67
2+00	597.61	591.77
2+10	596.13	593.13
2+20	594.66	594.74



3/30 FRENCH DRAIN DETAIL
SCALE: NTS

NOTE:
SEE OTHER PLAN SHEETS FOR STANDARD LEGEND.

RECORD DRAWING

FILE NO. -C180-C102-30_SEEP1.dgn

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DRAWING TITLE
LD/LCRS UNDERDRAIN DEWATERING SYSTEM-SEEP 1
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 2
SHEET NO. 30 OF 33

SCALE
DRAFTER
DATE 03-26-09

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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-07-08	TCJ	RWH	DBH	ISSUED FOR CONSTRUCTION
1	11-14-08	TCJ			REVISED BORING PATH AND ENTRY POINT - ISSUED FOR CONSTRUCTION
2	03-05-09	SKB	JMM		ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
–	–	–	–	–	–

REVISED	SKB	11-05-08
DRAWN	TCJ	11-05-08
CHECKED	DBH	11-05-08

30x42

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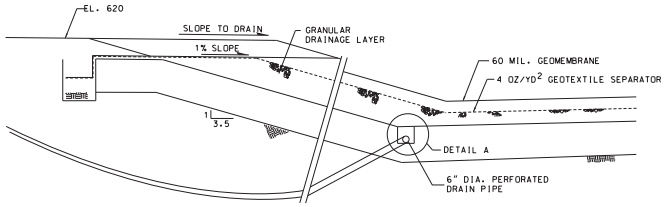

1/31 RISER DETAIL
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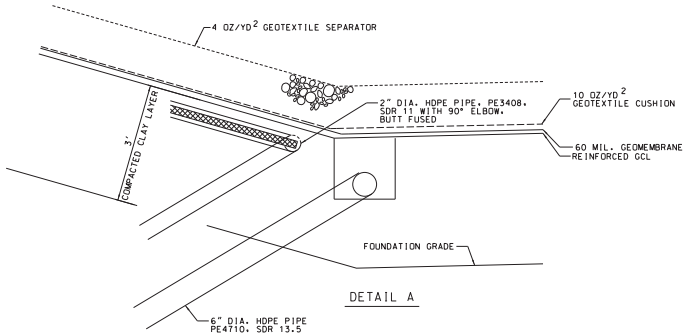
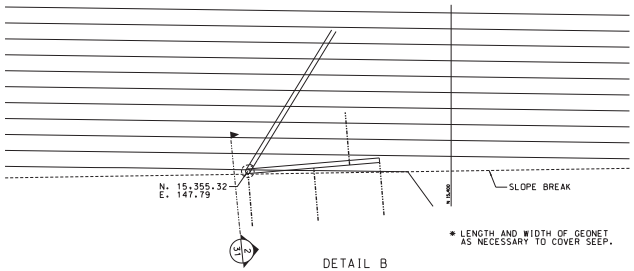
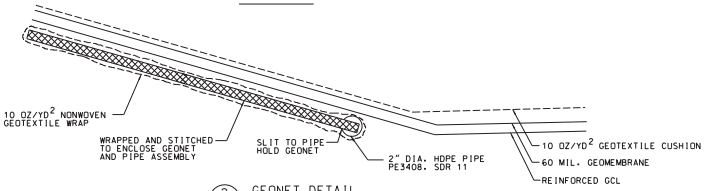


DETAIL A



DETAIL B



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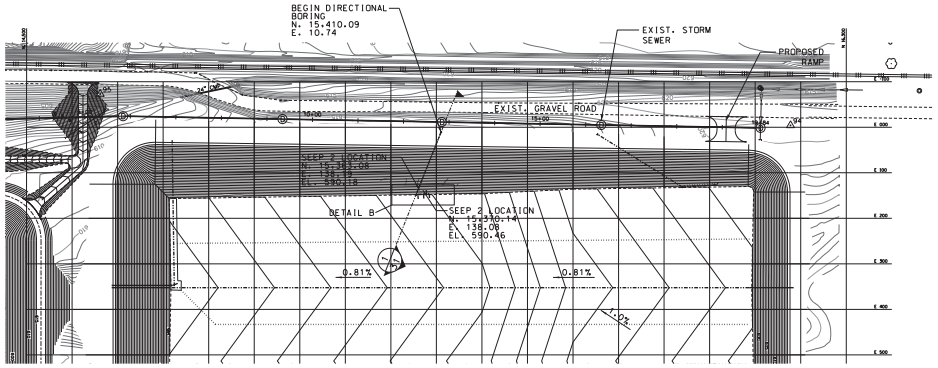

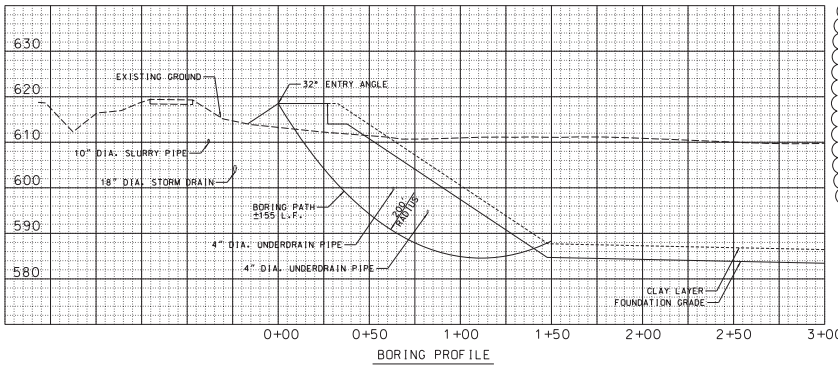

BORING PROFILE

STATION	CLAY LAYER ELEVATION	BORING PATH ELEVATION
0+00	618.50	618.50
0+10	618.50	612.21
0+20	618.50	606.70
0+30	618.50	601.90
0+40	616.55	597.77
0+50	613.88	594.24
0+60	611.21	591.30
0+70	608.55	588.91
0+80	605.88	587.05
0+90	603.21	585.72
1+00	600.54	584.89
1+10	597.88	584.57
1+20	595.21	584.75
1+30	592.54	585.43
1+40	589.88	586.61

① 1/31

STANDARD LEGEND

(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- 650 ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- 650 NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING

0' 100' 200'
SCALE: 1" = 100'

RECORD DRAWING

FILE NO. -C180-C102-31_SEEP2.dgn

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DRAWING TITLE

LD/LCRS UNDERDRAIN DEWATERING SYSTEM-SEEP 2

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER	REV.
C180-C102	2

SHEET NO. 31 OF 33

SCALE -
DRAFTER -
DATE 03-26-09

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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-19-08	TCJ	---	---	ISSUED FOR CONSTRUCTION
1	11-24-08	TCJ	RWH	DBH	ISSUED FOR CONSTRUCTION REVISED PENETRATION LOCATION
2	03-05-09	TCJ	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

LAYOUT TCJ 11-25-08
DRAWN TCJ 11-25-08
REVIEWED DBH

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AECOM

Appendix C: Duck Creek Power Station Boring and Piezometer Locations

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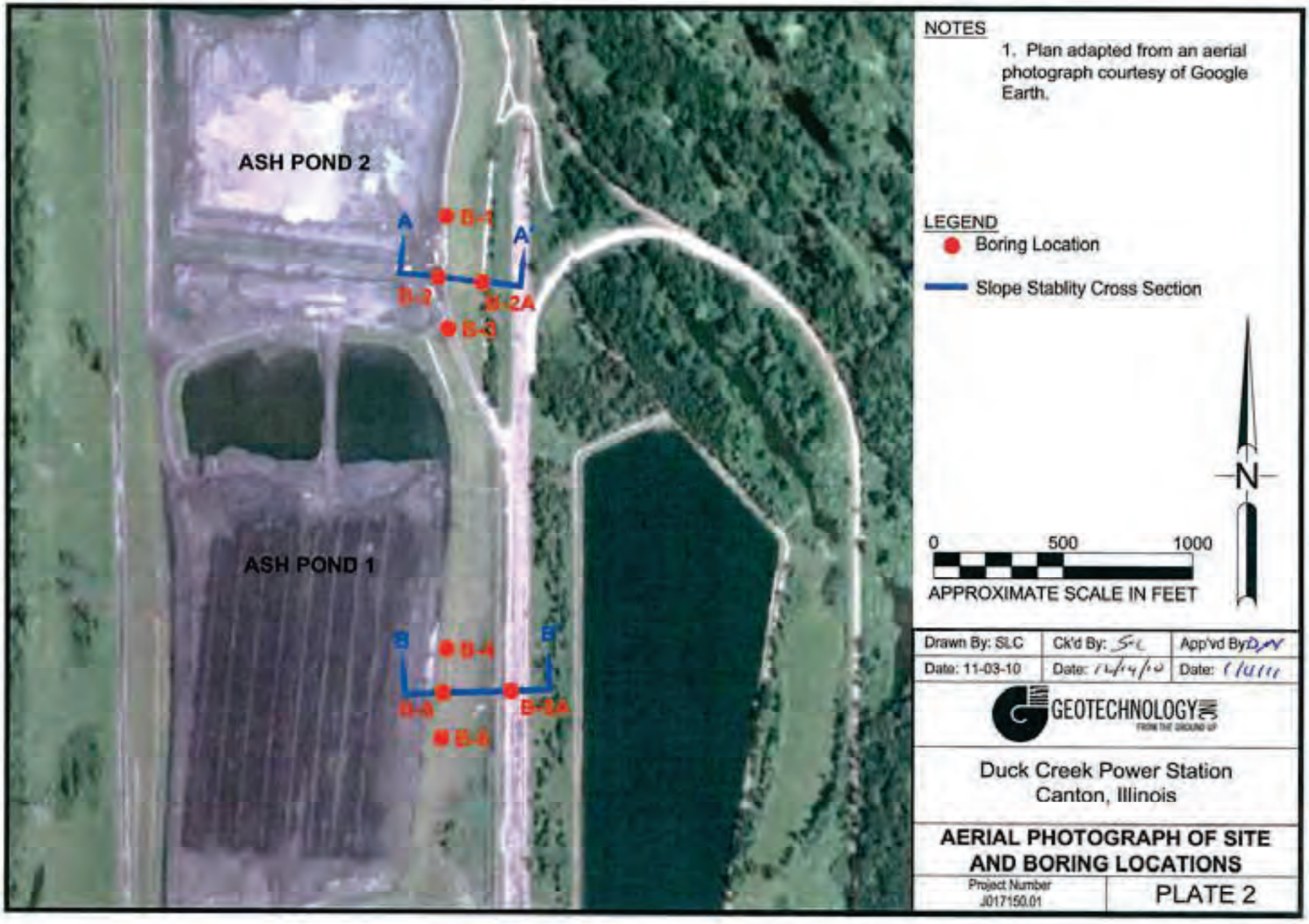

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AECOM



Figure C.1. Piezometer locations for Ash Pond No. 1 and Ash Pond No. 2.

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Appendix D: Project Manual; Specification No's.: C180-C102 (excerpt)

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PROJECT MANUAL
GYPSUM STACK AND RECYCLE POND AND CCB LANDFILL CONSTRUCTION
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

SPECIFICATION NO'S.: C180-C102

Prepared For:

AMEREN ENERGY RESOURCES GENERATING COMPANY

Prepared By:

HANSON PROFESSIONAL SERVICES INC.
1525 South Sixth Street
Springfield, Illinois 62703

Specifications for Construction

April 11, 2008

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BIDDING CLARIFICATIONS FOR AMEREN CONTRACT DOCUMENTS
AMEREN ENERGY RESOURCES GENERATING COMPANY
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
PROJECT SPECIFICATIONS NO. C180-C102
ADDENDUM #2

Prepared March 24, 2008
By Hanson Professional Services, Inc.
Preparer: DBH

Hanson Professional Services is please to provide the following clarifications to outstanding questions regarding the contract documents:

1) *Please clarify again Bid Form page BF-A-5 the 146,740 cy is the amount excavated and stockpiled. In addition in that price we include 146,740 cy going back in place?*

   Answer: The Estimated Quantity of 146,740 C.Y. shown on Bid Forms A and B is our estimated TOTAL excavation needed for the Over-excavation of Soil and Sand from NE & SW Corners of Gypsum Stack Area. The excavation shall be backfilled with suitable structural backfill after the unsuitable sand lens material has been removed and stockpiled. Our estimate for unsuitable sand material is the 17,600 C.Y. shown in the same section of the Bid Forms.

2) *What is the status of design on slurry piping plan and details? Currently sheet C102-27 does not provide sufficient information.*

   Answer: An updated sheet will be issued with Addendum #2.

3) *Per sheet C102-05, "All under drain pipes installed under the excavation contract C180-C101 shall remain in place. Subsurface drainage piping shall be sealed with bentonite slurry in accordance with project specifications upon completion of the liner system". Please provide specifications.*

   Answer: Sealing of the subsurface drainage system is specified in Section 02141 - Surface Water Management, paragraph 3.06.

4) *Is dwg. format available with Landfill, Gypsum and Recycle Pond area merged to one drawing. We specifically need existing and proposed contours for both projects consolidated as one design and existing layer. The tins provided are for the Gypsum Pond only, would appreciate fill for Landfill if drawings can not be merged. Will Hanson be able to provide design contours for cushion dirt layer? Currently available drawings provide points only from sheet C102-11.*

   Answer: We will be issuing updated tin & dwg files for the Gypsum Stack Recycle Pond that reflects the work completed under Contract C180-C101 with Addendum #2. Tin & DWG files for the CCB Landfill will be issued later in the week, as it is currently being surveyed and verified.

5) *The granular materials for the drainage layer and seperation berm shall provide a minimum hydraulic conductivity (ASTM D2434) of 1 X 10-3. Is there a specific material anticipated for the completion of this work?*

   Answer: The granular materials required for the drainage layer and separation berm are adequately specified in the Project Specifications. The Contractor shall be responsible for determining availability and sourcing for these materials.

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6) *Is a construction joint allowed in the Process Water Control Structure.*

Answer: A Bonded Construction Joint will be allowed for this structure, provided that it is constructed in accordance with article 503.09 of the Illinois Department of Transportation "Standard Specifications for Road and Bridge Construction" Adopted January 1. 2007.

7) *What if anything is required on the low water crossing on sheet 16 of the CCB Landfill?*

Answer: No special materials are required in this area, the invert of the existing spillway channel shall be maintained and crossed by the proposed haul road.

8) *Is the Coarse Aggregate for the Leachate collection pipe also the IDOT CA-7 Per Article 1004.1 of IDOT Specs.*

Answer: The Coarse Aggregate for the Leachate Collection Pipe shall be a gradation as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec. We will issue a correction to the specifications with Addendum #2.

9) *Detail 7/17 for the Ultrasonic Transducer from your web site is different than your handout at the pre-bid meeting is the web site detail the one we are to provide?*

Answer: The latest detail on the web site is the latest one, however a revision to that detail will be issued with Addendum #2.

10) *Bid Form page A-3 Riprap Class B4, the unit of measure is LF, should that be TONS or S.Y.?*

Answer: The correct unit should be S.Y.

11) *In an effort to utilize local aggregate sources, can we use "Special Provision Rock" as specified by IDOT for Contracts 68206 & 68205 for the aggregate base and surface course?*

Answer: All aggregates shall be supplied as specified in Section 02315 Granular Materials.

12) *Can we substitute a butt fusion reducer in lieu of the 50% welded extrusion joints" as shown in detail 5/13?*

Answer: A butt fusion reducer would be acceptable in that location (Detail 5/13 - Plans C180-C102)

13) *Page 27, slurry piping- Is this the sluice piping from section 2640? There is no size listed on the plans. The plan shows dashed and solid lines, what do they represent. Section 2640 calls for valves in the sluice piping, are these the valves shown on sheet 27?*

Answer: A revised sheet C180-102-27 and a new sheet C180-102-28 are included in Addendum #2.

14) *The specs say all underdrain within lined areas of cell is to be grouted. Is the recycle pond lined?*

Answer: The subdrainage outfall piping beneath the recycle pond is to be grouted.

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15) *We are trying to figure out what gradation of rock is required for detail 6/14 on the gypsum stack and also for detail 1/12 and 2/12 on the CCB Landfill. Section 2315 Part 2 does not have the gradation language we are used to looking at for the CCB Landfill Course Aggregate.*

Answer: The Coarse Aggregate material called out in these details is the same as is specified in Section 02315 - Part 2.01-B-2 for CCB Landfill Coarse Aggregate. A revised specification will be included in this Addendum.

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BIDDING CLARIFICATIONS FOR AMEREN CONTRACT DOCUMENTS
AMEREN ENERGY RESOURCES GENERATING COMPANY
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
PROJECT SPECIFICATIONS NO. C180-C102

ADDENDUM #3

Prepared March 27, 2008
By Hanson Professional Services, Inc.
Preparer: DBH

Hanson Professional Services is pleased to provide the following clarifications to outstanding questions regarding the contract documents:

Question: One GCL manufacturer produces a double nonwoven, needlepunch reinforced geosynthetic clay liner that will meet or exceed the project requirements and the GRI-GCL-3 specification, with only two clarifications:

Footnote #2 in Table 1 of the GRI-GCL-3 specification states that for nonwoven reinforced GCLs, one of the Geotextiles must contain a scrim component of mass > 2.9 oz/yd2 for dimensional stability. An exception to the scrim reinforcement requirement has been requested.

Table 1 of the GRI-GCL-3 specification states that nonwoven reinforced GCLs should be manufactured with minimum 5.9 and 5.8 oz/yd2 Geotextiles. Our product is manufactured with minimum 6.0 and 2.7 oz/yd2 nonwoven Geotextiles and it will still meet the peel and tensile strength requirements in the specifications. Accordingly, an exception to the minimum geotextile weights has been requested.

Answer: *We will allow these exceptions, provided that all of the other requirements of the specifications are met by the GCL being submitted for bid.*

Question: Aggregate suppliers cannot perform the testing required to qualify that their materials will meet the project specifications in the time allotted for bidding. What can the aggregate suppliers do to provide a reasonable quote for the aggregate materials within the Gypsum Stack and CCB Landfill footprints.

Answer: Adequate bidding time was allotted for relatively quick permeability and gradation testing, and these test results should be available. However, based on the time allotted for bidding and the turn-around time needed to complete the longer tests necessary to certify project specification compliance, we will allow aggregate suppliers to certify a unit price for these materials based on the contingency that they will meet the following required specifications:

ASTM D3042-03 Standard Test Method for Insoluble Residue in Carbonate Aggregates (15% loss Max.)

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Na_2SO_4 Soundness 5 Cycle, Illinois Modified AASHTO T 104 (15% Loss Max.)
ASTM C 1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) (Less than 0.10% internal expansions at 16 days after casting)

Additional question related to the overexcavation and replacement of materials in the NE and SW corners of the gypsum stack area:
Please clarify "The excavation shall be backfilled with suitable structural backfill". How and where will that backfill be paid for?

Answer: Please note that the bid form section for additional items to be paid on a unit cost or time and material basis provides estimated quantities only. The bid form allows for separate pricing for unsuitable sand soils that will need to be excavated from the NE and SW corners of the gypsum stack areas and transported to stockpiles (estimated at 17,600 cy) and for excavation and recompaction of soil material suitable for reuse (estimated at 146,740 cy). Based on these ESTIMATED volumes, the total ESTIMATED volume to be over-excavated from the NE and SW corners of the gypsum stack excavation is 164,340 cy (17,600 cy of which is estimated to be unsuitable sand that needs to be transported out of the excavation and stockpiled). Note again that we will be removing an unknown amount of sand from the excavation. Shrinkage as a result of the compaction process may also be a factor. Any shortage of suitable backfill shall be obtained from the subsoil stockpiles. Backfilling the excavation with Structural Fill to be obtained from stockpiles will be paid for at Time and Material or by the unit cost included on the bid form for "Backfill w/Structural Fill from Stockpile."

Question: Can the test pad for the clay liner be constructed outside the footprint of the cell?

Answer: The test soil liner must be constructed within the footprint of the cell.

What end treatment is to be applied to the upstream ends of the 6" and 12" perforated laterals shown on Sheet C180-C110-09 and detailed on sheet C180-C110-12 for the CCB Landfill?

Answer: Cleanouts with threaded caps shall be installed at the termination points for the 6" and 12" perforated laterals. Revised drawing #C180-C110-09 is attached indicating this detail.

Question: The new details for vaults on the slurry lines show 8" RFP being bolted into 8" Valves, then a 10" HDPE pipes. The bolt patterns on the 10" pipe and 8" valve are not compatible. Please clarify.

Answer: An FRP spindle needs to be provided to go from the 8" valve to the 10" HDPE pipe. Revised drawing #C180-C102-28 is attached to show this configuration.

FINAL NOTE: THE BIDS ARE DUE MONDAY, 3/31/08. NO MORE QUESTIONS WILL BE ACCEPTED PRIOR TO BIDDING. PLEASE INCLUDE ANY ADDITIONAL ASSUMPTIONS AND CLARIFICATIONS WITH YOUR BIDS.

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GYPSUM STACK AND RECYCLE POND AND CCB LANDFILL CONSTRUCTION
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

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Bid Forms	
Bid Form - A	BF-A-1 to BF-A-12
Bid Form - B	BF-B-1 to BF-B-11
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Appendix 2 – Construction Quality Assurance (CQA) Plan

Appendix 3 – Geotechnical Data

~~Appendix 4 – Construction Field Office~~

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DIVISION 1 - GENERAL REQUIREMENTS
Section 01010 - Summary of Work
ADDENDUM #1

PART 1. GENERAL

1.0 INTRODUCTION

A. Gypsum Management Facility

The intent of this contract is to provide the services of a General Contractor to construct Gypsum Management Facility, consisting of a lined Gypsum Stack and Recycle Pond for the disposal of gypsum at Ameren Energy Resources Generating Company (AERG) Duck Creek Power Station's Gypsum Management Facility located near Canton, Illinois.

Excavation to approximately 5.4 ft. above foundation grade, partial construction of Recycle Pond perimeter berm, installation of a temporary stormwater outlet ditch, a temporary subsurface drainage system and the Recycle Pond pump station pad with access road were completed under a prior contract as outlined in the plans. Excavated material was stockpiled north and east of the excavation for use in this contract.

B. CCB Landfill

The intent of this contract is to provide the services of a General Contractor to construct a CCB Landfill, consisting a base 3 ft. thick Compacted Clay Liner, Geosynthetic Clay Liner (GCL), High Density Polyethylene (HDPE) Geomembrane, Geotextile Cushion Fabric and Leachate Collection System for the permanent disposal of coal combustion by-products (CCB) at the Ameren Energy Resources Generating Company (AERG) Duck Creek Power Station CCB Landfill located near Canton, Illinois.

Excavation to approximately 6 in. above foundation grade, construction of perimeter berm, installation of a permanent berm ditch outlet structure and a temporary subsurface drainage system were completed under prior contract. Excavated material was visually segregated during excavation and stockpiled east of the excavation for use in this contract.

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2.0 DESCRIPTION OF WORK

2.01 Gypsum Management Facility

The scope of work shall consist of furnishing all materials, equipment, tools, labor, and incidentals necessary to perform the work as described below:

A. Gypsum Stack - Foundation Preparation

1. Excavate areas indicated on the plans to remove areas of underground sand seams and backfill with structural soil backfill.
2. Locally excavate to the foundation grade as indicated on the plans and finish grade the portion of the cell to be covered by Compacted Clay Liner.
3. Proof roll to identify unsuitable foundation soil materials.
4. As directed by the Owner's Representative, Excavate and replace unsuitable foundation materials consisting of unknown pockets of peat, sand, muck or other unsuitable materials with suitable structural backfill. Installation of geotextile fabric for ground stabilization, as deemed necessary by the owner's Representative, will be installed on a time and materials basis.

B. Gypsum Stack - Compacted Clay Liner

1. Construct Test Soil Liner, as outlined Section 5.0 of the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, to demonstrate construction procedures and equipment that will produce the specified permeability.
2. Obtain Foundation Grade Verification by Amerens Field Surveyor prior to constructing areas requiring Compacted Clay Liner, as outlined in Section 6.2.1a of the project Construction Quality Assurance Plan.
3. Install Compacted Clay Liner in accordance with the project specifications using the compactive means demonstrated by the Test Soil Liner.

C. Gypsum Stack - Excavation and Backfill of Anchor Trench

1. Excavate anchor trench.
2. Place initial trench backfill after installation of Geosynthetic Clay Liner (GCL) and High Density Polyethylene (HDPE) Geomembrane by geosynthetic liner Contractor.
3. Complete trench backfill after installation of separation geotextile.

D. Gypsum Stack - Geosynthetic Clay Liner (GCL)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Compacted Clay Liner with the Owner's Representative

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before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Compacted Clay Liner during GCL placement and submit a Certificate of Acceptance in the daily report that no GCL was placed over visibly defective Compacted Clay Liner.

2. Furnish and install GCL on accepted Compacted Clay Liner. Provide reinforced GCL on the sideslopes and bottom of Gypsum Stack. Protect GCL per the Manufacturer's recommendations until it is covered by HDPE Geomembrane

E. Gypsum Stack High Density Polyethylene (HDPE) Geomembrane (Lower Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the GCL with the Owner's Representative: continuously observe the condition of the GCL during HDPE Geomembrane placement; and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective GCL.
2. Furnish and install HDPE geomemebrane on accepted GCL. Provide textured HDPE liner on the side slopes and bottom of the Gypsum Stack. Protect HDPE liner until it is covered by geotextile cushion fabric.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

F. Gypsum Stack - Geotextile Cushion Fabric

1. The Geosynthetics Installer's Representative shall jointly inspect the HDPE Geomembrane with the Owner's Representative: continuously observe the condition of the HDPE Geomembrane during placement of the geotextile cushion fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective HDPE Geomembrane.
2. Furnish and install geotextile cushion on accepted Geomembrane.
3. Furnish and install drainage layer material for ballast.

G. Gypsum Stack - HDPE Leachate Collection Piping

1. Furnish and install geotextile fabric for coarse aggregate envelope.
2. Furnish and install initial lift of coarse agregate.
3. Furnish and install leachate collection piping as shown on the plans.
4. Furnish and install coarse aggregate along the pipe to provide lateral stability.
5. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design

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requirements before placing remainder of coarse aggregate and geotextile envelope.

H. Gypsum Stack - Drainage Layer

1. Furnish and install granular material for drainage layer in accordance with the project plans and specifications.
2. Obtain verification by the Owner's Field Surveyor that the minimum required Drainage Layer thickness has been achieved.

I. Gypsum Stack - Separation Fabric

1. The Geosynthetics Installer's Representative shall jointly inspect the Drainage Layer with the Owner's Representative; continuously observing the condition of the surface of the Drainage Layer during placement of the Geotextile Separation Fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective Drainage Layer surface.
2. Furnish and install geotextile fabric on accepted Drainage Layer and anchor geotextile fabric in anchor trench.

J. Gypsum Stack - Cushion Dirt

1. Place Cushion Dirt to facilitate installation of the second HDPE Geomembrane. The Contractor shall protect the underlaying Separation Fabric per the project specifications.
2. Obtain verification by the Owner's Field Surveyor that the minimum required Cushion Dirt thickness has been achieved.

K. Gypsum Stack High Density Polyethylene (HDPE) Geomembrane (Upper Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Cushion Dirt with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Cushion Dirt during HDPE Geomembrane placement and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective Cushion Dirt.
2. Furnish and install HDPE Geomembrane on approved Cushion Dirt. Provide textured HDPE Geomembrane on cell side slopes and bottom of cell. Protect HDPE Geomembrane until it is initially covered by gypsum waste material.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

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L. Gypsum Stack - HDPE Process Water Recovery System

1. Furnish and install HDPE Process Water Collection System, as shown on the plans.
2. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design requirements before covering the piping with aggregate and filter fabric as shown on the plan.

M. Gypsum Stack - Miscellaneous Earthwork

1. Provide access ramp to perimeter berm of cell.

N. Gypsum Sluice Piping

1. Connect to existing piping and install new Gypsum Sluice Piping, fittings and valves for the Gypsum Stack.

O. Gypsum Stack - Subdrainage System

1. Abandon existing subdrainage system, and remove vent pipes, vertical drains and inlet structures as specified in Section 02140 – Surface Water Management.

P. Gypsum Stack - Erosion Control

2. Maintain previously installed temporary erosion control systems during the life of the contract.
3. Seed and mulch all exposed soil surfaces.

Q. Recycle Pond - Earthwork

1. Strip topsoil from areas of the proposed excavation and proposed compacted berms.
2. Excavate the recycle pond to the lines and grades shown on the plans.
3. Proof roll stripped/excavated areas to expose unsuitable materials.
4. Remove and replace unsuitable foundation material and/or install geotextile fabric for ground stabilization as directed by the Owner's Representative. Work required to correct unsuitable foundation material will be paid by the Owner on a Time and Materials Basis.
5. Construct Recycle Pond Embankments, Process Water Transfer Channel and Emergency Spillway to the line and grades shown on the plans.

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R. Recycle Pond – Toe Drain

1. Furnish and install aggregate materials and filter fabric at the outside toe of the recycle pond dam as shown on the plans.

S. Recycle Pond - Excavation and Backfill of Anchor Trench

1. Excavate anchor trench.
2. Backfill trench after installation of High Density Polyethylene (HDPE) Geomembrane by Geosynthetics Installer.

T. Recycle Pond - HDPE Geomembrane

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the recycle pond foundation soils with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the foundation soils during HDPE Geomembrance placement and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective foundation soil.
2. Furnish and install HDPE Geomembrane on approved foundation soil. Provide textured HDPE Geomembrane on recycle pond side slopes and bottom. Anchor in the excavated anchor trench and backfill in accordance with the project specifications.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

U. Recycle Pond - Water Transfer Structures

1. Furnish, fabricate, and install all materials and aggregate necessary to construct the Process Water Control Structure, Process Water Transfer Channel, Recycle Pond Emergency Spillway/Riprap Stilling Basin, and Side Slope Decant Pipe/Riprap Basin as shown on the plans.

~~V. Construction Field Office~~

~~The Contractor shall furnish and install a Construction Field Office for the Owner's use in accordance with the Specifications of Appendix 4 of these Specifications.~~

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2.02 CCB Landfill

A. Foundation Preparation:

1. Remove top 6" of soil from the existing excavation and stockpile in an area designated on the Plans.
2. Finish grade the portion of the cell to be covered by Compacted Clay Liner.
3. Proof roll to expose any unsuitable foundation materials..
4. Remove and replace unsuitable foundation material and/or install geotextile fabric for ground stabilization as directed by the Owner's Representative.

B. Compacted Clay Liner

1. Construct Test Soil Liner, as outlined Section 5.0 of the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, to demonstrate construction procedures and equipment that will produce the specified permeability.
2. Obtain Foundation Grade Verification by Amerens Field Surveyor prior to constructing areas requiring Compacted Clay Liner, as outlined in Section 6.2.1a of the project Construction Quality Assurance Plan.
3. Install Compacted Clay Liner in accordance with the project specifications using the compactive means demonstrated by the Test Soil Liner.

C. Excavation and Backfill of Anchor Trench:

1. Excavate anchor trench.
2. Place initial trench backfill after installation of GCL and HDPE geomembrane by geosynthetic liner contractor.
3. Complete trench backfill after installation of separation geotextile.

D. Geosynthetic Clay Liner (GCL)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Compacted Clay Liner with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Compacted Clay Liner during GCL placement and submit a Certificate of Acceptance in the daily report that no GCL was placed over visibly defective Compacted Clay Liner.
2. Furnish and install GCL on accepted Compacted Clay Liner. Provide re-inforced GCL on the sideslopes and bottom of the cell. Protect GCL per the Manufacturer's recommendations until it is covered by HDPE Geomembrane

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E. High Density Polyethylene (HDPE) Geomembrane (Lower Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the GCL with the Owner's Representative; continuously observe the condition of the GCL during HDPE Geomembrane placement; and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective GCL.
2. Furnish and install HDPE Geomemebrane on accepted GCL. Provide textured HDPE Geomembrane on cell side slopes and smooth HDPE Geomembrane on bottom of the cell. Protect HDPE liner until it is covered by geotextile cushion fabric.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

F. Geotextile Cushion Fabric:

1. The Geosynthetics Installer's Representative shall jointly inspect the HDPE Geomembrane with the Owner's Representative; continuously observe the condition of the HDPE Geomembrane during placement of the geotextile cushion fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective HDPE Geomembrane.
2. Install geotextile cushion on accepted Geomembrane.
3. Install drainage layer material for ballast.

G. HDPE Leachate Collection Piping:

1. Place geotextile fabric for coarse aggregate envelope.
2. Place initial lift of Coarse Aggregate Bedding.
3. Furnish and install HDPE Leachate Collection Piping on Coarse Aggregate bedding.
4. Place coarse aggregate along the pipe to provide lateral stability.
5. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design requirements before covering the piping with remainder of coarse aggregate and geotextile envelope as shown on the plans.

H. Drainage Layer and Separation Berm:

1. Place granular material for separation berm and drainage layer.

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I. Separation Fabric:

1. Install geotextile fabric on accepted drainage layer and anchor geotextile fabric in anchor trench.

J. Haul Road

s

1. Funish materials and construct Haul Road to the top of the CCB Landfill.

K. Miscellaneous Earthwork:

1. Provide construction access ramp to bottom of cell.
2. Place general fill to form in-board side of berm ditch.

L. Construct and maintain temporary erosion control systems during the life of the contract. Remove and dispose of temporary erosion control items when no longer required. Seed and mulch all remaining disturbed soil surfaces.

3.0 OWNER AND MANUFACTURER'S DRAWINGS

3.1 Provided By Ameren Energy Resources Generating

A. Hard-Copy Drawings

The following drawings are intended to indicate the scope of the work to be done and details necessary for the installation of items set forth in this specification, and are part of this specification. These drawings in general are to scale, but dimensions shall always be followed and drawings are not to be scaled. In case of errors or discrepancies, the Owner's Representative shall be consulted for the adjustment of all complications arising therefrom. The Owner's Representative's decisions shall be final.

AERG DRAWING NO.	SHEET TITLE
C180-C102-01	Title & Index
C180-C102-02	General Notes
C180-C102-03	Site Plan
C180-C102-04	Existing Site Conditions
C180-C102-04A	Existing Subsurface Drainage Profiles
C180-C102-05	Existing Subsurface & Vertical Drain Details
C180-C102-06	Existing Subsurface Drainage Details
C180-C102-07	Existing Grading Plan
C180-C102-08	Gypsum Stack-Foundation Grade
C180-C102-09	Gypsum Stack-Top of Clay Layer
C180-C102-10	Gypsum Stack- Leak Detection/Leachate Collection

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AERG DRAWING NO.	SHEET TITLE
C180-C102-11	Recovery System (LD/LCRS) Drainage Layer Grade Process Water Recovery System (PWRS) - Ring Drain System Cushion Dirt Layer Grade
C180-C102-12	PWRS-Ring Drain Details
C180-C102-13	PWRS-Ring Drain Details
C180-C102-14	LD/LCRS Sections & Details
C180-C102-15	Recycle Pond Plan
C180-C102-16	Recycle Pond Details
C180-C102-17	Recycle Pond Details
C180-C102-18	Access Road and Pump Station Site Plan
C180-C102-19	Access Road Vertical Alignments
C180-C102-20	Erosion Control Plan
C180-C102-21	Erosion Control Details
C180-C102-22	Groundwater Monitoring & Boring Plan
C180-C102-23	Geological Cross Sections
C180-C102-24	Geological Cross Sections
C180-C102-25	Geological Cross Sections
C180-C102-26	Geological Cross Sections

AERG DRAWING NO.	SHEET TITLE
C180-C110-01	Title and Index
C180-C110-02	General Notes
C180-C110-03	Site Plan
C180-C110-04	Foundation Grade Plan
C180-C110-05	Foundation Grade Control Data
C180-C110-06	Base Grade Plan
C180-C110-07	Base Grade Control Data
C180-C110-08	Geomembrane Panel Layout
C180-C110-09	Drainage Layer Grade Plan & Leachate Collection Piping
C180-C110-10	Drainage Grade Control Data
C180-C110-11	Typical Sections and Details
C180-C110-12	Leachate Collection Details
C180-C110-13	Typical Cross Sections
C180-C110-14	Separation Berm Details
C180-C110-15	Exist. Sub-Drain Plan & Details
C180-C110-16	~~Haul Road / Construction Water Access Road Plan~~ ***Landfill Haul Road***
~~C180-C110-17~~	~~Construction Water Access Road~~
C180-C110-17	Boring Well and Section Locations

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AERG DRAWING NO.	SHEET TITLE
C180-C110-18	Geologic Cross Sections A and B
C180-C110-19	Geologic Cross Sections C, D, and E
C180-C110-20	Geologic Cross Sections F to K

B. Electronic Files

The following electronic files are provided solely for the convenience of the bidder and/or Contractor and are subject to the terms and conditions stipulated in the Disclaimer text included with the electronic files.

1. Drawings listed above in PDF format.
2. TIN files of the existing and proposed ground surfaces.
3. Bid Forms.
4. Disclaimer text.

In the event of a conflict between the hard-copy documents and the electronic files, the hard-copy documents shall govern.

3.2 Provided by the Contractor

The Contractor shall submit to the Owner's Representative, with such promptness as to cause no delay in the performance of the work, four copies of shop drawings, product data sheets, etc., as required by these specifications. No purchasing, fabrication, erection, processing, or shipping of the aforementioned materials may begin until the required documentation has been reviewed by the Owner.

Three copies of data required to be submitted to the Owner's Representative shall be forwarded to each of the following:

Ameren Energy Resources Generating
Dave Boyce
Duck Creek Power Station
17751 North CILCO Road
Canton, Illinois 61520

Hanson Professional Services Inc.
Steven Bishoff
1525 South Sixth Street
Springfield, Illinois 62703-2886

Data sheets and shop drawings shall be reviewed and returned to the Contractor within ten (10) working days after receipt. Approval is for general design features only and will not relieve the Contractor of responsibility for proper quantities, adequacy of details, and

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coordination with other trades. Deviation from Contract Documents are not approved unless specifically requested in writing by the Contractor and approved in writing by the Owner.

Should field changes be required, such changes shall be promptly documented by the Contractor and submitted to the Owner in the form of as-built drawings. The field change order process is included in Appendix 1.

4.0 MATERIALS AND EQUIPMENT SUPPLIED BY THE OWNER

The materials and equipment that are to be furnished by the Owner are listed in the schedule below:

ITEM	SHIPPING DATE	LOCATION
~~Drainage Layer Material (Gypsum Stack & CCB Landfill)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Coarse Aggregate Encasement for Ring Drain Piping (IDOT CA-7) (Gypsum Stack)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Filter Sand for Protection of Ring Drain Piping (IDOT FA-1) (Gypsum Stack)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Coarse Aggregate Coarse Encasement For Leachate Collection Piping (CCB Landfill)~~	~~Prior to Start of Construction~~	~~Stockpile~~

Note: Per Addendum #1, none of the above listed aggregates will be supplied by the owner

5.0 MATERIALS AND EQUIPMENT FURNISHED BY THE CONTRACTOR

All materials, equipment, tools, and any incidental items necessary to complete each portion of the work described herein and/or shown on the drawings shall be furnished by the Contractor.

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6.0 UTILITIES, FACILITIES, AND MISCELLANEOUS

The following utilities, facilities, etc., shall be provided as indicated.

	Item	Provided By
A.	Telephone Service for Use of Construction Forces	Contractor
B.	Sanitary Facilities	Contractor
C.	Drinking Water	Contractor
D.	Construction Water	Contractor
E.	Electric Service for Contractor's Use	Contractor
F.	Construction Office and Storage Facilities for Contractor's Use	Contractor
G.	Construction of Gravel Haul Roads and Parking Area for Construction Forces	Contractor

Submit with the bid documents a general layout of temporary facilities required for the Contractor's operations, such as haul roads, parking areas, temporary drainage facilities, Contractor's construction field office and storage facilities, electric service, telephone service, staging and laydown areas, etc.

7.0 SCHEDULE

The Contractor shall be required to furnish the Owner's Representative with a complete schedule of the Work to be performed under this contract broken down by major activity.

The schedule shall include the Contractor's estimate of man-days required for each activity, and shall show precedent relationships between activities. The schedule shall be included as part of the bid package presented by the Contractor. The schedule shall comply with the dates and guidelines listed below:

A. The required start date of this contract is upon receipt of Purchase Order. The Purchase Order is expected to be issued within two (2) weeks of the bid due date.

B. The required finish date of this for the Gypsum Management Facility Contract is September 30, 2008. The required finish date for the CCB Landfill Contract is December 31, 2008 for the Scope of Work incuded in Bid Forms A & C.

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C. The level of detail in each schedule shall be sufficient to permit the Owner to monitor the Contractor's performance relative to the specified guidelines. The required level of detail will be discussed at the pre-bid meeting.

D. The Contractor shall submit a daily construction report and shall furnish schedule status reports at weekly progress meetings until the work is completed. The schedule status reports shall indicate by activity the scheduled percent of completion as shown on the original schedule, the actual percent completion as of the date of the report, and the number of man-days expended on the project to date.

If at any time during this Contract, when the Contractor's actual progress, in the opinion of the Owner, is such that the completion dates of the work will not be met, the Contractor shall participate in a re-evaluation of the remaining work.

If, as a result of this re-evaluation of the remaining work, it is determined by the Owner that the completion date will not be met, the Owner retains the right to direct the Contractor to accelerate the construction program. It shall be the responsibility of the Contractor to initiate and comply with such corrective action as required or directed.

At the time of the award of this contract, scheduling requirements will be discussed in detail by all interested parties.

8.0 CONSTRUCTION QUALITY CONTROL ASSURANCE

A. Construction Quality Assurance Plan

A Construction Quality Assurance (CQA) Plan has been developed for this project to ensure compliance with the all applicable permit requirements. A copy of this plan is included in Appendix 2. The testing requirements and frequency of this plan will govern in instances which there may be discrepancies between the CQA Plan and these specifications.

B. Testing and Inspections:

1. The Contractor is responsible for construction quality control testing, sampling, and inspections to ensure that the materials and workmanship comply with the plans and specifications. The Contractor shall submit results of construction quality control testing. The Contractor shall visually inspect underlying surfaces on a continuous basis immediately ahead of placement of geosynthetics and geotextile and shall certify in the daily report that no material was placed over visibly defective substrate.
2. The Contractor is responsible for non-destructive testing of all Geomembrane seams and for providing samples for prequalification material testing and destructive seam testing as directed by the Owner's

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Representative. The minimum sampling frequencies are specified in Appendix 2.

3. Except as specified above, Construction Quality Assurance (CQA) testing, sampling, and inspections to verify compliance with the plans and specifications are the responsibility of the Owner. The CQA sampling and testing requirements are summarized in Appendix 2. The Contractor shall coordinate and cooperate with the Owner's materials testing consultant to provide samples and accommodate testing activities at no additional cost to the Owner.

C. Construction Surveying

Construction surveying for layout and grading control shall be the responsibility of the Contractor. Finished grades will be surveyed by the Owner's surveyor to verify that the finished grade is within 0.1 ft. of plan grade.

D. CQA Surveys to certify material thickness, leachate piping and ditch grades are the responsibility of the Owner. CQA Surveying requirements are summarized in Appendix 2.

9.0 COORDINATION WITH OTHERS

This Contractor will work in close harmony with other Contractors or AERG personnel who may be employed at this site. In the event of differences of opinion regarding scheduling of work, the decision of the Owner will be final and binding.

The following construction activities are anticipated within the landfill facility boundary during this contract:

A. Loading and Hauling of coal combustion by-product to the site by AERG personnel or Contractor.

B. Loading and Hauling of water for dust contol operations on AERG property.

C. Loading and hauling stockpiled excavated material from the stockpile south of East McKinley Road by Fulton County Highway Department Contractor and by Ameren personnel or contractor.

D. Monitoring, removing, and disposing of leachate by Ameren's CCB disposal facility operator.

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10.0 SAFETY AND SITE SECURITY

The Contractor will comply with safety and security requirements stipulated in the General Conditions and Supplemental General Conditions.

A. Although the Ameren Energy Resources Generating property is generally fenced and patrolled by Ameren Energy Resources Generating security, the site should not be considered secure.

1. A Security Check-In Station will be provided by AERG for the duration of the construction project at the entrance on McKinley Road.

B. Contractor personnel will be required to attend a 2-hour site-specific safety orientation conducted by the Owner.

C. Contractor personnel will be required to submit to a ten (10) panel drug test to be performed and provided by AERG.

D. A copy of the Contractor's Field Construction Safety Program shall be submitted with the Contractor's bid package.

E. The Contractor shall have a designated Safety Supervisor on site whenever construction work is being performed.

11.0 DUST CONTROL

The Contractor shall be responsible for controlling dust and air-borne dirt generated by construction activities. Dust shall be controlled by applying water to exposed surfaces, particularly surfaces on which construction vehicles travel. Water from the Duck Creek Reservoir is unsuitable. A pond north and east of the proposed CCB Landfill is designated at the only water source available for use by the Contractor.

No chemical dust suppressants shall be permitted unless approved in writing by the Owner's Representative. Dust control measures shall be readily available for implementation whenever the Contractor or the Owner's Representative deems that that dust control is needed. The cost of dust control shall be included in the contract lump sum price.

PART 2. PRODUCTS

No products used.

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PART 3. EXECUTION

1.0 The Contractor shall be responsible for inspecting the site to note any and all conditions that may affect the work under the contract. The Contractor shall satisfy himself as to the nature, extent and location of the work; the configuration of the ground; the equipment and facilities needed for construction; the general and local conditions of the area; and all other factors and conditions which can, in any way, affect the work under the contract. Any failure by the Contractor to do so will not relieve him from responsibility for successfully performing the work without additional expense to the Owner.

2.0 The Contractor is specifically advised of the presence of overhead power lines that traverse the project work area.

END OF SECTION 01010

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DIVISION 1–GENERAL REQUIREMENTS
Section 01356 – Storm Water Pollution Prevention Measures

PART 1. GENERAL

1.01 DESCRIPTION

A. This section pertains to the construction and maintenance of existing and proposed temporary erosion control systems to control erosion and sediment damage to adjacent properties and water resources.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

02936 - Topsoil, Seeding, and Mulching.

1.03 REFERENCES

The following reference, or cited portions thereof, governs the work:

Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SUBMITTALS

A. Submittals shall follow the provisions of Section 01010.

B. Preconstruction Submittals: A storm water best management practices (BMP) plan shall be submitted that includes the following items:

1. Inspection and record-keeping procedures; and
2. Maintenance procedures for erosion controls.

PART 2. PRODUCTS

2.01 EROSION CONTROL SYSTEMS

Materials for erosion control systems shall be in accordance with Article 280.02 of the IDOT Standard Specifications.

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PART 3. EXECUTION

3.01 EXAMINATION

The site shall be examined to determine the condition existing temporary erosion controls systems installed under a prior contract and the extent of new work required.

3.02 PRECONSTRUCTION JOBSITE INSPECTION

A. The person who shall be at the jobsite during construction and who shall be responsible for insuring that erosion control work is completed in a timely manner shall be identified at the preconstruction meeting.

B. A jobsite inspection shall be conducted with the Owner's Representative to review and designate the locations and types of erosion protection to be placed. The inspection shall be scheduled at the preconstruction conference and carried out on the job site before beginning any work that will disturb existing drainage or potentially create erodible conditions.

3.03 CONSTRUCTION

A. Temporary erosion control systems shall be constructed in accordance with IDOT Standard 280001 and Article 280.04 of the Standard Specifications and as directed by the Owner's Representative. Erosion control devices shall be in place and approved by the Owner's Representative prior to beginning other work.

B. Incorporate permanent erosion control features into the project at the earliest practicable time to minimize the need for temporary erosion controls.

3.04 MAINTENANCE

A. Temporary erosion control systems shall be maintained in accordance with Article 280.05 of the Standard Specifications, except that measurement and payment provisions shall not apply.

B. Temporary erosion control systems for unprotected disturbed areas shall be cleaned of trapped sediment and repaired immediately prior to project close out.

C. Temporary seeding shall be applied to all disturbed areas except the gypsum stack excavation and the future fill and topsoil stockpiles.

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3.05 REMOVAL AND DISPOSAL

All temporary erosion control system shall be left in place by the Contractor for future construction operations at both facilities.

END OF SECTION 01356

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DIVISION 2 - SITE WORK
Section 02010 - Subsurface Investigation

PART 1. GENERAL

1.01 DESCRIPTION

Logs of borings and laboratory soil test data.

PART 2. PRODUCTS

No products used.

PART 3. EXECUTION

3.01 TEST BORINGS

A. Test borings were taken at the locations shown on the drawings. Copies of boring logs, along with soil test data on soil samples recovered from the borings are included in Appendix 3.

B. Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. Data are made available for the convenience of the Contractor.

C. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner, provided such operations are approved by the Owner's Representative.

3.02 SITE OBSERVATIONS

B Gypsum Management Facility (Gypsum Stack & Recycle Pond)

1. The Gypsum Stack has been excavated to foundation grade on the sideslopes, and to within approximately 5.4 of foundation grade at the bottom of the cell. The remaining 5.4 feet of material will be utilized to construct the 3 foot thick clay layer. A drainage channel was cut from the southwest floor of the excavation to allow adequate surface water drainage. During the pre-bid meeting, Contractors will be given opportunity to view the excavation and resulting stockpiles, and to observe the in-situ conditions at the time of the meeting.

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2. The earthwork for the recycle pond pump station pad and access road, as well as sections of the recycle pond perimeter berm have been constructed to finish grade. During the pre-bid meeting, Contractors will be given the opportunity to view the in-situ conditions at the time of the meeting.

A. CCB Landfill

1. The CCB Landfill has been excavated to within 6 in. of foundation grade. During the pre-bid meeting, Contractors will be given opportunity to view the excavation and observe the in-situ conditions near foundation grade at the time of the meeting.

END OF SECTION 02010

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DIVISION 2 - SITEWORK
Section 02100 - Site Preparation
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to stripping of topsoil and vegetation from areas of the site that are to be excavated.

1.02 RELATED SECTIONS

No related sections.

PART 2. PRODUCTS

No products used.

PART 3. EXECUTION

3.01 EXAMINATION

The Contractor shall examine the site to determine the extent of work required, as well as the extent of previously stripped topsoil completed under a previous contract.

3.02 SITE PREPARATION - STRIPPING

A. The Gypsum Stack and portions of the Recycle Pond grading limits have been previously stripped under a separate contract as shown on the plans. Any remaining vegetation and topsoil encountered within the Gypsum Stack and Recycle Pond grading limits required to complete the work in this contract shall be stripped ~~Topsoil shall be kept clean and free of all foreign material, and stored in separate stockpiles from vegetation and common excavations. Stockpiles shall be located as indicated on the drawings or as directed by the Owner's Representative.~~ ***Topsoil removed by stripping shall not be stockpiled, and shall be deposited completely as described in section 3.02-C of this specification.***

B The top 6" of the existing excavation area of the CCB Landfill-Cell 1 within the CCB Landfill shall be removed and stockpiled per Specification Section 02200 Earthwork.

C Stripped Topsoil shall be used to fill depressions east of the Gypsum Management Facility as shown in the Plans.

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3.03 DISPOSAL

A. All materials resulting from site preparation operations shall be stockpiled in the designated spoil area. Contractor shall obey all laws and regulations when disposing of the materials.

END OF SECTION 02100

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PART 1. GENERAL

1.01 DESCRIPTION OF WORK

Control of surface water caused by precipitation and abandonment of existing subsurface drainage facilities within the construction limits of the Gypsum Management CCB Landfill shall be considered as part of the work under this specification.

A. The work to be completed by the Contractor includes, but is not necessarily limited to, the following:

1. Maintenance of existing Erosion and Sedimentation Control Measures according to Section 01356; and
2. Dewatering excavations from water caused by precipitation.
3. Abandonment of the existing subdrainage systems.

B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control and abandonment of the existing subsurface dewatering systems at the end of the Contract.

1.02 EXISTING FACILITIES

A. Gypsum Management Facility

1. An existing ditch at the south end of the existing excavation provides gravity outlet for the excavation to 5.4 feet above the foundation grade.

2. An existing subdrainage system provides limited control of groundwater migration into the excavation. The subdrainage system outlets by gravity flow to an existing ditch approximately 0.3 mile south of the existing excavation.

B. CCB Landfill Facility

1. An existing ditch at the southeast corner of the existing excavation provides gravity outlet for the excavation to foundation grade.

2. An existing subdrainage system provides limited control of groundwater migration into the excavation. The subdrainage system outlets by gravity flow to an existing channel approximately 0.2 mile east of the existing excavation.

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1.03 REQUIREMENTS

B. The General Contractor shall employ standard surface water management practices to prevent the ponding of stormwater runoff and/or erosion of existing and proposed earth surfaces, as required to complete the work.

1.04 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 01356 – Storm Water Pollution Prevention Measures
2. 02010 - Subsurface Investigation
3. 02200 - Earthwork

PART 2. PRODUCTS

2.01 MATERIALS

A. Materials and equipment for surface water management shall be reviewed by the Owner's Representative for compatibility with future construction and operation of the facility.

PART 3. EXECUTION

3.01 SURFACE WATER MANAGEMENT

A. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water caused by precipitation from all construction work areas and excavations.

B. Drainage features shall have sufficient capacity to avoid flooding of work areas.

C. Drainage features shall be so arranged and altered, as required to avoid degradation of the final excavated surface(s).

D. The Contractor shall utilize all necessary erosion and sediment control measures according to Section 01356 to avoid construction-related sedimentation of existing and proposed facilities.

3.02 WATER DISPOSAL

A. Dispose of water removed from the excavations in such a manner as:

1. Will not endanger portions of work under construction or completed.
2. Will cause no inconvenience to Owner or to others working near site.
3. Will comply with the stipulations of Section 01356.

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4. Will control runoff. The Contractor shall be responsible for control of runoff in all work areas, including, but not limited to: excavations, access roads, parking areas, stockpile, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with Section 01356.

B. Existing site drainage features or proposed subdrainage system may be used for water disposal.

3.03 DAMAGES

A. Immediately repair damages to adjacent facilities caused by the surface water management facilities, as constructed by the Contractor.

3.04 REMOVAL OF STORMWATER MANAGEMENT SYSTEMS INSTALLED BY CONTRACTOR

A. Remove and backfill temporary sumps, ditches, trenches, etc. according to Section 02300, as required by the Owner.

3.05 CORRECTIVE ACTION

Work shall be performed as necessary for reinstatement of foundation soil and damaged structure resulting from such inadequacy or failure by Contractor to control surface water, at no additional cost to Owner.

3.06 ABANDONMENT OF EXISTING SUBDRAINAGE SYSTEMS

Concurrence shall be obtained from Owner before discontinuing operation of subdrainage system.

The General Contractor shall maintain the existing subdrainage systems during construction of the Gypsum Management and CCB Landfill Facilities.

Prior to construction of the Compacted Clay Liner at the Gypsum Management Facility, all vertical drains consisting of a geotextile fabric encased pea gravel envelope shall be removed. The pea gravel shall be stockpiled and the geotextile fabric shall be removed and disposed of in a legal manner. Subdrainage piping damaged during removal of the vertical drains shall be repaired with equal material incidental to the work. An existing drainage structure consisting of 24" diameter reinforced concrete pipes with a ditch grate shall be removed. The concrete pipes shall be disposed of in a legal manner and the ditch grate shall be salvaged per the direction of Owner's Representative

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Upon completion of the construction of either facility, that facility's existing subdrainage system within the lined portion of the cell shall be abandoned as follows:

1. At each subdrainage vent pipe riser location, a mixture of high solids bentonite grout shall be pumped into the subdrainage piping to completely seal the system. The high solids bentonite grout shall be CETCO Volclay Grout or an approved equal that is NSF/ANSI Standard 60 certified. The grout shall be mixed according to the manufacturer's specifications for this application to provide a low permeability seal less than $1x10^{-7}$ cm/sec.
2. Cut the vent pipe risers 36 inches below with the ground surface. Fill the remaining vent piping with concrete as shown on the plans.
3. Remove completely the existing concrete inlet at the southeast quadrant of the gypsum stack excavation and dispose of in a legal manner. The grate will be salvaged and stored at the direction of the owner.
4. Remove completely the vent pipe protective bollards and dispose of in a legal manner.

END OF SECTION 02140

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DIVISION 2 – SITEWORK
Section 02200 – Earthwork
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to excavation, fill, and backfill required for foundation preparation, construction of Compacted Clay Liners, anchor trench construction, miscellaneous site grading, berm construction.

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 01356 – Storm Water Pollution Prevention Measures
2. 02100 - Site Preparation
3. 02140 – Surface Water Management
4. 02373 – Geotextiles
3. 02936 - Topsoil, Seeding, and Mulching

1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007
2. Department of Sustainable Natural Resources, Soil Survey Standard Test Method, Unified Soil Classification System: Field Method (USCS).

1.04 MEASUREMENT AND PAYMENT

A. The Contractor shall be responsible for estimating the extent of excavation and fill required to complete the work, including, but not limited to, excavation to required elevations; loading, transporting, placing, and compacting the Compacted Clay Liners; excavation and backfill of anchor trench; and miscellaneous site grading, including berm construction. The Contractor shall include the dollar amount associated with all earthwork in his Lump Sum Bid amount.

B. Removal and replacement of unsuitable foundation material (including underground sand channel materials) and subgrade stabilization measures directed by the Owner's Representative will be paid for on a time and material basis. Payment quantities will be based volume of excavation, determined from field surveys by the Owner's Field Surveyor.

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1.05 EARTHWORK COMPLETED UNDER PRIOR CONTRACT

A. Gypsum Management Facility

1. The gypsum stack has been excavated to approximately 5.4 ft. above foundation grade across the bottom of the cell.

2. Excavated subsoil material was stockpiled north and east into short term and long term subsoil stockpiles as shown on the plans. Stripped Topsoil was stockpiled separately.

3. The ~~75,000 yard~~ subsoil stockpile east of the Gypsum Stack shall be completely depleted under this contract. Schedule and timing shall be determined by the Contractor.

B. CCB Landfill

1. The cell has been excavated to approximately 6 in. above foundation grade and the perimeter berm has been completed, except for an existing construction access ramp on the east side of the cell near Sta. 205+00.

2. Excavated material was stockpiled in locations east of the excavation. The intended use and location for each stockpile is shown on the plans

1.06 COORDINATION

Existing utilities or other plant facilities shall not be interrupted, except when permitted in writing by the Owner's Representative and then only after acceptable temporary services have been provided. A minimum 48-hour notice shall be provided prior to proceeding with an approved temporary interruption.

1.07 SURFACE WATER MANAGEMENT

Control of surface water caused by precipitation necessary for completion of the work under this contract according to Section 02140 is the responsibility of the Contractor and shall be included in the contract lump sum price.

1.08 SUBMITTALS

A. Materials Handling Plan.

A materials handling plan shall be submitted for construction and protection of the Compacted Clay Liner. The plan shall describe the following:

1. Processing and placement of the Compacted Clay Liner: type, model number, weight, and critical dimensions of equipment to be used for soil processing, compaction, scarification, and smooth rolling;

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2. Method of protecting the Compacted Clay Liner from changes in moisture content and freezing after placement.

PART 2. PRODUCTS

2.01 MATERIALS

A. Earth Fill Material

Earth Fill Material shall consist of a mixture of clay, silt, sand, and gravel-sized particles obtained from previously constructed subsoil stockpiles. These materials can be used separately or mixed as required for best results. These materials shall be free of ice, snow, organic matter, rubbish, and debris. Coarse-grained particles shall be well dispersed to prevent the development of segregated pockets or zones with insufficient fine material to fill the interstices.

B. Compacted Clay Liners

1. Gypsum Management Facility

The Compacted Clay Liner for the Gypsum Management Facility shall be soil materials obtained from the approximately 5.4 ft. of material remaining above the foundation grade that was left in-place under the previous excavation contract. The material shall be free of ice, snow, organic matter, rubbish, and debris, and shall have a maximum clod size no greater than the length of the compactor foot for the compaction equipment proposed by the Contractor. When compacted, the material shall have a vertical hydraulic conductivity of less than 1×10^{-4} cm/sec.

2. CCB Landfill

The Compacted Clay Liner for the CCB Landfill shall be soil materials obtained from on-site excavations and materials stockpiled east of the cell. The material shall be free of ice, snow, organic matter, rubbish, and debris, and shall have a maximum clod size no greater than the length of the compactor foot for the compaction equipment proposed by the Contractor. When compacted, the material shall have a vertical hydraulic conductivity of less than 1×10^{-6} cm/sec.

C. Soil Stabilizers and Moisture Conditioning Agents

Additives to accelerate drying or to improve stability and workability of soil shall not be permitted unless approved in writing by the Owner's Representative.

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2.02 EQUIPMENT

A. Compaction Equipment

1. Tamping foot rollers

Compaction equipment shall consist of tamping foot rollers which have a minimum weight of 40,000 pounds. At least one tamping foot shall be provided for each 110 square in. of drum surface. The length of each tamping foot, measured from the outside surface of the drum, shall be at least 1 in. longer than the loose lift thickness.

2. Steel-Wheeled Rollers

Equipment used to produce a smooth compacted surface shall be a smooth, non-vibratory steel wheeled roller weighing not less than 1,000 lb. per lineal ft.

B. Scarification Equipment

Discs, rotor tillers, or other equipment used to scarify the surface shall be capable of uniformly disturbing at least the upper 6 in. of surface to provide good bonding between lifts.

C. Mixing and Spreading Equipment

Discs, harrows, and motor graders or other similar equipment shall be available at the site for use in spreading, mixing, and drying Compacted Subsoil Stockpile Material.

PART 3. EXECUTION

3.01 PREPARATION

A. Control of Work

Benchmarks, monuments, and other reference points shall be maintained throughout the work area.

B. Utility Location

Before starting excavation, the location and extent of underground utilities in the work area shall be established.

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3.02 EXCAVATION

A. General

Excavation consists of removal and redistribution of material encountered when establishing required grade and subgrade elevations. The Contractor shall be responsible for dewatering, protection, shoring, and disposal of excavated materials as necessary to complete the excavation.

B. Procedures

Excavation may be accomplished by any method and by use of any equipment that is suitable to the work, except that blasting will not be permitted. Based on previous construction experience at the site, it is recommended that excavation to the foundation grade be completed as far in advance of the Compacted Clay Liner placement as possible to allow the foundation surface to dry and form a "crust" capable of sustaining compactive effort.

C. Overexcavation

Overexcavation shall be performed to the lines and grades indicated on the plans. Additional overexcavation required to remove unsuitable materials as requested by the Owner's Representative shall be paid for by the Owner for at the Unit Price for Excavation. Any overexcavation or excess excavation not requested by the Owner's Representative shall be at the expense of the Contractor.

D. Disposal of Excavated Materials

Contractor shall stockpile excess excavated subsoil or topsoil materials in their corresponding stockpile for future use.

3.03 SUBGRADE PREPARATION

A. Areas to receive fill shall be proof rolled under the observation of the Owner's Representative. Soft, loose, weak, or wet materials shall be removed and replaced with compacted fill or stabilized with geotechnical fabric or geogrid as directed by the Owner's Representative and paid on a time and materials basis. Joints, fractures, and moisture seeps shall be repaired, and local sand deposits, if present at foundation grade, shall be removed and backfilled with compacted fill material as directed by the Owner's Representative.

B. The Owner's Representative may recommend additional drying time for soft, wet subgrade that has not been exposed long enough to permit "crust" formation. If approved by the Owner's Representative, the Contractor may install, at his own expense, geotechnical fabric to stabilize the wet subgrade and expedite construction.

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C. Following the excavation for the Compacted Clay Liner, the CQA Officer shall direct the Owner's Field Surveyor to verify that actual depths and grades of the foundation are in accordance with the plans and specifications. Elevations shall be surveyed on a 100 ft. grid pattern for the bottom of the cell. The points surveyed for side slopes will be at the top, midpoint, and toe. In addition, all breaks in grade will be surveyed. Foundation excavation grading shall meet a control tolerance requirement of 0 ft to -0.4 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor agency. The CQA Officer shall review the survey data for conformance to requirements and, if found in agreement with requirements, provide certification for the work in accordance with CQA Plan Procedures.

C. The Contractor shall not place fill until the subgrade has been examined jointly with the Owner's Representative and a certificate of approval for the subgrade has been submitted to the Owner's Representative.

3.04 STRUCTURAL FILL

A. Placement

1. Unless otherwise indicated on the plans, all Fill shall be composed of Earth Fill Material.
2. Fill materials used in embankment construction shall normally be placed in lanes parallel to the embankment axis and shall be placed in conformance with the lines, grades, and slopes as indicated on the plans. Placement of fill materials in lanes which are not parallel to the embankment will be allowed only where working room is too restricted for normal placement as determined by the Owner's Representative.
3. Fill shall be spread in approximately flat layers in such a manner as to obtain lifts of relatively uniform thickness without spaces between successively deposited loads. Segregation shall be prevented during placing and spreading. Hauling equipment shall be routed across the fill in such a way as to promote uniform compaction and to prevent the formation of ruts.
4. The maximum compacted thickness of each lift shall not exceed 8 in. where heavy compaction equipment will be used. The maximum compacted thickness shall not exceed 3 in. where power tampers or similar smaller equipment will be used. It may be necessary to reduce the thickness of lifts in order to obtain the required minimum density.
5. Where compacted Fill is to be placed against existing slopes, each lift shall be keyed into existing slope by removing existing slope material in steps as each new lift is placed.
6. The surface of the fill shall be kept reasonably smooth. The fill surface shall be sloped transverse to the axis of the embankments to allow drainage. If the compacted surface is, in the opinion of the Owner's Representative, too smooth or too dry to bond properly with the succeeding lift, it shall be roughened by scarifying, light discing, or other acceptable means, and it shall be sprinkled with water before the

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succeeding lift is placed thereon. If the surface becomes rutted or uneven subsequent to compaction, it shall be flattened and leveled before placing the next lift. This extra work shall be at the Contractor's expense.

7. Fill operations shall be suspended during periods of extended wet weather. Upon resuming operations, all fill materials that are excessively wet or soft shall be reprocessed in place or removed and stockpiled for reprocessing. The removal of soft material shall be carried to such depth as is necessary to expose firm materials. Fill shall not be placed on frozen surfaces.

8. When filling operations at any section will be suspended for any period in excess of 12 hours or in wet weather, the surface of the fill shall be rolled smooth to seal it against excessive absorption of moisture and to facilitate runoff. Prior to resuming fill placement and compaction, the fill surface shall be scarified and/or disced and moisture conditioned as required.

9. The Contractor will receive no additional compensation for any removal, reprocessing, stockpiling, recompaction, wasting, or similar operation related to suspensions or conditions due to weather or other causes unless caused by the Owner.

10. Earth fill access ramps shall not be constructed within the limits of the compacted embankments without the approval of the Owner's Representative. When such ramps are approved, they shall be constructed of Compacted Clay Liner material (in-board of the perimeter berm) or compacted Fill (out-board of the perimeter berm).

B. Compaction -

1. Fill materials shall be compacted to a dry density equal to or greater than the following:

   a. The Gypsum Management Facility: 95 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.
   b. The CCB Landfill: 90 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.

   In order to insure uniform coverage and to facilitate construction inspection and control, the compaction of each layer shall proceed in a systematic, orderly, and continuous manner. Rolling shall be parallel to the embankment axis, except where there is insufficient working room for such operations.

2. The moisture content of all earth fill materials shall be as uniform as practicable throughout each lift. Fill shall be compacted at a moisture content that is no more than 2 percent below and no more than 2 percent above optimum moisture content.

3. Moisture conditioning of fill materials shall be performed by discing, harrowing, plowing, blading, or other suitable means prior to excavation. Moisture conditioning where the fill is placed shall be limited to minor adjustments prior to compaction. Addition of moisture shall be by using a

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pressure spray bar mounted in front of or to one side of a water tanker so that water will not collect in the tracks of the truck.

4. Any materials that are placed but not compacted prior to drying out or becoming too wet shall be removed and replaced or reprocessed at the Contractor's expense.
5. No admixtures as drying agents or to improve the workability of the soil will be allowed.

3.05 GENERAL FILL

General Fill materials shall be placed to the specifications for Structural Fill, except it shall be compacted to a dry density equal to or greater than 92 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698

3.06 COMPACTED CLAY LINERS

A. Sources

The Compacted Clay Liners for both the Gypsum Management Facility and the CCB Landfill shall be constructed from Compacted Clay Liner material as described in paragraph 2.01(B) above.

B. Test Soil Liner

A Test Soil Liner of the actual full scale liner shall be constructed in accordance with the following requirements:

1. Test liner will be constructed from the same soil material sources, to the same design specifications, and with similar equipment and procedures as are proposed for the full scale liner.
2. Test liner will be at least four times the width of the widest piece of equipment to be used.
3. Test liner will be no less than 100 ft long to allow equipment to reach normal operating speed before reaching a central 40-ft test area.
4. Test liner will be constructed with maximum 8-in. compacted lifts for a total liner thickness of 3 ft.
5. Test liner will be tested by the Owner's Testing Firm in accordance with the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, summarized below for each of the following physical properties:

    a. Multiple two-stage Boutwell permeameter tests will be used on the test liner to determine the hydraulic conductivity. The two-stage field hydraulic conductivity test is a falling head infiltration test conducted in a cased borehole, typically 4 in. in diameter. The test is cited in the U.S. EPA Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, September 1993 (EPA/600/R-93/182).

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b. Undisturbed samples (Shelby tubes) will be tested in the laboratory for hydraulic conductivity to determine if there is a statistical correlation to the field testing results.

c. Other engineering parameters including, but not limited to, particle size analysis, liquid limits, plasticity, water content, and in-place density that are needed to evaluate the full scale liner will be determined.

6. Additional test fills will be constructed for each new soil type or for each change in equipment or procedures.

C. Full Scale Liner Construction:

1. Full scale liner construction shall not be commenced until the results of the in-place compaction testing and Boutwell permeameter tests on the test liner confirm that the construction procedures and specified compaction requirements produce in-situ hydraulic conductivities as specified in Section 2.01(B) above.

2. The liner shall be constructed according to the placement and compaction requirements for general fill, except the material shall be compacted to a density of no less than 95 percent of maximum dry density as determined by the Standard Proctor Test (ASTM D 698) at the following moisture contents:

a. Gypsum Stack Compacted Clay Liner shall be compacted at a moisture content between 100 percent and 105 percent of optimum.

b. CCB Landfill Compacted Clay Liner shall be compacted at a moisture content determined by the "acceptable zone" criteria as outlined in the project CQA Plan.

The same compaction procedures, such as number of passes, speed, and compaction equipment used on construction of the test liner shall be used. Grade stakes shall not be driven into the clay liner.

3. Moisture/density, hydraulic conductivity, and strength testing of the Compacted Clay Liner shall be conducted by the soil testing agency under the requirements and frequencies specified in the project CQA Plan to verify that ongoing liner placement meets the criteria developed by the Test Soil Liner.

4. The completed liner shall be smooth rolled to limit moisture loss and promote run-off of surface water. Moisture content shall be maintained within the specified range and erosion or other damage that occurs in the soil liner shall be repaired as directed by the Owner's Representative until the geosynthetic liner is placed.

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5. Voids created in the Compacted Clay Liner during construction (including, but not limited to, penetrations for test samples, and other penetrations necessary for construction) shall be repaired by removing material that does not meet the requirements for Compacted Clay Liner material, backfill with Compacted Clay Liner material, granular or pelletized bentonite, or a mixture of bentonite and Compacted Clay Liner material in lifts no thicker than 2 in. and tamping each lift with a steel rod. Each lift shall be tamped a minimum of 25 times altering the location of the rod within the void for each blow. Other ruts and depressions in the surface of the lifts shall be scarified, filled, and then compacted to grade.

3.07 CUSHION DIRT (Gypsum Management Facility Only)

Cushion Dirt to be placed beneath the upper High Density Polyethylene (HDPE) Geomembrane is to be placed to the specifications for General Fill in Section 3.04 above, except fill materials for Cushion Dirt shall be compacted to a dry density equal to or greater than 90 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.

3.08 ANCHOR TRENCH CONSTRUCTION

A. Gypsum Management Facility – Gypsum Stack

1. The anchor trench shall be excavated to the depth and width shown on the anchor trench details. The front edge of the trench shall be rounded to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Loose soil shall be removed or compacted into the floor of the trench.

2. Subsequent to Geosynthetic Clay Liner (GCL), Bottom HDPE Geomembrane and Geotextile Cushion installation, the liners shall be placed in the trench to fully cover the entire trench floor, but do not extend up the back of the trench wall. After the liner installation, the trench shall be backfilled with 1 ft. of Compacted Clay Liner material. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the GCL and liner materials.

3. Subsequent to installation of separation geotextile on top of drainage layer, it shall be verified that the fabric extends across the top of the initial 1 ft layer of trench backfill, but does not extend up the back of the trench wall. After the separation geotextile has been installed in, the trench shall be backfilled with 2 ft of Compacted Clay Liner material. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the separation geotextile.

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4. Subsequent to installation of the upper HDPE Geomembrane, the liner shall be installed into the trench and extend across the top of the initial 1 ft layer of trench backfill, but not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the HDPE Geomembrane.

B. Gypsum Management Facility – Recycle Pond

1. The anchor trench shall be excavated to the depth and width shown on the anchor trench details. The front edge of the trench shall be rounded to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Loose soil shall be removed or compacted into the floor of the trench.

2. Subsequent to HDPE Geomembrane installation, it shall be verified that the liner covers the entire trench floor, but does not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Recycle Pond berm. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the liner material.

C. CCB Landfill

1. Excavate a ledge at bottom of anchor trench elevation and place and compact Compacted Clay Liner material on the ledge as shown on the anchor trench details in the plans.

2. Excavate the anchor trench to the depth and width shown on the anchor trench details. Round the front edge of the trench to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Remove loose soil or compact it into the floor of the trench.

3. Subsequent to GCL and HDPE geomembrane installation by the geosynthetic liner contractor, verify that the liners cover the entire trench floor, but do not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was

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installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the GCL and HDPE geomembrane.

4. Subsequent to installation of separation geotextile on top of drainage layer, verify that the fabric extends across the top of the initial 1 ft layer of trench backfill, but does not extend up the back of the trench wall. After the fabric installation in the trench has been inspected and approved by the Owner's Representative, backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the geotextile fabric.

3.09 TESTING

A. Construction Quality Assurance (CQA) compaction and permeability tests will be made by the Owner's Testing Consultant during the progress of the work as indicated in the Construction Quality Assurance Plan, included in Appendix 2. The Contractor shall cooperate with the Testing Consultant and allow such tests to be performed.

B. If tests indicate that an area of fill or Compacted Clay Liner does not meet the specified requirements, additional tests shall be performed to determine the extent of non-compliance. The Contractor shall moisture condition and recompact that area until a passing test result is obtained.

C. Moisture/density testing by nuclear methods will be conducted by the Owner's Testing Firm at a minimum frequency as outlined in the Construction Quality Assurance (CQA) Plan. The range of moisture content will be determined in accordance with the "acceptable zone" method which is also outlined in the Project CQA Manual. A moisture test will be considered failed if the result indicates that the moisture content does not lie within the "acceptable zone." Material that fails will be dried or wetted until satisfactory moisture content is achieved. A density test will be considered failed if the result indicates a dry density outside the "acceptable zone." The material will be compacted until a passing test is achieved.

To ensure accuracy and reproducibility of testing of the soil liner for compaction and moisture content, all density gauges shall be certified by annual calibration.

3.10 FINISH GRADING

All excavated and filled areas shall be fine graded and leveled to provide a smooth finish free of debris, foreign matter, objectionable stones, clods, lumps, pockets, or high spots, properly drained and true to indicated elevations. Finish grading shall be only near completion of work or when requested. Any portions

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of the berm damaged by construction shall be restored. The berm ditch shall be finished to design grade, and the ditch side slopes shaped and trimmed to provide a uniform ditch cross section.

3.11 CONSTRUCTION TOLERANCES

A. Elevations will be surveyed at breaks in slopes and on a 100 ft. grid pattern on the base before and after liner construction to verify liner thickness and to verify that proper drainage slopes to leachate collection piping are maintained. To verify material thickness, all horizontal survey coordinates will be the same for the bottom and the top of the material that is placed. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points. A test will be considered failed if it does not meet the minimum design requirements. To obtain the specified design thickness, additional soil material will be placed and compacted in failing areas where the as-built thickness is less than the design thickness. Surveying required for verification of final construction tolerances will be performed by the Owner's Land Surveyor.

B. The minimum specified design thickness of all Compacted Clay Liners shall be 3.00 ft.

END OF SECTION 02200

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DIVISION 2 - SITE WORK
Section 02275 - Riprap

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to the placement of riprap for erosion control.

1.02 RELATED SECTIONS

The following section contains items which are related to the work in this section:

02200 - Earthwork

1.03 REFERENCES

Specified references or cited portions thereof, current at date of bidding documents unless otherwise specified, govern the work.

A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SUBMITTALS

Product Data: Provide quarry name and material type prior to delivery.

PART 2. PRODUCTS

2.01 MATERIALS

A. Stone Riprap and Bedding materials according to Article 1005.01 of the Illinois Standard Specifications for Road and Bridge Construction.

B. Filter Fabric material, where required by IDOT specifications for Stone Riprap, shall furnished according to Article 1080.03, with an AOS (Apparent Opening Size) as indicated on the plans.

C. Riprap Source shall be listed on the current IDOT Approved Aggregate Source List.

D. Gradation as indicated in the drawings. Quality shall be Class A.

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PART 3. EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

A. Stone Riprap and Bedding shall be installed in accordance with Section 281 of the Illinois Standard Specifications for Road and Bridge Construction for the placement of Stone Riprap. Measurement and payment provisions of Section 281 shall not apply.

B. Filter Fabric for Stone Riprap shall be installed in accordance with Section 282 of the Illinois Standard Specifications for Road and Bridge Construction.

C. The Owner's Representative shall be allowed to visually inspect Riprap for compliance with specifications prior to placement.

END OF SECTION 02275

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DIVISION 2 – SITEWORK
Section 02315 – Granular Materials
ADDENDUM #2

PART 1. GENERAL

1.01 DESCRIPTION

A. Gypsum Management Facility

This section pertains to the following

1. Furnishing and placing granular drainage materials for the drainage layer and Leachate Collection System piping.
2. Furnishing and placing coarse aggregate for encasement of the Process Water Recovery System piping.
3. Furnishing and installing Filter Sand for the protection of the Process Water Recovery System piping.
4. Furnishing and installing materials for roadbed construction related to the Gypsum Management Facility access roads.
5. Recycle Pond Drain.
6. Furnishing and installing materials for roadbed construction related to maintaining McKinley Road on AERG property.
7. ***Furnishing and installing materials for roadbed construction related to the Landfill Haul Road.***

B. CCB Landfill

This section pertains to the following:

1. Placing granular material for Drainage Layer.
2. Placing granular material for Separation Berm.
3. Placing Coarse Aggregate for encasement of leachate collection piping.
4. Furnishing and installing materials for roadbed construction related to the landfill access road.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 02300 - Earthwork
2. 02373 - Geotextiles
3. 02640 - Leachate Collection Piping

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1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.
2. American Society for Testing and Materials (ASTM):
   a. ASTM D 75 (2003) Practice for Sampling Aggregates.
   b. ASTM D 422 (1963; R 2002) Test Method for Particle-Size Analysis of Soils.
   c. ASTM D 2434 (1968, R 2000) Test Method for Permeability of Granular Soils (Constant Head).
   d. ASTM D 3042 (2003) Test Method for Insoluble Residue in Carbonate Aggregates.
   e. ASTM C 1260 (2005) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
3. American Geological Institute (AGI). Geoscience Handbook AGI Data Sheets, 4th Edition.

1.04 MEASUREMENT AND PAYMENT

The Contractor shall be responsible for estimating the extent of granular materials required to complete the work including, but not limited to, construction of drainage layer, encasement of leachate collection piping, and road-bed construction. The Contractor shall include the dollar amount associated with furnishing and placing all granular materials in his Lump Sum Bid amount.

1.05 COORDINATION

A. The geosynthetic liner shall be covered with granular materials as soon as practicable after a section of liner has been approved by the Owner's Representative.

1.06 SUBMITTALS

A. Product Data:

1. Aggregate source list: Submit a list of proposed aggregate sources.

2. Shipping Tickets: Submit shipping tickets for the granular materials delivered to the site. Shipping tickets shall be according to paragraph 1004.01f of the IDOT Standard Specifications.

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B. Test Reports

1. Submit results of grain size analysis (ASTM D422) and hydraulic conductivity testing (ASTM D2434) for gradations established by the Contractor that provide the specified hydraulic conductivity. Test results are required for each proposed source and gradation. Submit test results for each source demonstrating compliance with reactivity, soundness, and abrasion requirements specified herein.

C. Samples:

1. Submit one sample per source for each gradation proposed for use on the project. Samples shall be at least one pound and shall be obtained and shipped according to ASTM D75. Submit samples at least 15 days prior to starting construction of the drainage layer and coarse aggregate encasement for leachate piping.

1.07 STORAGE AND HANDLING

A. Storage and handling of granular materials shall be according to paragraph 1004.01e of the IDOT Standard Specifications.

PART 2. PRODUCTS

2.01 MATERIALS

A. General

1. Coarse Granular materials shall be meet the Description of Gravel, as described in Section 1004.01(a)(1) of the IDOT Standard Specifications, and shall be spherical to sub-discoidal, sub-rounded to well rounded particles as defined by AGI Data Sheet, 4th Edition, Sheet 8.4 – Comparison Charts for Estimating Roundness and Sphericity.
2. Granular materials shall experience no more than 15 percent carbonate loss per ASTM D3042.
3. Granular materials shall be free of deleterious material, and shall meet the Na_2SO_4 soundness and Los Angeles Abrasion Specifications for Class B quality aggregate per paragraph 1004.01 of the IDOT Standard Specifications.
4. All material shall pass the 2 in. sieve, and no greater than 5 percent shall be retained on the No. 200 sieve.
5. Granular materials shall be innocuous to alkali-silica reactivity, and shall exhibit internal expansions of less than 0.10 percent at 16 days after casting as determined by ASTM C 1260.

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B Gypsum Management Facility Granular Materials

1. Granular Materials for Drainage Layer

Gradation for granular material for Drainage Layer shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec.

2. Coarse Aggregate around Ring Drain Collection Piping

Coarse Aggregate used to encase the ring drain collection piping shall be IDOT Gradation CA 7 material as outlined in Article 1004.01 of the IDOT Standard Specifications for Road and Bridge Construction.

3. Filter Sand

Filter Sand used for protective cover over the ring drain collection system shall be IDOT Gradation FA 1, Class B or better according to Article 1003 of the IDOT Standard Specifications for Road and Bridge Construction.

4. Aggregate Base Course, Type B

Aggregate Base Course, Type B used for base material for all new access roads and ***the Landfill Haul Road*** shall be IDOT Gradation CA 2, in accordance with Section 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction. The requirements from Section 2.01A of this specification shall not apply.

5. Aggregate Surface Course, Type B

Aggregate Surface Course, Type B used for surface material for all new access roads and the ***Landfill Haul Road*** ~~McKinley Road relocation~~ shall be IDOT Gradation CA 6, in accordance with Section 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction. The material shall originate from an IDOT approved source. The requirements from Section 2.01A of this specification shall not apply.

6. Coarse Aggregate for Leachate Collection/Leachate Detection Piping

Gradation for coarse aggregate encasement around Leachate Collection/Leachate Detection Laterals shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-1} cm/sec.

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B. CCB Landfill Granular Materials

1. Granular Materials for Drainage Layer and Separation Berm.

Gradation for granular material for drainage layer and separation berm shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec.

2. Coarse Aggregate.

Gradation for coarse aggregate shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-1} cm/sec.

2.02 EQUIPMENT

Equipment for spreading and compacting granular materials shall be low ground pressure equipment to prevent damage to the underlying geosynthetic liners.

PART 3. EXECUTION

3.01 PROTECTION OF GEOSYNTHETICS

A. Protection of the geosynthetic liners is critically important. Approved geosynthetic liner shall be covered by granular material as soon as practicable. Granular material shall be placed to a minimum thickness of 1 ft before any heavy equipment or loaded trucks are allowed on the lined area.

B. No vehicular traffic shall travel directly on the geosynthetic liner other than an approved low ground pressure All Terrain Vehicle or equivalent.

C. Any damage to the geosynthetic liner system shall be repaired, as directed by the Owner's Representative, at the expense of the Contractor.

3.02 DRAINAGE LAYER (GYPSUM STACK)

A. Placement on Cell Floor

1. The granular material shall be back-dumped on the geotextile cushion fabric in a sequence of operations beginning at the perimeter of the liner on the cell floor.
2. Placement of material on the fabric shall be accomplished by spreading dumped material off of previously placed material with a bulldozer blade or endloader, in such a manner as to prevent tearing or shoving of the cloth. Dumping of material directly on the fabric will only be permitted to establish an initial working platform. No vehicles or construction

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equipment shall be allowed on the fabric prior to placement of the granular blanket to a minimum thickness of 1 ft.

B. Placement on Cell Side Slopes

1. Placement of granular material on cell side slopes shall be accomplished using methods and equipment similar to that specified for placement of material on cell floor.
2. The Contractor may place earth fill material underlain with separation geotextile fabric to buttress the granular material on the slope:

   a. The Construction Quality Assurance (CQA) survey to certify thickness of drainage material shall be completed within the footprint of the gypsum stack before it is covered with separation geotextile fabric.
   b. Separation geotextile fabric shall extend beyond the toe of gypsum buttress a sufficient distance to prevent contamination of the granular drainage layer. See Sections 02373 and 02320 for construction of separation geotextile fabric.

3.03 DRAINAGE LAYER (CCB LANDFILL)

A. Placement on Cell Floor

1. The granular material shall be back-dumped on the geotextile cushion fabric in a sequence of operations beginning at the perimeter of the liner on the cell floor.
2. Placement of material on the fabric shall be accomplished by spreading dumped material off of previously placed material with a bulldozer blade or endloader, in such a manner as to prevent tearing or shoving of the cloth. Dumping of material directly on the fabric will only be permitted to establish an initial working platform. No vehicles or construction equipment shall be allowed on the fabric prior to placement of the granular blanket to a minimum thickness of 1 ft.

B. Placement on Cell Side Slopes

1. Placement of granular material on cell side slopes shall be accomplished using methods and equipment similar to that specified for placement of material on cell floor.
2. The Contractor may place CCB underlain with separation geotextile fabric to buttress the granular material on the slope:

   a. The Construction Quality Assurance (CQA) survey to certify thickness if drainage material shall be completed within the footprint of the CCB before CCB placement.

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b. Separation geotextile fabric shall extend beyond the toe of CCB buttress a sufficient distance to prevent contamination of the granular drainage layer. See Sections 02373 and 02320 for construction of separation geotextile fabric and CCB, respectively.

C. Placement in Separation Berm.

1. Granular material for the separation berm shall be placed and spread in uniform lifts not to exceed 1 ft. The initial lift shall be placed according to paragraph A. The separation berm shall be constructed across the floor of the cell to at least the level of the top of drainage layer before any CCB is placed within the cell, and the top of berm shall be maintained at or above the level of adjacent CCB as CCB placement progresses.

3.04 COARSE AGGREGATE FOR ENCASEMENT OF RING DRAIN COLLECTION PIPING (GYPSUM MANAGEMENT FACILITY)

A. The geotextile filter fabric for encasement of leachate collection piping shall be placed on the approved cushion geotextile fabric according to Section 02373 – Geotextiles.

B. The coarse aggregate shall be placed and consolidated with a vibratory plate compactor on the encasement fabric to the width shown on the plans to the level of the bottom of the ring drain collection piping.

C. Course aggregate shall be placed and consolidated with a vibratory plate compactor along the pipe during pipe installation. The coarse aggregate shall be placed longitudinally along the pipe in lifts not to exceed 8 in. thick to a height of at least the center of the pipe. The aggregate shall be maintained at equal elevation on each side of the pipe, and the first lift of material shall be mechanically tamped to ensure that the space under the pipe is completely filled. The top of pipe shall not be covered until the CQA survey certifies leachate piping grade has been completed.

D. After the CQA survey has been completed, coarse aggregate material shall continue to be placed in lifts not to exceed 8 in. thick, as specified in the previous paragraph until the minimum cover height shown in the plans is attained.

E. The running of trucks or heavy equipment over leachate piping shall be avoided until there is at least a 12 in. cover of Filter Sand over the completed geotextile envelope.

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3.05 COARSE AGGREGATE FOR ENCASEMENT OF LEACHATE COLLECTION PIPING (CCB LANDFILL)

A. Place geotextile fabric for encasement of leachate collection piping on the approved cushion geotextile fabric according to Section 02373 – Geotextiles.

B. Place and consolidate coarse aggregate with a vibratory plate compactor on the encasement fabric to the width shown on the plans to the level of the bottom of the leachate piping.

C. Place and consolidate course aggregate along the pipe during pipe installation. Place coarse aggregate longitudinally along the pipe in lifts not to exceed 8 in. thick to a height of at least the center of the pipe. Maintain the aggregate at equal elevation on each side of the pipe, and mechanically tamp the first lift of material to ensure that the space under the pipe is completely filled. Do not cover the top of pipe until the CQA survey to certify leachate piping grade has been completed.

C. After the CQA survey has been completed, continue placing coarse aggregate material in lifts not to exceed 8 in. thick, as specified in the previous paragraph until the minimum cover height shown in the plans is attained.

D. Avoid running trucks or heavy equipment over leachate piping until there is at least 12 in. cover over the completed geotextile envelope. Provide temporary ramps no steeper than 10H:1V transverse to the piping for temporary equipment crossings until the first lift of CCB is placed.

3.06 ROADWAY CONSTRUCTION

A. Prepare the roadway subgrade as shown on the plans, in accordance with Section 02200 – Earthwork.

B. Furnish Geotechnical Fabric for Ground Stabilization in accordance with Section 02373 – Geotextiles.

C. Furnish Aggregate Base Course, Type B in accordance with Article 351 of the IDOT Standard Specifications for Road and Bridge Construction.

D. Furnish Aggregate Surface Course, Type B in accordance with Article 402 of the IDOT Standard Specifications for Road and Bridge Construction.

3.07 TESTING

A. Independent gradation and permeability tests will be made by the Owner's Testing Lab during the progress of the work at frequencies as required in the project Construction Quality Assurance (CQA) Plan, included in Appendix 2.

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The Contractor shall cooperate with the Testing Lab and allow such tests to be performed.

B. If tests indicate that an area of granular material or coarse aggregate does not meet the specified requirements of the project CQA Plan, then the Contractor shall remove the material and replace it with suitable material.

3.05 FINISH GRADING

The granular drainage layer shall be fine graded, but not compacted, to provide a smooth finish before a CQA survey of the completed portion of the drainage layer is requested. The CQA Officer shall direct the survey agency to determine elevations at the top of the final constructed surface of the Drainage Layer using a 100 ft. grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify thickness, all horizontal survey coordinates shall be the same for the top of the cushion, and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points. In co instance shall the field determined thickness be less than 1.0 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the survey agency. Ruts or erosion damage shall be repaired before placement of the separation geotextile fabric.

END OF SECTION 02315

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PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to furnishing and installing geotextile fabrics on prepared surfaces.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 02300 - Earthwork
2. 02315 - Granular Materials
3. 02800 – HDPE Geomembrane

1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.
2. American Society for Testing and Materials (ASTM):
   a. ASTM 3776 (1996; R 2002) Standard Test Method for Mass per Unit Area (Weight) of Fabric;
   b. ASTM D 3786 (2001) Test Method for Hydraulic Bursting Strength of Textile Fabrics -- Diaphragm Bursting Strength Tester Method;
   c. ASTM D 4533 (2004) Test Method for Trapezoid Tearing Strength of Geotextiles;
   d. ASTM D 4632 (1991; R 2003) Test Method for Grab Breaking Load and Elongation of Geotextiles;
   e. ASTM D 4751 (2004) Test Method for Determining Apparent Opening Size of Geotextile;
   f. ASTM D 4833 (2000) Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products;
   g. ASTM D 4873 (2002) Guide for Identification, Storage, and Handling of Geosynthetic Rolls;
   h. ASTM D 4884 (1996; R 2003) Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles;
   i. ASTM D5261-92(2003) Standard Test Method for Measuring Mass per Unit Area of Geotextiles

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j. ASTM D6241-04 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.04 MEASUREMENT AND PAYMENT

A. The Contractor shall be responsible for estimating the extent of geotextile fabric required to complete the work including fabric for laps, anchorage, repairs, and samples for Construction Quality Assurance (CQA) testing. The Contractor shall include the dollar amount associated with all geotextile construction in his Lump Sum Bid amount, except as specified in paragraph B.

B. Geotextile Fabric for Ground Stabilization, when directed by the Owner's Representative for stabilization of foundation soils, will be paid for on a time and materials basis.

C. No additional payment will be made for geotextile fabric for ground stabilization installed at the Contractor's discretion.

1.05 SUBMITTALS

A. Product Data

1. The manufacturer's list of guaranteed properties for each geotextile fabric proposed for use on the project shall be submitted.
2. The manufacturer's installation guidelines shall be submitted.

B. Samples

Samples of geotextile fabrics shall be submitted for CQA prequalification testing. Sample size and sampling frequency are specified in Appendix 2.

C. Inventory

A copy of the roll inventory that identifies, as a minimum, manufacturer or supplier, product or style number, roll number, width, and length of roll as identified on the roll label shall be submitted.

1.06 STORAGE AND HANDLING

Geotextiles shall be stored and handled according to ASTM D4873.

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PART 2. PRODUCTS

2.01 MATERIALS

A. Geotextile Fabric for Liner System

Geotextile fabrics for use in the cell liner system shall consist of non-woven filaments of polypropylene, polyester, or polyethylene. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Non-woven fabric may be needle-punched, heat-bonded, or a combination thereof. The filaments shall be dimensionally stable (i.e., filaments shall maintain their relative position with respect to each other) and resistant to delamination. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile. The filaments shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

Fabric shall have the following physical properties:

Physical Properties[1]	4 oz. (Separation)	6 oz. (PWRS)	16 oz. (CA Envelope & Rub Sheet)
Mass/Unit Area (oz./yd^2) ASTM D5261	4.0	6.0	16.0
Grab Tensile Strength (lb.) ASTM D4632	115	160	380
Grab Elongation (%) ASTM D4632	50	50	50
Puncture Strength (lb.) ASTM D4833	65	85	240
Puncture (CBR) Strength (lb.) ASTM D6241	310	410	1025
Mullen Burst Strength (psi) ASTM D3786	210	280	750
Trapezoidal Tear Strength (lb.) ASTM D4533	50	60	150
Width (ft.)	15	15	15
Apparent Opening Size (AOS) Max. US Std. Sieve No. ASTM D4751	70	70	100
UV Resistance[2] (%) ASTM D4355	70	70	70
Roll Width (ft.)	15	15	15

Notes

(1) All Values listed are Minimum Average Roll Values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations.

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(2) UV Resistance is a minimum value and not a MARV. Evaluation to be on 2.0 inch strip tensile specimens after 500 hours exposure.

B. Geotextile Cushion

Fabric for Geotextile Cushion shall consist of non-woven filaments of polypropylene, polyester, or polyethylene. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Non-woven fabric may be needle-punched, heat-bonded, or a combination thereof. The filaments shall be dimensionally stable (i.e., filaments shall maintain their relative position with respect to each other) and resistant to delamination. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile. The filaments shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

Fabric shall have the following physical properties:

Physical Properties[1]	10 oz. (Geotextile Cushion)
Mass per unit area (oz/yd^2) ASTM D5261	10
Grab Tensile Strength (lb.) ASTM D4632	230
Grab Tensile Elongation (%) ASTM D4632	50
Trapezoidal Tear Strength (lb.) ASTM D4533	95
Puncture (CBR) Strength (lb.) ASTM D6241	700
Puncture (CBR) Elongation (in.) ASTM D6241	1.5
UV Resistance[2] (%) ASTM D4355	70
Apparent Opening Size (Max.) (AOS) Sieve No. - ASTM D4751	---
Roll Width (ft.)	15

Notes

(1) All Values listed are Minimum Average Roll Values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations.

(2) UV Resistance is a minimum value and not a MARV. Evaluation to be on 2.0 inch strip tensile specimens after 500 hours exposure.

C. Geotechnical Fabric for Ground Stabilization

Geotechnical fabric for ground stabilization shall conform to Article 1080.02 of the IDOT Standard Specifications for Road and Bridge Construction.

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D. Thread for Seams

High strength thread should be used such that seam test should conform to ASTM D4884. The thread shall meet the chemical, ultraviolet, and physical requirements of the geotextile, and the color shall be different from that of the geotextile.

E. Securing Devices

Pins, staples, and other devices that project through the geotextile fabric are not permitted for fabrics installed above the geomembrane. Sandbags, stone, or other appropriate means approved by the Owner's Representative shall be used to prevent movement of the geotextile.

2.02 EQUIPMENT

A. Equipment for spreading and compacting granular materials shall be low ground pressure equipment to prevent damage to the underlying geosynthetic liners.

PART 3. EXECUTION

3.01 SAMPLES FOR CQA TESTING

A Geotextile fabric samples shall be obtained, identified and packaged from rolls designated by the Owner's Representative according to ASTM D4873.

B. Samples shall be 3 ft. wide by the full roll width.

3.02 BASE PREPARATION

A. Surface on which the geotextile will be placed shall be prepared to a relatively smooth surface condition, and shall be free from obstruction, debris, depressions, erosion features, or any irregularities that would prevent continuous, intimate contact of the geotextile with the entire surface. Rills, gullies, and ruts must be graded out of the surface before geotextile placement. Areas on which geotextile are to be placed shall be graded and/or dressed in accordance with Section 02200 – Earthwork and Section 02315 – Granular Materials. Prior to daily placement, the Installer shall provide the CQA Officer daily "certificates of acceptance" which document the Installer's inspection and acceptance of the underlying surface as being suitable for the geotextile installation.

B. Geotextile cushion fabric will be installed directly on the geosynthetic liner. Jointly inspect the liner with the Owner's Representative before commencing fabric installation each day. Notify the Owner's Representative promptly of any damage or defects observed in the liner as fabric installation progresses. Do not place fabric in the damaged or defective area until the liner has been repaired and

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approved by the Owner's Representative. Submit a daily inspection report identifying the area of fabric placement and certifying that there were no visible defects in the area of fabric placement.

C. Do not run heavy vehicle traffic directly on the geosynthetic liner or cushion geotextile. Use vehicles and equipment as specified in paragraph 2.02 to transport and deploy fabric on the liner. Operate the equipment with care, and place protective cover over the geomembrane, if necessary, to avoid damaging the liner. Route traffic and personnel over installed cushion fabric and use the installed fabric as a working platform to the greatest extent possible.

3.03 INSTALLATION

A. General Requirements:

1. Geotextile fabric shall be unrolled and laid out following these requirements to the greatest extent practical:

   a. Orient panels with the longest dimension parallel to the slope.
   b. Minimize the number of seams in corners and odd-shaped areas.
   c. Extend panels on slopes a minimum of 5 ft onto a horizontal surface.

   Geotextile panels shall be unrolled using methods that will not damage the fabric and will protect underlying surface from damage. While unrolling, the geotextile fabric shall be visually inspected for imperfections and faulty or suspect areas marked. Ballast shall be placed on fabric to prevent wind uplift. Expansion and contraction should be allowed for by leaving slack.

   Heavy vehicle traffic shall not be run directly on geotextile fabric. Fabric in areas of heavy traffic shall be protected with protective cover over the fabric.

2. Laps

   Individual panels of geotextile fabric shall be lapped according to manufacturer's instructions and as specified herein. Provide a minimum overlap of 3 in. unless otherwise specified herein or in the plans. Shingle overlaps so that water or other material cannot run down the slope between the two layers of fabric.

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3. Field Seams

Continuously sew all laps on slopes steeper than 10H:1V. This requirement does not apply to the heavy geotextile fabric for envelopment of coarse aggregate around leachate piping.

4. Defects and Repairs

Examine the installed geotextile fabric for defects, holes discontinuous seams, puckered or separated laps, etc. Repair defective laps and seams. Patch holes and defects according to manufacturer's recommendations and as directed by the Owner's Representative. Do not cover suspect or patched areas until they have been inspected and approved by the Owner's Representative.

B. Geotextile Fabric for Separation

1. Use low ground pressure equipment to avoid rutting the granular material.
2. Horizontal seams (parallel to top of slope) will be permitted on cell side slopes to facilitate staged construction of the drainage layer on the side slope.
3. Extend separation geotextile fabric into and across the bottom of the anchor trench and complete backfill of the trench according to Section 02200.

C. Geotextile Fabric for Coarse Aggregate Envelope

1. Geotextile for coarse aggregate envelope will be installed directly on the cushion fabric. Remove any foreign materials from the cushion fabric within the footprint of the coarse aggregate leachate piping encasement before installing the geotextile envelope. Place sufficient width to completely envelop the coarse aggregate and provide a longitudinal lap of at least 6 in.
2. After the coarse aggregate encasement has been completed, according to Section 02315, wrap the geotextile around the mounded aggregate, and cover the lap with at least 6 in. of material before permitting vehicle or equipment on the fabric.
3. Any ballast material other than coarse aggregate, according to Section 02315, that is placed within the envelope will require removal during coarse aggregate construction.

D. Geotechnical Fabric for Ground Stabilization

1. Install Geotechnical Fabric for Ground Stabilization in accordance with Section 210 of the IDOT Standard Specifications for Road and Bridge Construction.

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2. If approved by the Owner's Representative, the Contractor may, at his own expense, install geotextile or geogrid for ground stabilization outside the limits designated by the Owner's Representative.
3. Submit as-built drawings that clearly delineate limits and type of ground stabilization.

3.04 PROTECTION

A. Protect installed fabric until it is covered by at least 1 ft. of overlying material.

B. Any damage to the geotextile during its installation or during placement of overlying materials shall be replaced by the Contractor at no cost to the Owner. Unless otherwise noted, the work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 14 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile. The geotextile shall be protected from damage prior to and during the placement of overlying materials. Before placement of overlying materials, the Contractor shall demonstrate that the placement technique will not cause damage to the geotextile.

3.05 TESTING AND INSPECTION

A. Prequalification Testing

Geotextiles are subject to CQA testing by the Owner's Testing Consultant to verify conformance with the manufacturer's list of guaranteed properties according to the project Construction Quality Assurance Plan, included in Appendix 2. The Contractor shall provide samples as specified herein. Any fabric that does not conform to the list of guaranteed properties shall be removed from the site.

B. Installed fabric shall be inspected by the Owner's Representative. No material shall be placed on the fabric, other than ballast, until the installation has been approved by the Owner's Representative. Ballast shall not obscure seams or significant length of unseamed laps. The Owner's Representative may require removal of ballast to inspect suspect areas.

C. If the Owner's Representative suspects that completed work has been damaged by construction methods that do not conform to the specifications, he may require removal of completed work to verify the integrity of the underlying materials. The Contractor shall bear the cost of removal and subsequent repair as directed by the Owner's Representative, if the integrity of the underlying materials was damaged. If no damage was found, the Owner will pay the Contractor for the investigation work on a time and materials basis.

END OF SECTION 02373

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DIVISION 2 - SITEWORK
Section 02376 – Geosynthetic Clay Liner

PART 1. GENERAL

1.01 DESCRIPTION

A This section covers furnishing and installation of a reinforced needlepunched Geosynthetic Clay Liner (GCL) at the Gypsum Management Facility and the CCB Landfill.

B The work includes furnishing all equipment and materials, providing all labor, supervision, administration and management necessary to perform the work as specified herein and as shown on the plans.

1.02 RELATED SECTIONS

None.

1.03 REFERENCES

The following references, or cited portions thereof, govern the work

1. Geosynthetic Institute

   a. GRI-GCL3, Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).

2. American Society for Testing and Materials (ASTM):

   a. ASTM D 4632 (1991; R 2003), Standard Test Method for Grab Breaking Load and Elongation of Geotextiles;
   b. ASTM D 4643 (2000), Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method;
   c. ASTM D 5084 (2003), Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter;
   d. ASTM D 5261 (1992; R 2003), Test Method for Measuring Mass Per Unit Area of Geotextiles;
   e. ASTM D 5321 (2002), Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method;

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f. ASTM D 5887 (2004), Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter;
g. ASTM D 5888 (1995; R 2002), Practice for Storage and Handling of Geosynthetic Clay Liners;
h. ASTM D 5889 (1997; R 2003), Practice for Quality Control of Geosynthetic Clay Liners;
i. ASTM D 5890 (2002), Test Method for Swell Index of Clay Minerat Component of Geosynthetic Clay Liners;
j. ASTM D 5891 (2002), Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

1.04 SUBMITTALS

A. With the bid, the Contractor shall furnish the following information:

1. Conceptual description of the proposed plan for placement of the GCL panels over the areas of installation.
2. GCL Manufacturer's Quality Control (MQC) Plan for documenting compliance with Sections 2.01 and 2.02 of these specifications.
3. GCL manufacturer's historical data for reinforced GCL of a) 10,000-hour creep shear testing per Section 2.01 D. and b) seam flow data at 2 psi confining pressure per Section 2.01 E.
4. A copy of GCL manufacturer's International Standards Organization (ISO) Quality Certificate of Registration.
5. Statement of experience from the proposed GCL supplier.
6. Statement of experience from the proposed GCL installer.

B. At the Owner Representative's or Owner's request, the Contractor shall furnish:

1. A representative sample of the GCLs.
2. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million sq. ft (100,000 sq. meters) in size.

C. Upon shipment, the Contractor shall furnish:

1. The GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.
2. Inventory of materials received.

D. As installation proceeds, the Geosynthetics Installer's Representative shall submit certificates of subgrade acceptance, signed by the Contractor and Construction Quality Assurance (CQA) Inspector (see Sections 1.06 and 3.03) for each area that is covered by the GCL.

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E. Warranty

After construction, the contractor shall submit material and installation warranty certificates.

1.05 QUALIFICATIONS

A. GCL Manufacturer must have produced at least 10 million sq. ft. (1 million sq. meters) of GCL, with at least 8 million sq. ft. (800,000 sq. meters) installed.

B. The GCL Installer must either have installed at least 1 million sq. ft. (100,000 sq. meters) of GCL, or must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.06 CONSTRUCTION QUALITY ASSURANCE (CQA)

A. Construction Quality Assurance of the GCL installation shall be performed as outlined in the project Construction Quality Assurance Plan, included in Appendix 2 of these Specifications.

B. The GCL Installer shall provide his own CQA inspector. The Owner shall provide a third-party inspector for CQA monitoring of the GCL installation. The inspector shall be an individual or company who is independent from the manufacturer and installer and who shall be responsible for monitoring and documenting activities, related to the CQA of the GCL throughout installation.

C. Testing of the GCL as necessary to support the CQA effort shall be performed by a third party laboratory retained by the Owner and independent from the GCL manufacturer and installer.

WARRANTY

The geomembrane material shall be warranted, on a pro-rata basis against manufacturer's defects for a period of five (5) years from the date of liner installation. The installation shall be warranted against defects in workmanship for a period of (1) year from the date of liner completion.

PART 2. PRODUCTS

2.01 MATERIALS

A. The GCL shall be manufactured as a hydraulic barrier consisting of clay bonded between two layers of nonwoven geotextile by needle punching.

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B. The GCL shall be manufactured to conform with the test methods, required properties, and testing frequencies of the GRI-GCL3 specification for Reinforced, Geotextile Related GCL.

C. In addition to the minimum properties given in Table 1(a) of GRI-GCL3, the GCL shall conform to the following specifications.

Test Method	Minimum Value
Bentonite Mass/Area (ASTM D 5993)	0.75 lb./ft^2
GCL Grab Tensile Strength (ASTM D 4632)	90 lb.
GCL Peel Strength (ASTM D 4632)	15 lb.

D. The reinforced GCL shall have seam test data from an independent laboratory showing that the seam flow with a grooved cut in one of the nonwoven geotextiles is less than 1 x 10^{-8} $m^3/m^2/s$ at 2 psi hydraulic pressure.

E. The minimum acceptable dimensions of full-size GCL panels shall be 150 ft. (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 ft. (21 meters) but less than a full-length roll)] may be supplied at a rate no greater than three (3) per truckload or three (3) rolls every 36,000 sq. ft. (3,500 sq. meters) of GCL, whichever is less.

2.02 PRODUCT QUALITY DOCUMENTATION

The GCL manufacturer shall provide the Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

A. The Manufacturer's Certification that the material was manufactured and tested in accordance with GRI-GCL3 specifications, together with a report of the test results, shall be furnished at the time of shipment.

B. The manufacturers recommended seaming method with seam test data from an independent laboratory showing that the seam flow is less than 1 x 10^{-8} $m^3/m^2/s$ at 2 psi hydraulic pressure.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

2.03 PRODUCT LABELING

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand product code).

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2. Lot number and roll number.
3. Roll length, width and weight.

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2.04 PACKAGING

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

2.05 ACCESSORY BENTONITE

A. The granular bentonite sealing clay used for overlap seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. Seaming of GCLs shall be conducted in accordance with the manufacturer's guidelines for each particular GCL.

PART 3. EXECUTION

3.01 SHIPPING AND HANDLING

A. The rolls of GCL shall be packaged and shipped by appropriate means to prevent damage to the material and to facilitate off-loading.

B. The Installation Supervisor shall be present during delivery and unloading of the GCL. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage. The Installation Supervisor shall prepare and submit an inventory that includes lot and roll number for materials received.

C. The Installer is responsible for unloading the GCL. The Installer should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

3.02 STORAGE

A. Storage of the GCL rolls and accessory bentonite shall be the responsibility of the Installer.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

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C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

3.03 EARTHWORK

A. The compacted clay liner upon which the GCL is installed shall be prepared and compacted prior to installation. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation.
2. Construction debris.
3. Sticks.
4. Sharp rocks.
5. Void spaces.
6. Ice.
7. Abrupt elevation changes.
8. Standing water.
9. Cracks larger than 0.25 in. (6 mm) in width.
10. Any other foreign matter that could contact the GCL.

B. Immediately prior to GCL deployment, the compacted clay liner shall be final-graded by the contractor to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than 0.5 in. (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

C. Prior to daily GCL placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" which document the Installer's inspection and acceptance of the underlying surface as being suitable for GCL installation.

D. It shall be the Installer's responsibility thereafter to indicate to the Owner's Representative any change in the condition of the compacted clay liner that could cause the subgrade to be out of compliance with any of the requirements listed in this Section. The Installation Supervisor shall certify in the daily report that no GCL was placed over visibly defective low permeability soil surface.

E. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated by the contractor in accordance with the project plans. The trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

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3.04 GCL PLACEMENT

A. GCL rolls shall be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) shall be in accordance with the Owner Representative's recommendations.

B. Equipment which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

C. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

D. The GCL panels shall be placed parallel to the direction of the slope.

E. All GCL panels shall lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.

F. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, the Installer shall remove and replace the hydrated material as directed by the Owner Representative.

3.05 ANCHORAGE

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope. The front edge of the trench shall be rounded so as to eliminate any sharp corners. Loose soil shall be removed from the floor of the trench. The GCL shall cover the entire trench floor, but shall not extend up the rear trench wall.

3.06 SEAMING

A. The GCL seams shall be constructed by overlapping their adjacent edges according to the manufacturer's recommendations. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

B. End-of-roll overlapped seams shall be constructed with a minimum overlap of 24 in. (600 mm). Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff

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flow to enter the overlap zone. End-of-roll overlapped seams for all reinforced GCL seams require bentonite-enhanced seams as described below.

C. Bentonite-enhanced seams shall be constructed between the overlapping adjacent panels as follows. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150 mm) line. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal ft. (0.4 kg/m). A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

3.07 DETAIL WORK

A. There shall be no penetrations through the GCL.

B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.08 DAMAGE REPAIR

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible, if approved by the Owner's Representative, to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 in. (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic shall be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement. Patching shall be certified by the Installer's CQA Inspector and observed by the Owner's Representative.

PART 4. GRI-GCL3 SPECIFICATIONS

Geosynthetics Research Institute (GRI) GRI-GCL3, "Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).", Dated -- May 16, 2005.

END OF SECTION 02376

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Original - May 16, 2005

GRI-GCL3*

Standard Specification for

"Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers the manufacturing quality control (MQC) of geosynthetic clay liners (GCLs), describing types of tests, the proper test methods, minimum and sometimes maximum values, and the minimum testing frequencies.

Note 1: Geosynthetic Clay Liners (GCLs) are also called Clay Geosynthetics Barriers (GBR-Cs).

1.2 There are two general categories of GCLs covered in this specification: reinforced and nonreinforced. Within each category there are geotextile, polymer coated geotextiles, and geomembrane/geofilm related types.

1.3 This specification is intended to aid manufacturers, suppliers, purchasers and users of GCLs in establishing an acceptable level of effort for manufacturing quality control.

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

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1.4 This specification does not address manufacturing quality assurance (MQA), product acceptance testing, or conformance testing. These are independent activities taken by organizations other than the GCL manufacturer.

1.5 The values stated in SI (metric) units are to be regarded as the standard. The U.S. (English) units are calculated values using a "soft" conversion accuracy.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards

D 638 Test Method for Tensile Properties of Plastics
D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D 882 Test Method for Tensile Properties of Thin Plastic Sheeting
D 1141 Practice for Preparation of Substitute Ocean Water
D 1505 Test Method for Density of Plastics by the Density-Gradient Method
D 4354 Practice for Sampling of Geosynthetics for Testing
D 4439 Terminology for Geosynthetics
D 4632 Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4759 Practice for Determining the Specification Conformance of Geosynthetics
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5887 Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using Flexible Wall Permeameter
D 5888 Practice for Storage and Handling of Geosynthetic Clay Liners
D 5889 Practice for Quality Control of Geosynthetic Clay Liners
D 5890 Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
D 5891 Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
D 5993 Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liners
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembrane
D 6102 Guide for Installation of Geosynthetic Clay Liners
D 6141 Guide for Screening the Clay Portion of a GCL for Chemical Compatibility to Liquids

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D 6243 Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
D 6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners
D 6496 Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 6766 Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Liquids
D 6768 Test Method for Tensile Strength of Geosynthetic Clay Liners

2.2 GRI Standards

GM13 Test Properties, Testing Frequency and Recommended Warrant for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
GM18 Test Properties, Testing Frequency and Recommended Warrant for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes (Presently suspended as of May 3, 2004)

2.3 Government Document:

U.S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182. September 1993. 305 pgs.

3. Terminology

3.1 Definition

3.1.1 Geosynthetic Definitions:

3.1.1.1 geotextile, n a permeability geosynthetic comprised solely of textiles. (ASTM D 4439)
3.1.1.2 geomembrane, n—an essentially impermeable geosynthetic barrier composed of one or more synthetic sheets. (ASTM D 4439)
3.1.1.3 geofilm, n—a thin polymeric film which is essentially impermeable having a thickness no greater than 0.25 mm (10 mils).
3.1.1.4 geotextile-polymer, n -a geotextile which has been coated with, or impregnated by, a polymer such as polypropylene

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3.1.1.5 geosynthetic clay liner, n—a manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetic materials. (ASTM D 4439)

Note 1: Geotextile Related GCL is one in which two geotextiles are used respectively as cap and carrier to the bentonite. Cap and carrier designations in this standard refer to respective orientations during manufacturing. This may or may not be the as-placed orientation in the field. It can be internally reinforced by needle punching or stitching, or be nonreinforced.
Geotextile Polymer Coated GCL is one in which two geotextiles are used respectively as cap and carrier to the encased bentonite, however, one of the geotextiles has been polymer coated in a manner that the permeability and flux are decreased. Cap and carrier designations refer to the as manufactured product and not necessarily to the as-placed orientation. It can be internally reinforced by needle punching or stitching, or be nonreinforced.
Geomembrane/Geofilm Related GCL is one in which a geomembrane or geofilm is included in the cross section either above or below the cap geotextile. It can be internally reinforced needle punching or be nonreinforced. Also in the nonreinforced category is bentonite adhesively bonded to a geomembrane.

3.1.2 Material Definitions

3.1.2.1 bentonite—a distinct type of fine-grained clay soil typically containing not less than 80% montmorillionite clay, usually characterized by high swelling upon wetting.

3.1.2.2 Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For geosynthetic materials, a formulation refers to the exact percentages of resin, additives, carbon black and/or other additives. It does not necessarily refer to individual suppliers of each ingredient. The individual suppliers must meet the manufacturer's internal quality control specification.

3.1.3 Organizational Definitions:

3.1.3.1 installer, n—the party who installs, or facilitates installation of, any materials purchased from manufacturers or suppliers.

3.1.3.2 manufacturer, n—the group, corporation, partnership, or individual that manufactures a product.

3.1.3.3 purchaser, n—the person, company, or organization that purchases any materials or work to be performed.

3.1.3.4 supplier, n- the party who supplies material or services.

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3.1.4 Quality Definitions:

3.1.4.1 Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications. ref. EPA/600/R-93/182

3.1.4.2 Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project. ref. EPA/600/R-93/182

3.1.4.3 Construction Quality Control (CQC) - A planned system of inspections that are used to directly monitor and control the quality of a construction project. Construction quality control is normally performed by the geosynthetics manufacturer or installer, or for natural soil materials by the earthwork contractor, and is necessary to achieve quality in the constructed or installed system. Construction quality control (CQC) refers to measures taken by the installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project. ref. EPA/600/R-93/182

3.1.4.4 Construction Quality Assurance (CQA) - A planned system of activities that provide assurance that the facility was constructed as specified in the design. Construction quality assurance includes inspections, verification, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. Construction quality assurance (CQA) refers to measures taken by the CQA organization to assess if the installer or contractor is in compliance with the plans and specifications for a project. ref. EPA.600/R-93/182

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4. Significance and Use

4.1 GCLs must be properly manufactured in a manner consistent with a minimum level of quality control as determined by in-house testing of the final product. This specification presents the types of tests, standard methods of the testing, required (usually minimum) test values, and minimum testing frequencies which should be embodied in the manufacturer's quality control documents. The quoted tests, test methods and test values in Table 1 must appear in the MQC plan and the MQC report.

4.2 It should be clearly recognized that manufacturers may perform additional tests or at greater frequency than required in this specification, or both. In this case, the manufacturer's quality control plan will then take precedence over this specification.

4.3 It should also be recognized that purchasers and installers of GCLs may require additional tests or at a great frequency than called for in this specification, or both. The organization(s) producing such project specific specification or quality assurance plan should recognize that such requirements are beyond the current state-of-the-practice. If such a request is made by purchasers or installers, they should clearly communicate the requirements to the manufacturer or supplier during the contract decisions in order that disputes do not arise at a subsequent time.

5. Procedure

5.1 The procedures embodied in this specification are contained in the respective test methods given in Table 1.

5.1.1 The minimum recommended quality control tests for the manufacture of GCLs are given in Table 1. Specific tests are performed on the bentonite, the geosynthetic component materials, and the finished GCL. Table 1(a) is in S.I. (Metric) units and Table 1(b) is in U.S. (English) units.

Note 2: The conversion from S.I. units into U.S. units is soft.

5.1.2 The individual properties in Table 1 are minimum values; except fluid loss, moisture content, and permeability (or flux). They are maximum values. The manner of taking specimens is described in the appropriate test method. When an average value is indicated, it is listed in the table as "min. ave.", or "max. ave.".

5.2 Bentonite (as received)
Two tests are required; swell index and fluid loss. The latter is a maximum value. These tests should be performed on the bentonite prior to fabrication into a GCL.

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or on bentonite taken from the manufactured product if the bentonite is modified in any way during manufacturing, e.g., if an adhesive is added.

5.3 Geotextile (as received)
Mass per unit area is required on the as-manufactured cap and carrier fabrics, with different values depending on the fabric being nonwoven or woven.

Note 3: These tests are to be performed on the geotextiles before manufacturing into the final GCL. Removal of the geotextiles from the manufactured product and subsequent testing will give erroneous values and is not an acceptable practice. The exception is polymer coated GCLs where the geotextile must be removed to determine its mass per unit area.

5.4 Geomembrane/Geofilm (as received)
The following tests are required; thickness, density, and tensile strength at break. All are minimum required values. Tensile strength at break is the lowest of machine direction and cross machine direction.

Note 4: These tests are to be performed on the geomembrane or geofilm before manufacturing into the final GCL. Removal of the geomembrane or geofilm from the manufactured product and subsequent testing will give erroneous values and is not an accepted practice.

5.5 GCL (as manufactured)
Six tests are required on the as-manufactured GCL with one having an alternative, i.e., hydraulic conductivity or flux. All are minimum values, with the exception of moisture content and hydraulic conductivity or flux.

5.6 GCL (long-term)
The purpose of these long-term or endurance tests is to provide confidence in the continuing acceptable performance of the bentonite and geosynthetic components of the installed GCL.

5.6.1 The durability of the bentonite is evaluated using a permeant consisting of 0.1 M calcium chloride solution. See ASTM D 6141 which is a guide for this particular aspect of the specification. The GCL is to be hydrated with distilled dionized water prior to conducting the tests with the calcium chloride solution. In this regard, ASTM D6766 Scenario 1 and Method C is the procedure to be used. Furthermore, this test is conducted twice at two different normal pressures, i.e., 35 and 500 kPa. The maximum allowable values are listed in Table 1.

5.6.2 The geotextiles in their as-received condition are evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The

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minimum percent in tensile strength retained at break, as measured by ASTM D6768, is 65%. If individual yarns are used in reinforcing GCLs, they must also meet this same endurance criterion.

5.6.3 The geomembrane in its as-received condition is evaluated for durability via the appropriate GRI Specification. For high density polyethylene (HDPE), the specification is GRI GM13. For linear low density polyethylene (LLDPE), the specification is GRI GM17. For flexible polypropylene (fPP), the specification is GRI GM18.

5.6.4 The geofilm in its as-received condition is evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The minimum percent tensile strength retained at break for either MD or XMD, as measured by ASTM D882, is reported accordingly and must meet or exceed the specification value.

Note 5: It should be recognized that the above durability criterion for geofilms is not as stringent as the criteria for geomembranes stated in Section 5.6.3.

6. Workmanship and Appearance

6.1 Waterproof ink overlap lines should be printed on both edges of one of the surfaces (geotextile or geomembrane) of the manufactured GCL.

Note 6: The overlap lines are minimally 150 mm (6.0 in.) from the edges of the GCL. Other design-related situations may require greater overlap distances to be printed on the GCLs, e.g., when not backfilled in a timely manner.

6.2 Needle punched and stitch bonded GCLs shall be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product. There must be continuous needle detection and removal devices, e.g., metal detectors and magnets, used during manufacture of GCL products.

6.3 The manufactured GCL shall have good appearance qualities. It shall be free from such defects that would affect the specified properties and integrity of the product.

6.4 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents. ASTM D5888 and D5889 should be followed in this regard.

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7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Table 1. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width, see ASTM D 4354.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Table 1.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave.". When the property is a maximum value, the designation is "max. ave.".

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marking

9.1 The GCL shall be rolled, clearly labeled, and onto a substantial core, encased in a waterproof wrapper. Packaging must be adequate for safe transportation to the point of delivery.

9.2 The label should include manufacturer, style, lot and/or roll number, weight, length and width.

10. Conformance and Certification

10.1 Conformance of the manufactured GCL to this specification, or agreed-upon variation thereof, shall be performed by the MQA organization or designated by the purchaser/owner. ASTM D 4759 can be used as a general guide, but individual test methods must be clearly stipulated and communicated to the parties involved.

10.2 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

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Table 1(a) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)[1]	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (g/m^2)[2]	D5261	200	200	200	70	100	n/a/70	20,000 m^2
cap fabric -(woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
carrier fabric (nonwoven composite) - mass/(g/m^2)[2]	D5261	240	240	240	90	100	n/a/90	20,000 m^2
carrier fabric (woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
coating - mass/unit area (g/m^2)[3]	D5261	n/a	100	n/a	n/a	100	n/a	4,000 m^2
Geomembrane/Geofilm (as received)								
thickness[3,4] (mm)	D5199/D5994	n/a	n/a	0.40/0.50/0.10	n/a	n/a	0.40/0.75/0.10	20,000 m^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	20,000 m^2
break tensile strength, MD&XMD (kN/m)	D6693	n/a	n/a	n/a	n/a	n/a	6.0	20,000 m^2
break tensile strength, MD (kN/m)	D882	n/a	n/a	2.5	n/a	n/a	2.5	20,000 m^2
GCL (as manufactured)								
mass of GCL (g/m^2)[6]	D5993	4000	4050	4100	4000	4050	4100	4,000 m^2
mass of bentonite (g/m^2)[6]	D5993	3700	3700	3700	3700	3700	3700	4,000 m^2
moisture content[1,2] (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	4,000 m^2
tensile str., MD (kN/m)	D6768	4.0	4.0	4.0	4.0	4.0	4.0	20,000 m^2
peel strength (N/m)	D6496	360	360	360	n/a	n/a	n/a	4,000 m^2
permeability[4] (m/sec), "or"	D5887	5×10^{-11}	5×10^{-12}	5×10^{-12}	5×10^{-10}	5×10^{-12}	5×10^{-12}	25,000 m^2
flux[3] ($m^3/sec\text{-}m^2$),	D5887	1×10^{-8}	1×10^{-9}	1×10^{-9}	1×10^{-8}	1×10^{-9}	1×10^{-9}	25,000 m^2
GCL permeability[4,7,8] (m/sec) (max. at 35 kPa)	D6766	1×10^{-8}	1×10^{-9}	1×10^{-9}	1×10^{-8}	1×10^{-9}	1×10^{-9}	yearly
GCL permeability[4,7,8] (m/sec) (max. at 500 kPa)	D6766 mod.	5×10^{-10}	5×10^{-11}	5×10^{-11}	5×10^{-10}	5×10^{-11}	5×10^{-11}	yearly
Component Durability								
geotextile and reinforcing yarns[8] (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec[9]	n/a	n/a	GM Spec[9]	yearly
geofilm/polymer treated[8] (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum)

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs, one, or the other, must contain a scrim component of mass ≥ 100 g/m^2 for dimensional stability

(3) Calculated value obtained from difference of coated fabric to as-received fabric

(4) Value is both site-specific and product-specific and is currently being evaluated

(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm

(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method

(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g CaCl2 in 1-liter water)

(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days

(9) Durability criteria should follow the appropriate specification for the geomembrane type used, i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP

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Table 1(b) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)[1]	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (oz/yd^2)[2]	D5261	5.8	5.8	5.8	2.1	2.9	n/a/2.1	25,000 yd^2
cap fabric (woven) - mass/unit area (oz/yd^2)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd^2
carrier fabric (nonwoven composite) - mass/(oz/yd^2)[2]	D5261	5.9	5.9	5.9	2.7	2.9	n/a/2.7	25,000 yd^2
carrier fabric (woven) - mass/unit area (oz/yd^2)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd^2
coating - mass/unit area (oz/yd^2)[3]	D5261	n/a	2.9	n/a	n/a	2.9	n/a	5,000 yd^2
Geomembrane/Geofilm (as received)								
thickness[5] (mils)	D5199/D5994	n/a	n/a	15/20/4	n/a	n/a	15/30/4	25,000 yd^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	25,000 yd^2
break tensile strength, MD&XMD (lb/in.)	D6693	n/a	n/a	n/a	n/a	n/a	34	25,000 yd^2
break tensile strength, MD & XMD (lb/in.)	D882	n/a	n/a	13	n/a	n/a	14	25,000 yd^2
GCL (as manufactured)								
mass of GCL (lb/ft^2)[6]	D5993	0.82	0.83	0.84	0.82	0.83	0.84	5,000 yd^2
mass of bentonite (lb/ft^2)[6]	D5993	0.75	0.75	0.75	0.75	0.75	0.75	5,000 yd^2
moisture content[13] (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	5,000 yd^2
tensile str., MD (lb/in.)	D6768	23	23	23	23	23	23	25,000 yd^2
peel strength (lb/in.)	D6496	2.1	2.1	2.1	n/a	n/a	n/a	5,000 yd^2
permeability[14] (cm/sec), "or"	D5887	5×10^{-9}	5×10^{-10}	n/a	5×10^{-9}	5×10^{-10}	n/a	30,000 yd^2
flux[14] ($cm^3/sec\text{-}cm^2$)	D5887	1×10^{-7}	1×10^{-7}	n/a	1×10^{-6}	1×10^{-7}	n/a	30,000 yd^2
GCL permeability[7][8] (cm/sec) (max. at 5 lb/in.^{2})	D6766	1×10^{-8}	1×10^{-8}	1×10^{-9}	1×10^{-8}	1×10^{-9}	1×10^{-9}	yearly
GCL permeability[7][8] (cm/sec) (max. at 70 lb/in.^{2})	D6766 mod.	5×10^{-8}	5×10^{-8}	5×10^{-9}	5×10^{-8}	5×10^{-9}	5×10^{-9}	yearly
Component Durability								
geotextile and reinforcing yarns[15] (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec[9]	n/a	n/a	GM Spec[9]	yearly
geofilm/polymer treated[15] (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum)

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs: one, or the other, must contain a scrim component of mass > 2.9 oz/yd^2 for dimensional stability

(3) Calculated value obtained from difference of coated fabric to as-received fabric

(4) Value is both site-specific and product-specific and is currently being evaluated

(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm

(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method

(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g CaCl2 in 1-liter water)

(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days

(9) Durability criteria should follow the appropriate specification for the geomembrane used; i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP

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DIVISION 2 - SITE WORK
Section 02640 – HDPE Piping
ADDENDUM #2

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to construction of the HDPE (High Density Polyethylene) Piping for the Leachate Collection System, Process Water Recovery System, ~~***the Slurry Piping and Valves,***~~ and Recycle Pond Decant System at the Gypsum Management Facility and the Leachate Collection System for the CCB Landfill.

1.02 RELATED SECTIONS

None.

1.03 REFERENCES

The following references, or cited portions thereof, govern the work

A. American Society of Testing and Materials:

1. ASTM D 2683 (2004); Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
2. ASTM D 3261 (2003); Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
3. ASTM D 3350 (2005); Specification for Polyethylene Plastics Pipe and Fittings Materials.
4. ASTM F 412 (2001a); Terminology Relating to Plastic Piping System.
5. ASTM F 1055 (1998); Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
6. ASTM F 1056 (2004); Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings.
7. ***ASTM F714-06a Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.***
8. ***ASTM F2164-02 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure***

1.04 SUBMITTALS

A. Qualifications

Submit qualifications of the Welding Supervisor who will be responsible for construction quality control of the pipe joining process.

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B. Material Certifications

Submit manufacturer certifications that the pipe provided complies with the requirements herein.

C. Product Data

1. Submit product data and operating instructions for pipe joining equipment.
2. Submit pipe manufacturer's recommended procedures for storing, handling, and installing pipe and fittings.

1.05 QUALIFICATIONS

A. The Contractor or Subcontractor performing the work under this section shall have in his employ a Welding Supervisor who has completed a minimum of 10,000 ft of pipe joining work using the type of equipment proposed for use in this work. The Welding Supervisor shall be on site at all times during pipe line installation, and shall provide direct supervision over other employees.

1.06 WARRANTY

A. The pipe and fittings shall be warranted, on a pro-rata basis, against manufacturer's defects for a period of five (5) years from the date of pipe installation. The installation shall be warranted against defects in workmanship for a period of one (1) year from the date of completion.

PART 2. PRODUCTS

2.01 MATERIALS

A. Leachate and Process Water Collection Piping

1. Pipe material shall be High Density Polyethylene (HDPE) PE 3408, according to ASTM F412, with minimum cell classification values of 345464C, according to ASTM D3350. Iron pipe size (IPS) and standard dimension ratio (SDR) shall be as indicated in the plans.

2. Size and spacing of holes in perforated pipe shall be as indicated in the plans.

~~B. *Slurry* Sluice Piping~~

~~Pipe for HDPE Sluice Lines shall be manufactured from a PE 3408 resin. The resin material shall meet the specifications of ASTM D3350-02 with a minimum cell~~

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~~classification of PE345464C. Pipe O.D. sizes 4" to 54" shall be available in steel pipe sizes (IPS). Pipe shall have a manufacturing standard of ASTM D3035 and be manufactured by an ISO 9001 certified manufacturer. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.~~

~~*Pipe shall be manufactured from a pipe resin which meets ASTM D 3350-05 with a minimum cell classification of 445474C. Pipe shall be manufactured to the dimensions of ASTM F-714. The service factor to determine the pressure rating shall be 0.63. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.*~~

C. Fittings *(Leachate and Process Water Collection Piping)*

1. Fittings shall be made of the same material and size as the HDPE piping, and shall have a pressure rating no less than 160 psi.

2. Butt Fusion Fittings

   Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Fabricated fittings are to be manufactured using a Data Logger. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records.

3. Electrofusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99. Electrofusion Fittings shall have a manufacturing standard of ASTM F-1055. Fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans.

4. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D-3350. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D-3261. Fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Flanged and Mechanical Joint Adapters are to be used for Sluice Piping only.

~~D. Valves *and Valve Piping* for Sluice *Slurry* Piping~~

~~Valves used for Sluice Piping shall be ITT Fabri-Valve XS150-ULV-Urethane~~

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~~Lined Knife Gate Valves. Valve Material: Yet to Be Determined~~

~~*Valves used for the Slurry Piping System shall be Clarkson KGF Knife Gate Valve with ductile iron housing high tear strength gum rubber sleeves, C276 gate rated at 300 psig, with manual handwheel actuation.*~~

~~*Fittings and piping at valve stations shall be SILVER STREAK model fiberglass reinforced plastic (FRP) as manufactured by Fiber Glass Systems. Flanges shall have ANSI B16.5 Class 150 bolt hole patterns. Flanged connections to valves shall have ANSI B16.5 Class 300 bolt hole patterns. ASTM A307, Grade B, hex head bolts shall be supplied. Washers shall be supplied on all nuts and bolts. Gaskets shall be 1/8" thick, 60-70 durometer full-face type suitable for the service shown on the drawings and as recommended in the manufacturer's standard installation procedures. Pipe shall be installed as specified and indicated on the drawings.*~~

~~*E. Fittings for HDPE Slurry Piping*~~

~~*1. Butt Fusion Fittings – Fittings Pipe shall be manufactured from a pipe resin which meets ASTM D 3350-05 with a minimum cell classification of 445474C. Pipe shall be manufactured to the dimensions of ASTM F-714. The service factor to determine the pressure rating shall be 0.63. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material*~~

~~*2. Molded Butt Fusion Fittings shall have a manufacturing standard of ASTM D-3261. Molded & fabricated fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Fabricated fittings must have the same pressure rating as the pipe; a DR less than the pipe shall be used. Fabricated fittings are to be manufactured using a Data Logger to record temperature, fusion pressure, and a graphic representation of the fusion cycle shall be part of the Quality Control records.*~~

~~*3. Electrofusion Fittings – Fittings shall be made from resin or pipe meeting ASTM D 3350-05 with a minimum cell classification of 445474C.; Electrofusion Fittings shall meet the manufacturing standard of ASTM F-1055. Fittings shall have the same pressure rating as the pipe or higher unless otherwise specified on the plans.*~~

~~*4. Flanged and Mechanical Joint Adapters – Flanged and Mechanical Joint Adapters shall be made from materials containing resin that meets ASTM D 3350-05 with a minimum cell classification of 445474C.*~~

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2.02 EQUIPMENT

A. Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400 degrees Fahrenheit, alignment, and an interfacial fusion pressure of 75 PSI. The butt fusion joining will produce a joint weld strength equal to or greater than the tensile strength of the pipe itself. All field welds shall be made with fusion equipment equipped with a Data Logger. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records.

B. Sidewall fusions for connections to outlet piping shall be performed in accordance with HDPE pipe and fitting manufacturer's specifications. The heating irons used for sidewall fusion shall have an inside diameter equal to the outside diameter of the HDPE pipe being fused. The size of the heating iron shall be ¼ inch larger than the size of the outlet branch being fused.

C. Mechanical joining will be used where the butt fusion method can not be used. Mechanical joining will be accomplished by either using a HDPE flange adapter with a Ductile Iron back-up ring or HDPE Mechanical Joint adapter with a Ductile Iron back-up ring.

D. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe.

PART 3. EXECUTION

3.01 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. HDPE pipe and fittings shall be packaged and shipped by appropriate means to prevent damage to the material and to facilitate off-loading. The Owner will provide an on-site storage site. Storage site requirements (size and preferred location) shall be submitted with the bid documents.

B. Storage and handling shall be according to manufacturer's recommendations.

3.02 BASE PREPARATION

HDPE Piping for leachate and process water collection shall be installed on a layer of coarse aggregate placed by the Contractor in accordance with the plans. The grade of the coarse aggregate base shall be verified before installing the piping.

3.03 TRENCH INSTALLATION

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Excavation, Foundation, Bedding and Haunching for the underground installation of HDPE Sluice Piping shall be in accordance with Section 20-2.20 of the "Standard Specifications for Water and Sewer Main Construction in Illinois". The trench shall be backfilled with excavated material to the top of trench surface. Excavations in areas of Structural Fill shall be backfill with and compacted to the specifications of Section 02200-Earthwork for Structural Fill. All other areas shall be backfilled to 92% of the dry density, as determined by the Standard Proctor Test ASTM D698.

3.03 INSTALLATION

All pipe and fittings shall be installed according to the manufacturer's recommendations. Removal of weld beads is not required. Contractor shall place coarse aggregate along the pipe to provide lateral stability. Welds shall not be obscured until they have been approved by the Owner's Representative, the top of pipe shall not be covered until the Construction Quality Assurance (CQA) survey has been completed to verify conformance with specified tolerances.

3.04 INSPECTIONS

A The Owner's Representative shall shall visually inspect pipe materials to verify that each pipe material is properly stamped (by the manufacturer) for ASTM acceptance before installation. Defective or damaged materials shall be removed from the site.

B Each weld and connection shall be visually inspected by the Owner's Representative. Defective welds shall be repaired as directed by the Owner's Representative and according to manufacturer's recommendations. Welds and connections shall not be covered until they have been approved by the Owner's Representative.

3.05 TOLERANCES

A HDPE piping shall be located within 0.5 ft. of plan location, and elevation shall be within 0.1 ft. of plan elevation with no adverse slopes.

~~*3.06 TESTING*~~

~~*A. All Slurry Piping shall be Hydrostatic Tested in accordance with ASTM F 2164, using a Design Pressure of 270 PSIG.*~~

END OF SECTION 02936

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DIVISION 2 - SITEWORK
Section 02700–Storm Drainage
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

A. This section includes installing pipe culverts and end sections for pipe culverts.

B. Storm Drainage installation shall include incidental related work such as topsoil removal, trench excavation, backfill, compaction, tie-in of existing system, etc.,

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 02200 - Earthwork

1.03 REFERENCES

A. The following reference, or cited portions thereof, governs the work:

1 Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007. Payment provisions shall not apply.

PART 2. PRODUCTS

2.01 PIPE CULVERTS

A ***HDPE*** Pipe Culverts shall be installed in accordance with Article 542 of the Standard Specifications. All piping shall be Corrugated PE (Polyethylene) with a Smooth Interior, in accordance with AASHTO M 294, Type S.

2.02 METAL END SECTIONS

A. Metal End Sections shall be either aluminum or steel in accordance with Article 542.07(c) of the Standard Specifications.

2.03 REINFORCED CONCRETE CULVERT PIPE

A. Reinforced Concrete Culvert Pipe shall be furnished in accordance with Article 1042.06(a) of the Standard Specifications.

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2.03 PRECAST REINFORCED CONCRETE FLARED END SECTIONS

A. Precast Reinforced Concrete Flared End Sections shall be furnished in accordance with Article 1042.07(a) of the Standard Specifications.

PART 3. EXECUTION

3.01 STORM DRAINAGE PIPING INSTALLATION

A. Construct pipe culverts in accordance with the Article 542 of the Standard Specifications. Bedding and Haunching shall be IDOT CA-6 Gradation. Trench excavations are to be backfilled with on-site clayey materials instead of sand. Compact backfill to 95 percent of the maximum dry density as determined by the Standard Proctor test – ASTM D-698.

3.02 ~~METAL~~ END SECTION INSTALLATION

A. End Treatments shall be installed according to Article 542.07 of the Standard Specifications.

END OF SECTION 02700

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DIVISION 2 - SITEWORK
Section 02800 - HDPE
Geomembrane
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

A. This section includes manufacturing, furnishing, and installing High Density Polyethylene (HDPE) Geomembranes for the Gypsum Management Facility and the CCB Landfill.

B. The work includes furnishing all equipment and materials and providing all labor, supervision, administration and management necessary to perform the work as shown on the plans.

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 02373 – Geotextiles
2. 02376 – Geosynthetic Clay Liner

1.03 REFERENCES

A. The following references, or cited portions thereof, govern the work:

1. American Society for Testing and Materials (ASTM):

a. D 638, Standard Test Method for Tensile Properties of Plastics.
b. D 751, Standard Test Methods for Coated Fabrics.
c. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
d. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
e. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
f. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
g. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
h. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
i. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.

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j. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
k. D 4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
l. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
m. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
n. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.
o. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
p. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
q. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
r. D 5820, Test Method for Air Testing.
s. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
t. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes
u. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test

2. Geosynthetic Research Institute (GRI):

a. GRI GM 6, Pressurized Air Channel Test for Dual Seamed Geomembranes
b. GRI GM 9, Cold Weather Seaming of Geomembranes
c. GRI GM 10, Specification for Stress Crack Resistance of HDPE Geomembrane Sheet
d. GRI GM 13, Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
e. GRI GM 14, Test Frequencies for Destructive SeamTesting

1.04 SUBMITTALS

A. Submit the following to the Engineer or Owner, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:

1. Documentation of manufacturer's qualifications as specified in subsection 1.05A of this Section.

2. Manufacturer's Quality Control program manual or descriptive documentation.

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3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.

4. Sample of the material.

5. Documentation of Installer's qualifications, as specified below and in subsection 1.05B of this Section.
   a. Submit a list of at least ten completed facilities. For each name and type of facility; its location; the date of installation; phone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
   c. Quality Control Program.

6. Example Material Warranty and Liner Installation Warranty complying with subsections 1.07 and 1.08 of this Section.

7. Resin Supplier's name, resin production plant identification, resin brand name and number, production date of the resin, resin Manufacturer's quality control certificates, and certification that the properties of the resin meet the requirements of these specifications.

B. Shop Drawings

1. Submit copies of shop drawings for engineer's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner's Representative. Butt seams on a slope, if allowed, should be staggered.

2. Placement of geomembrane will not be allowed to proceed until Owner's Representative has received and approved the shop drawings.

C. Additional Submittals (In-Progress and at Completion)

1. Manufacturer's warranty (refer to subsection 1.08).
2. Geomembrane installation warranty (refer to subsection 1.09).
3. Daily written acceptance of subgrade surface (refer to subsection 3.01.C).
4. Low-temperature seaming procedures if applicable (refer to subsection 3.03.A)
5. Prequalification test seam samples (refer to subsection 3.05.A.6).
6. Field seam non-destructive test results (refer to subsection 3.05.B.1).
7. Field seam destructive test results (refer to subsection 3.05.C.6).
8. Daily field installation reports (refer to subsection 3.05.G).

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9. Installation record drawing, as discussed in subsection 3.05.G).

1.05 QUALITY CONTOL

A. Manufacturer's Qualifications:

The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 sq. ft. of the specified type of geomembrane or similar product during the last five years.

B. Installer's Qualifications:

1 The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner's Representative to install the geomembrane.

2 The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 5,000,000 sq. ft. of the specified type of geomembrane or similar during the last three years.

3 Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 5,000,000 sq. ft. of geomembrane of the type specified or similar product.

4 Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 3,000,000 sq. ft. of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming, patching, other welding operations, and testing is performed.

5 All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

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C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

D. Rolls shall not be stacked more than three high.

1.07 PROJECT CONDITIONS

Geomembrane shall not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.03.

1.08 MATERIAL WARRANTY

As required by specification, or as required in GRI GM 13 (attachment A)

1.09 GEOMEMBRANE INSTALLATION WARRANTY

The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.10 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A. Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative (Engineer and/or CQA Firm), and the General Contractor.

B. Topics for this meeting shall include:

1. Responsibilities of each party.
2. Lines of authority and communication. Resolution of any project document ambiguity.
3. Methods for documenting, reporting and distributing documents and reports.
4. Procedures for packaging and storing archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels and seams including details for marking on geomembrane.
7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation.
9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
10. Deployment techniques including allowable subgrade for the geomembrane.
11. Plan for controlling expansion/contraction and wrinkling of the

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geomembrane.

12. Covering of the geomembrane and cover soil placement.
13. Measurement and payment schedules.
14. Health and safety.

C. The meeting shall be documented by the Owner's Representative and minutes shall be transmitted to all parties.

PART 2. PRODUCTS

2.01 SOURCE QUALITY CONTROL

Manufacturing Quality Control

A. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM13, or modified as required for project specific conditions.

B. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.01.C of this Section, must be supplied to the Owner's Representative. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

C. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project have the same base resin and material properties.

2.02 GEOMEMBRANE

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE- Density >0.94g/cm) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. Smooth Geomembrane shall meet the property requirements shown in Table 1(a) of the GRI GM13 Specifications included at the end of this Section. Textured Geomembrane shall meet the property requirements shown in Table 2(a) of the GRI GM13 Specifications included at the end of this Section.

B. Material shall be reviewed for conformance to the project specifications by the Owner's Representative.

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PART 3. EXECUTION

3.01 SUBGRADE PREPARATION

A. Geomembrane installed over geosynthetic clay liner (GCL) (Gypsum Stack and CCB Landfill).

The area of GCL to be covered with geomembrane shall be jointly inspected by the Geosynthetics Installer's CQA Representative daily with the Owner's Representative before commencing geomembrane installation for the day, and the condition of the GCL shall be continuously observed as geomembrane installation progresses. Rocks, stones, sticks, sharp objects and debris of any kind shall be removed from the surface of the GCL. The Owner's Representative shall be notified of any discontinuities, premature hydration, or otherwise defective GCL. Geomembrane shall not be placed over suspect areas until they have been repaired to the satisfaction of the Owner's Representative. The Geosynthetics Installer's CQA Representative shall submit a certificate of acceptance to the Owner's Representative daily, stating that the GCL surface was acceptable at the time of geomembrane installation.

B. Geomembrane installed over cushion dirt.(Gypsum Stack only) ***or Earth Fill Material (Recycle Pond only)***

The area of cushion dirt to be covered with geomembrane shall be prepared in accordance with the Section 02200 – Earthwork. The surface shall be smooth and free of ruts and holes, rocks, stones, sticks, sharp objects and debris of any kind.

C. The Geomembrane installer shall provide daily, a certificate of acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.

D. All subgrade damaged by construction equipment and deemed unsuitable by the Owner's Representative for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be reviewed by the Owner's Representative and approved by the Geomembrane Installer. This damage, repair, and the responsibilities of the contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.02 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.04 of this Section are submitted to and approved by the Owner's Representative. Should geomembrane material be deployed prior to approval by the Owner's Representative it will be at the sole risk of the Geomembrane Installer and/or Contractor. If the material does not meet project specifications it shall be removed from the work area at no cost to the

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owner.

B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.

C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F). Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure All Terrain Vehicle or equivalent.

E. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably - expected wind conditions. Sand bag material shall be sufficiently close- knit to prevent soil fines from working through the bags and discharging on the geomembrane.

F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations will be defined in the preconstruction meeting.

G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.

H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. In these areas, the subgrade shall be prepared to allow the geomembrane to rest in intimate contact with the subgrade.

I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.10 B11.

J. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade.

K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to effect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 in.).

3.03 SEAMING PROCEDURES

A. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F).

B. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple.

C. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.

D. Fishmouths or excessive wrinkles at the seam overlaps, shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to

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effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The key hole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

3.04 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown in the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The pre-fabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.05.B. Alternatively, where field non destructive testing can not be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM 6365. Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.
2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.
3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.
4. Care should be taken if flammable gases are present in the area to be tested.

3.05 FIELD QUALITY CONTROL

The Owner's Representative shall be notified prior to all pre qualification and production welding and testing, or as agreed upon in the pre construction meeting.

A. Prequalification Test Seams

1. Test seams shall be prepared and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.
2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The

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test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, tests seams should be made by each technician 1 time every 4–6 hours; additional tests may be required with changes in environmental conditions.

3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen shall fail in the parent material and not in the weld, "Film Tear Bond"(F.T.B. failure). Seam separation equal to or greater than 10% of the track width shall be considered a failing test.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.05.C.4 of this Section. All four specimens shall pass for the test seam to be a passing seam.
5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.
6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner's Representative for archiving.

B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner's Representative.
2. Testing should be done as the seaming work progresses, not at the completion of all field seaming. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.
3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.
4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Owner's Representative all test methods to verify the test procedures are valid.
5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:
   a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket

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attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.

b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).

c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.

d. All areas where soap bubbles appear shall be marked, repaired and then retested.

e. At locations where seams cannot be non destructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.04.B) or equivalent should be substituted.

f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:

a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.

b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed,. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of

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the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.

c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.

d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner's Representative. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner's Representative as seaming progresses.

2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner's Representative as an archive sample; one section given to the Owner's Representative for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.

4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from his sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.02 with less than 10% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.

5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437 or GRI GM 6.

6. Reports of the results of examinations and testing shall be prepared and submitted to the Owner's Representative.

7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall

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then be taken by the Geomembrane Installer at locations indicated by the Engineer, typically 3 m (10 ft) on either side of the failed sample and laboratory seem tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 M in length (150 FT) shall be destructively tested.

D. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Owner's Representative during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

E. Evaluation of Defects: Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.05.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.
2. Defective seams, tears or holes shall be repaired by reseaming or applying a extrusion welded cap strip.
3. Reseaming may consist of either:
   a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
   b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.
4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.
5. All repairs shall be measured, located and recorded.

F. Verification of Repairs on Seams: Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

G. Daily Field Installation Reports: At the beginning of each day's work, the Installer shall provide the Engineer with daily reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;

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2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4. Results of pre-qualification test seams;
5. Results of non-destructive testing; and
6. Results of vacuum testing of repairs.

H. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.06 LINER ACCEPTANCE

A. Geomembrane liner will be accepted by the Owner's Representative when:

1. The entire installation is finished or an agreed upon subsection of the installation is finished;
2. All Installer's QC documentation is completed and submitted to the owner
3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.07 ANCHOR TRENCH

A. Construct as specified on the project drawings.

3.08 DISPOSAL OF SCRAP MATERIALS

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in a location designated by the Owner's Representative, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. Scrap sections larger than 5 feet on each edge shall be segregated from smaller scraps and retained by the Owner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4. GRI GM13 SPECIFICATIONS

Geosynthetics Research Institute (GRI) Test Method GM13 – "Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes", Revision 8, Dated July 10, 2006.

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ATTACHMENT A:

Minimum Average Weld Properties for Smooth and Textured HDPE Geomembranes (English units)								
Property	**Test Method**	**30 mil**	**40 mil**	**50 mil**	**60 mil**	**80 mil**	**100 mil**	**120 mil**
Peel strength (fusion & extrusion) lb/in.	ASTM 4437	39	52	65	78	104	130	156
Shear strength (fusion & extrusion) lb/in	ASTM 4437	60	80	100	120	160	200	239

END OF SECTION 02800

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Revision 8: July 10, 2006
Revision schedule on pg. 11

GRI Test Method GM13*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1 Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

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values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet
GM 11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device
GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

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2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities." EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

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5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength

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associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 8: There are several GRI tests currently included in this standard. Since these topics are not covered in ASTM standards, this is necessary. They are the following:

- UV Fluorescent Light Exposure
- Asperity Height Measurement

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 9: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

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6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

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ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties *(1)* (min. ave.)	D 6693 Type IV								20,000 lb
• yield strength		63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.	
• break strength		114 lb/in.	152 lb/in.	190 lb/in.	228 lb/in.	304 lb/in.	380 lb/in	456 lb/in.	
• yield elongation		12%	12%	12%	12%	12%	12%	12%	
• break elongation		700%	700%	700%	700%	700%	700%	700%	
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
— or —									
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%	per each formulation
or									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance *(7)*	GM 11								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50%	50%	50%	50%	50%	50%	50%	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

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SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	11 kN/m 20kN/m 12% 700%	15 kN/m 27 kN/m 12% 700%	18 kN/m 33 kN/m 12% 700%	22 kN/m 40 kN/m 12% 700%	29 kN/m 53 kN/m 12% 700%	37 kN/m 67 kN/m 12% 700%	44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM-10
Carbon Black Content - %	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 3895 D 5885	N. R. *(8)* 50%	N.R. *(8)* 50%	N R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in 45 lb/in 12% 100%	84 lb/in 60 lb/in 12% 100%	105 lb/in 75 lb/in 12% 100%	126 lb/in 90 lb/in 12% 100%	168 lb/in 120 lb/in 12% 100%	210 lb/in 150 lb/in 12% 100%	252 lb/in 180 lb/in 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT or (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	200,000 lb
Oven Aging at 85°C *(7) (8)* (a) Standard OIT (min. ave.) - % retained after 90 days - - or - - (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils, also see Note 6

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value

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SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM12	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	11 kN/m 8 kN/m 12% 300%	15 kN/m 10 kN/m 12% 100%	18 kN/m 13 kN/m 12% 200%	22 kN/m 16 kN/m 12% 100%	29 kN/m 21 kN/m 12% 100%	37 kN/m 26 kN/m 12% 100%	44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 2004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	per GR1 GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	90,000 kg
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings, 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm, also see Note 6

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value

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Adoption and Revision Schedule

for

HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.

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DIVISION 2 - SITE WORK
Section 02936 - Topsoil, Seeding, and Mulching

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to seeding and placing mulch or erosion control blanket over seeded areas.

1.02 RELATED SECTIONS

A Specified elsewhere:

1. 02200 - Earthwork

1.03 REFERENCES

The following reference or cited portions thereof, current at date of bidding documents unless otherwise specified, governs the work.

A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SPECIFICATIONS

A Work shall conform to the applicable requirements of Sections 250 and 251 of Standard Specifications for Road and Bridge Construction and to the requirements hereinafter specified.

B. Exceptions: All references in the IDOT specifications to methods of measurement and payment shall not apply.

1.05 WARRANTY

A. Warranty for one (1) year plus one growing season from date of substantial completion shall be provided.

PART 2. PRODUCTS

2.01 MATERIALS

A. Seed: Seed shall conform to Article 1081.04 of the IDOT Standard Specifications where IDOT seed mixtures are specified. In areas where Ameren Energy

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Generating hay seeding mix is specified, it shall be composed as follows:

Seed Type	Pounds/Acre
Vernal Alfalfa	12
Wrangler Alfalfa	8
Medium Red Clover	6
Timothy	4

B. Mulch Material and Erosion Control Blanket: Mulch material shall conform to Article 1081.06 and the excelsior blanket/knitted straw mat shall conform to Article 1081.10 of the IDOT Standard Specifications.

C. Fertilizer and agricultural ground limestone will not be permitted.

PART 3. EXECUTION

3.01 CONSTRUCTION

A. Seed bed preparation and seeding methods shall conform to Section 250 of the IDOT Specifications. Seeding of areas disturbed by construction activities after September 30, 2008 may be deferred until Spring 2009 at no additional cost to the Owner.

B. Seed shall be applied to the perimeter berm ditch, to disturbed portions of the perimeter berm, and to all disturbed earth surfaces outside of the existing perimeter berm. IDOT seeding mixture 7 shall be used on stockpiles. IDOT seeding mixture 1A shall be used on the gypsum stack perimeter earthen berm, the recycle pond dam embankment and on slopes that are 4H:1V or steeper. The Ameren hay seed mix shall be used on slopes flatter than 4H:1V.

C. Application rates for IDOT seed mixtures shall be as specified in Section 250 of the IDOT Specifications. The application rate for the Ameren Energy Resources Generating's seed mix shall be as specified in the Ameren Energy Resources Generating's hay seeding mix.

D. Seeded areas shall be mulched in accordance with Article 251.03. The Contractor may use either Method 2 or Method 3.

3.02 MAINTENANCE OF COMPLETED WORK

A. All areas seeded by the Contractor shall be maintained by the Contractor during the period between completion of such work and final completion and acceptance of the Contractor's work by the Owner. This maintenance shall be such that the completed work, at time of acceptance, complies in all respects with the requirements herein

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specified.

B. The areas seeded will be required to germinate. If the seed does not germinate, the Contractor will be required to regrade and reseed at no additional cost to the Owner.

END OF SECTION 02936

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DIVISION 3 - CONCRETE
Section 03100 - Concrete Formwork

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of the formwork for cast-in-place concrete, with shoring, bracing and anchorage, openings for other work, form accessories, form stripping.

1.02 RELATED SECTIONS

A. Section 03200 - Concrete Reinforcement.

B. Section 03300 - Cast-In-Place Concrete.

C. Section 03400 – Concrete Embedment Liner.

1.03 REFERENCES

A. ACI 347 - Recommended Practice For Concrete Formwork.

B. ACI 301 - Specifications For Structural Concrete For Buildings.

1.04 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 347 and 301.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for design, fabrication, erection and removal of formwork.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

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1.08 COORDINATION

A. Coordinate this Section with other Sections of work which require attachment of components of formwork.

B. If formwork is placed which results in insufficient concrete cover over reinforcement. request instructions from Owner's Representative before proceeding.

PART 2. PRODUCTS

2.01 WOOD FORM MATERIALS

A. Softwood Plywood: 3/4 in. PS 1-83 "B-B" (concrete form) plywood, Class I, exterior grade or better, mill-oiled and edge sealed with each piece bearing legible inspection trademark.

B. Architectural Plywood: 3/4 in. PS 1-83 "B-B" plyform. Class I, with High Density smooth overlay, 1 surface, edge sealed with each piece bearing legible inspection trademark.

2.02 MANUFACTURERS - PREFABRICATED FORMS

A. Weyerhauser Concrete Form.

B. Georgia Pacific, G-P Exterior Soft Wood Plywood Product.

C. Plywood and Door Corporation's Finn-Form.

2.03 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

2.04 FORMWORK ACCESSORIES

A. Form Ties: Snap-off type, galvanized metal, adjustable length, 1 in. back break dimension, free of defects that could leave holes larger than 1 in. in concrete surface; Dayton-Sure Grip snap-in-form ties, as manufactured by Dayton Superior

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Corp., Symons Ties as manufactured by Symons Corporation, Snap-Tys as manufactured by Richmond Corporation. Ties shall be removed after forms are removed, and holes filled with mortar that matches the adjacent surfaces.

B. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture; by Magic Kote manufactured by Symons Manufacturing Co., Form Coat manufactured by Concrete Services Co., Formcel manufactured by Lambert Corp.

C. Corners: Chamfered, wood strip type; 3/4 x 3/4 in. size on all exterior corners, 3 x 3 in. size where shown on the drawings; maximum possible lengths.

D. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

E. Concrete Embedment Liner, where required, shall be installed in accordance with Section 03400 – Concrete Embedment Liner.

PART 3. EXECUTION

3.01 EXAMINATION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

A. Earth forms are not permitted, except for footings.

3.03 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301. Metal forms shall be installed in strict accordance with manufacturer's directions and specifications.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Obtain approval before framing openings in structural members which are not indicated on drawings.

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3.04 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in or passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate work of other Sections in forming and placing openings, slots, reglets, recesses, chases, sleeves, bolts, anchors, and other inserts.

D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

A. Clean and remove foreign matter within forms as erection proceeds.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts or water to clean out forms. Use compressed air or other means to remove foreign matter.

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3.07 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 301.

3.08 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

B. Do not reuse wood formwork more than three times for concrete surfaces to be exposed to view. Do no patch formwork.

3.09 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finished concrete surfaces scheduled for exposure to view.

C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION 03100

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DIVISION 3 - CONCRETE
Section 03200 - Concrete Reinforcement

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of the reinforcing steel bars and accessories for cast-in-place concrete.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork.

B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.

B. ACI 318 - Building Code Requirements For Reinforced Concrete.

C. ACI SP-66 - American Concrete Institute - Detailing Manual.

D. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

E. CRSI - Concrete Reinforcing Steel Institute Manual of Practice.

1.04 SUBMITTALS

A. Submit under provisions of Section 01010.

B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel, and bending and cutting schedules. Contract drawings shall not be reproduced as the basis for shop drawings.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with CRSI Manual of Standard Practice.

B. Submit certified copies of mill test report of reinforcement materials analysis.

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1.06 COORDINATION

A. Coordinate with placement of formwork, formed openings and other work.

PART 2. PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars

2.02 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage, annealed steel wire, epoxy coated when used with epoxy-coated reinforcement.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions.

C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel type; size and shape as required.

2.03 FABRICATION

A. Fabricate concrete reinforcing in accordance with CRSI Manual of Standard Practice and ACI SP-66.

B. Splice reinforcement on at locations indicated on drawings. Indicate location of splices on shop drawings.

PART 3. EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Clean reinforcement of foreign particles or coatings.

B. Accommodate placement of formed openings.

C. Conform to ACI 318 code for concrete cover over reinforcement.

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3.02 FIELD QUALITY CONTROL

A. Contractor shall notify the Owner's Representative at least 24 hrs. in advance of concrete placement. Placement of reinforcing shall occur in such sequence that the Owner's Representative has sufficient time to inspect the correctness of the reinforcing within the placement area. The Owner's Representative retains the right to require necessary revisions be made before concrete is placed.

END OF SECTION 03200

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DIVISION 3 - CONCRETE
Section 03300 - Cast-In-Place Concrete

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of cast-in-place concrete structures, including joint sealants.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork: Formwork and accessories.

B Section 03200 - Concrete Reinforcement.

C. Section 03400 – Concrete Embedment Liner

1.03 REFERENCES

A. ACI 301 – Structural Concrete for Buildings.

B. ACI 302 - Guide for Concrete Floor and Slab Construction.

C. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

D. ACI 305R - Hot Weather Concreting.

E. ACI 306R - Cold Weather Concreting.

F. ACI 308 - Standard Practice for Curing Concrete.

G. ACI 318 - Building Code Requirements for Reinforced Concrete.

H. ASTM C31 - Concrete Test Specimens.

I. ASTM C33 - Concrete Aggregates.

J. ASTM C94 - Ready-Mixed Concrete.

K. ASTM C150 - Portland Cement.

L. ASTM C260 - Air Entraining Admixtures for Concrete.

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M. ASTM C494 - Chemical Admixtures for Concrete.

1.04 SUBMITTALS

A. Product Data: Provide data on joint devices, attachment accessories, admixtures.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Acquire cement and aggregate from same source for all work.

C. Conform to ACI 305R when concreting during hot weather.

D. Conform to ACI 306R when concreting during cold weather.

1.06 COORDINATION

A. Coordinate this Section with other Sections which require embedment of components in cast-in-place concrete.

1.07 PRODUCT DATA

A. Submit proposed mix design to Owner's Representative for review prior to commencement of work. Identify source and provide material certificates for cement, fine and coarse aggregates. Provide recent laboratory gradation for fine and coarse aggregates and mix design information in accordance with ACI 301.

B. Submit Construction joint plan.

PART 2. PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I - Normal Portland Type, Gray Color.

B. Fine and Coarse Aggregates: ASTM C33.

C. Water: Potable.

2.02 ADMIXTURES

A. Air Entrainment: ASTM C260.

B. Chemical: ASTM C494, Maximum 0.05% Chloride Ion Contents.

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C. The use of calcium chloride in any concrete is not permitted.

2.03 ACCESSORIES

A. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

B. Curing Compound: Dress and Seal No. 18 by L&M Construction Chemicals, MB-429 by Master Builders, or Sikagard Cure/Hard by the Sika Corporation.

C. Epoxy Grouted Adhesive Anchors: Hilti, Red Head, Simpson, or Rawl.

2.04 CONCRETE MIX

A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.

B. Select proportions for normal weight concrete in accordance with ACI 301.

C. Provide normal weight concrete of the following characteristics:

1. Compressive strength at 28 days: 4,000 psi.

2. Slump: 4 in. - A tolerance of up to 1 in. above the maximum shall be allowed for one batch in any five consecutive batches tested.

3. Water/cement ratios: 0.4 (max).

D. Use accelerating admixtures in cold weather only when approved by Owner's Representative. Use of admixtures will not relax cold weather placement requirements.

E. Use set-retarding admixtures during hot weather only when approved by Owner's Representative.

F. Water-reducing admixtures may be used in all concrete except footings and in strict compliance with the manufacturer's directions.

G. Add air-entraining agent to concrete mix for air content of 6% (± 1%).

PART 3. EXECUTION

3.01 EXAMINATION

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A. Verify requirements for concrete cover over reinforcement.

B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.02 PLACING CONCRETE

A. Place concrete in accordance with ACI 301.

B. Notify Owner's Representative minimum of 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, and embedded parts are not disturbed during concrete placement.

D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

E. Place concrete continuously between predetermined expansion, control, and construction joints.

F. When air temperature is between 80°F and 90°F, reduce the mixing and delivery time specified in ASTM C94 from 1-1/2 hours to 75 minutes. When the air temperature is above 90°F, reduce the mixing and delivery time to 60 minutes.

G. Cold weather concreting. Comply with ACI 306 except as follows:

1. In freezing weather, provide suitable means for maintaining concrete temperature at a minimum of 70°F for three days, or 50°F for five days after placing.

2. Cooling of concrete to outside temperature: Not faster than 1° per hour for first day and 2° per hour thereafter until outside temperature is reached.

3. Maximum temperature of concrete produced with heated aggregated, heated water, or both, at any time during its production or transportation: 90°F.

4. Do not mix chemicals or other foreign materials in concrete to prevent freezing or to accelerate hardening of concrete, unless approved in writing by Owner's Representative.

H. Hot weather concreting. Comply with ACI 305R.

1. ACI recommendations shall be observed when any combination of high air

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temperature, low relative humidity and wind velocity tend to impair the quality of fresh or hardened concrete.

2. Retarding and water reducing admixtures shall be approved in writing for each concrete mix design prior to placement.

3.03 CONCRETE FINISHING

A. Provide exterior concrete formed surfaces to be left exposed with smooth rubbed finish in accord with ACI 301. All other formed surfaces shall have fins, projections and offsets removed.

B. Provide Class A tolerances to exterior concrete slabs according to ACI 301.

1. Broom finish all exterior slabs. Broom out all tool marks.

C. Pitch slabs to drain.

3.04 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for a period necessary for hydration of cement and hardening of concrete in accordance with ACI 308.

C. Cure and protect finished concrete slabs in accordance with ACI 308.

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of Section 01010, paragraph 8.0.

B. Testing firm will take cylinders, perform slump and air entrainment tests in accordance with ACI 301.

C. Provide free access to Work and cooperate with appointed firm.

D. Submit proposed concrete mix design to Owner's Representative firm for review 14 days prior to commencement of Work.

E. Testing frequency shall be as specified in Section 01010, paragraph 8, except that one additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

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3.06 PATCHING

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by Owner's Representative and performed by the Contractor at no additional cost to the project.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Owner's Representative for each individual area.

END OF SECTION 03300

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DIVISION 3 - CONCRETE
Section 03400 - Concrete Embedment Liner

PART 1. GENERAL

1.01 WORK INCLUDES

A Specifications and guidelines for manufacturing and installing high-density polyethylene embedment liners.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork.

B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
2. D 1603 Test Method for Carbon Black in Olefin Plastics
3. D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
4. D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
5. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
6. D 1204 Standard Test Method for Linear Dimensional Changes of Nongrid Thermoplastic Sheeting or Film at Elevated Temperature
7. D 696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
8. D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
9. D 570 Standard Test Method for Water Absorption of Plastics
10. E 96 Standard Test Method for Water Vapor Transmission of Material

1.04 SUBMITTALS

A. All work for and in connection with the installation of the lining, field seaming and welding joints shall be completed in strict conformity with all applicable instructions and recommendations of the liner manufacturer.

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B. Included with the shipment of liner, submit certified test reports that the liner and material are manufactured in accordance with standards specified herein.

1.05 QUALIFICATIONS

A. The HDPE liner specified in this section shall be furnished by a manufacturer who is fully experienced, reputable and qualified in the manufacturing of the materials. The manufacturer must at least 10 years of manufacturing experience.

B. Locking devices must be extruded to the sheet as a one step process.

C. Liner shall be GSE StudLiner as manufactured by GSE Lining Technology, Inc.

D. Liner shall be 8 feet in width.

E. Liner shall demonstrate a minimum pull-out strength of 14,000 psf.

1.06 COORDINATION

A. Coordinate with placement of formwork, formed openings and other work.

PART 2. PRODUCTS

2.01 ROLL DIMENSIONS

A. Embedment sheets shall be produced in rolls that are 8.0 ft (2.4 m) in width and a thickness range of 80 mils (2.0 mm) to 200 mils (5.0 mm) in thickness. Roll lengths vary according to thickness.

B. Locking studs of the same material as that of the liner shall be integrally extruded with the sheet. Stud spacing shall be on approximate 1.25 in (30 mm) centers, such that there are approximately 110 studs per square foot (1200 per square meter).

2.02 MATERIAL PROPERTIES

A. The material used in the embedment liner and in all welding strips shall be made from 97-98% virgin high density polyethylene and 1.5-3% carbon black or pigmentation for the purpose of an otherwise specified color.

B. Plasticizer shall not be added to the resin formulation.

C. Embedment sheet and welding strips shall be free of holes, pinholes, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

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D The HDPE cap strips shall be made from HDPE, have good impact resistance and have an elongation sufficient to bridge up to 1/4 inch settling cracks.

E. Cap strips shall be approximately 4 inches wide or greater and shall be equivalent to that of the liner.

F. Material shall maintain a repairable state through it's lifecycle by methods approved and recommended by the manufacturer.

G. Embedment sheets shall have the following physical properties when tested in accordance with Table 1.

H. Raw resin shall have the following properties when tested in accordance with Table 2.

Table 1: Material Properties

Property	Test Method	Nominal Value				Testing Frequency
Thickness, mm (mil)	ASTM D 5199	2.00 (80)	3.00 (120)	4.00 (160)	5.00 (200)	Every 5th roll
Density, g/cm³	ASTM D 1505	0.94	0.94	0.94	0.94	1/100,000 ft²
Tensile Properties Strength@Yield,lb/in² (MPa) Elongation @ Break, %	ASTM D 6693 Type IV, Dumbell G.L.= 2.0in.	2,200 (14.5) 500	2,200 (14.5) 500	2,200 (14.5) 500	2,200 (14.5) 500	1/100,000 ft²
Stud Pull-Out Strength[1], lb/ft² (kN/m²)		>14,000 (669.89)	>14,000 (669.89)	>14,000 (669.89)	>14,000 (669.89)	1/ product
Carbon Black Content/ Pigment Content, % Black Liner Gray Liner	ASTM D 1603, mod. ASTM D 5630, mod.	2-3 1.5 – 2.5	2-3 1.5 – 2.5	2-3 1.5 – 2.5	2-3 1.5 - 2.5	1/100,000 ft²
Carbon Black Dispersion[2]	ASTM D 5596	Note 2	Note 2	Note 2	Note 2	1/100,000 ft²
Notched Constant Tensile Load, hours	ASTM D 5397	400	400	400	400	1/ formulation
Coefficient of Linear Thermal Expansion, per °C	ASTM D 696	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1/ product
Low Temperature Brittleness, °C	ASTM D 746	-77	-77	-77	-77	1/ product
Dimensional Stability, % (each direction)	ASTM D 1204	± 1.0	± 1.0	± 1.0	± 1.0	1/ product
Water Absorption, %	ASTM D 570	0.1	0.1	0.1	0.1	1/ product
Water Vapor Transmission, (g/m²/day)	ASTM E 96	<0.01	<0.01	<0.01	<0.01	1/ product

[1]Note: Concrete must have a compressive strength of at least 5,000 lb/in² (34,500 kPa)

[2]Note: Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view for category 3

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Table 2: Raw Material Properties

Property	Test Method	Value	Testing Frequency
Density, g/cm3	ASTM D 1505	0.932	1/ resin lot
Melt Flow, g/10 min	ASTM D 1238 (190/2.16)	≤ 1.0	1/ resin lot
OIT, minutes	ASTM D 3895 (1atm/200°C)	100	1/ formulation

2.03 MATERIAL SUPPLY

A. Embedment sheets shall be supplied in roll form, sheets, pre-fabricated tubes or panels.

B. Cap strips shall be supplied in 4 inch widths or greater.

PART 3. EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Clean reinforcement of foreign particles or coatings.

B. Accommodate placement of formed openings.

C. Conform to ACI 318 code for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

A. Contractor shall notify the Owner's Representative at least 24 hrs. in advance of concrete placement. Placement of the Concrete Embedment Liner shall occur in such sequence that the Owner's Representative has sufficient time to inspect the correctness of the placement within the concrete formwork area. The Owner's Representative retains the right to require necessary revisions be made before concrete is placed.

END OF SECTION 03200

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APPENDIX 2

CONSTRUCTION QUALITY ASSURANCE PLAN

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A – Table A.1 Material Testing & Frequency
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1.0 INTRODUCTION

This Plan describes the Construction Quality Assurance (CQA) program for the proposed Gypsum Management and CCB Landfill Facilites at the Ameren Duck Creek Power Plant in Fulton County, Illinois. The plan has been developed in accordance with the requirements of 35 IAC Part 811, Subpart E entitled *Construction Quality Assurance* Programs.

The Plan requires a scheduled program of CQA monitoring, inspection, sampling and testing to verify compliance with project plans and specifications. The Plan also addresses the testing requirements for test soil liners that will be constructed to verify materials and construction methods for the full-scale liners. The goal of this program is to achieve a reasonable degree of certainty that the construction of the facilites meets the specified designs.

Appendix A lists the testing methods, acceptance requirements and testing frequencies that shall guide the implementation of this plan. Also listed is the party responsible for conducting the testing for each of the constucted components of the landfill. The plan requires oversight by the CQA Officer for all testing carried out by the geosynthetic installers.

The CQA Plan also requires preparation by the CQA Officer of a final report at the end of construction that provides all inspection and testing documentation and certifies that the facilites have been constructed in accordance with the engineering design.

This Plan is intended to supplement, the project plans and specifications. Where a conflict exists, the approved CQA Plan will govern.

2.0 RESPONSIBILITY AND AUTHORITY OF PROJECT PERSONNEL

The project participants involved in the construction and quality assurance oversight of the construction are shown in Figure 2.1 *Project Organization Chart*. The Owner is the Ameren Energy Resources Generating Company (AERG or Ameren) who will retain a General Contractor to construct the facilities and a CQA Officer to provide the quality assurance oversight services. The following list the responsibilities and authority of each of the participants shown in Figure 2.1.

2.1 Owner

Ameren Energy Resources Generating Company (Ameren) is responsible for obtaining all necessary permits for construction and operation of the facilities. Ameren retains under contract all parties for the construction including the General Contractor, the Design Engineer (Hanson Professional Services Inc.), the CQA Officer, and the CQA testing and monitoring firms.

The Ameren Construction Manager will be in charge of coordinating overall construction activities and will act as Ameren's primary interface with the General Contractor. The Construction Manager coordinates all matters involving contract issues with the Ameren Project Manager including approving field changes to the project plans and specifications.

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2.2 Design Engineer

The Design Engineer (Hanson Professional Services Inc.) is responsible for development of plans and specifications that fulfill the needs of the Owner and meet the requirements of the regulatory agencies. The Design Engineer is also responsible for responding to Contractor requests for information (RFIs) during the construction process as may be required to clarify the plans and specifications or to address identified conflicts in the documents. The Design Engineer is further responsible for developing any modifications to the plans and specifications as may be required to address changed field conditions, field cost savings, design improvements or other necessary or desired modifications as approved by the Owner.

2.3 CQA Personnel

2.3.1 Key Personnel (Owner's Representative)

Ameren will retain a CQA Officer for the project who will report directly to Ameren's Construction Manager (see Figure 2.1 *Organization Chart*). The CQA Officer shall be a professional engineer registered in the State of Illinois, who is a person other than the operator or an employee of the operator, and who will supervise and be responsible for all inspection, testing, and other activities required to be implemented as part of the CQA program. The CQA Officer will also be responsible for, and will provide direct supervision to, the testing and monitoring firms shown in Figure 2.1 who will perform the monitoring, testing, sampling, and inspections required by the CQA program as described more specifically in Section 6.0. The CQA Officer will be present at the outset of major undertakings and at critical times during the construction. The time that the CQA Officer must be at the project site will be dependent upon the type of construction being conducted. The CQA Officer will exercise his/her own professional judgment to be present at the project site as required to assume full responsibility for the inspection and testing performed by those persons under his/her direct supervision. The CQA Officer shall have sufficient on-site full-time staff to adequately carry out the quality assurance activities specified herein.

If the CQA Officer is unable to be present to perform duties as outlined, then the CQA Officer will provide, in writing, reasons for his/her absence including designation of the person who will exercise professional judgment in carrying out the duties of a CQA Officer as the designated CQA Officer-in-absentia. A signed statement shall be provided and recorded that the CQA Officer assumes full responsibility for all inspections performed and reports prepared by the designated CQA Officer-in-absentia during any absence of the CQA Officer.

It is required that the CQA Officer (or his designated representative), with on-site support personnel as required, provide oversight of the monitoring, inspection, testing and/or sampling of the following construction activities for the facilities:

- Test Liner,
- Excavation, grading, and preparation of the subgrade and foundation,
- Placement of the compacted soil liner,
- Placement of geosynthetic components,

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- Installation of the leachate drainage and collection systems.
- Construction of surface water ditches, channels, berms, and drainage structures, and
- Placement of concrete structures.

The CQA Officer (or his designated representative) must certify that the sampling, inspection and test results for the major elements of the construction are in compliance with established design requirements before subsequent sequential items of the construction can be initiated. The major elements of Work requiring compliance certification include:

- Subgrade prior to placement of soil test liner (CCB landfill facility only),
- Soil test liner prior to placement of the low permeability soil liner,
- Subgrade prior to placement of the low permeability soil liner (CCB landfill facility only),
- Low permeability soil liner prior to placement of the geosynthetic clay liner (GCL),
- GLC liner prior to placement of the geomembrane,
- Geomembrane prior to placement of the geotextile cushion,
- Geotextile cushion prior to placement of the drainage layer,
- Piping installation prior to completed placement of the drainage layer,
- Drainage layer prior to placement of geotextile fabric,
- Cushion Dirt prior to placement of the geomembrane (gypsum facility only), and
- Geosynthetic installations in anchor trenches prior to backfilling.

Certification will require a through review of all inspection, sampling and testing completed for the work item to ensure that all design requirements have been met, a visual inspection of the work item, and the completion and signing of form CQAP 2.1 *CQA Certification* by the CQA Officer. The Contractor or Installer for the immediately following item of work shall not be allowed to initiate work until completion of the signed form by the CQA Officer.

The completed and signed forms CQAP-2.1 shall be filed as a project records in accordance with the provisions of Section 11.0

2.3.2 *Document Controller*

The staff of the CQA Officer shall include a Document Controller who will be responsible for: (1) control of the CQA Plan to ensure that only current documents are being employed by the CQA staff and (2) filing of all CQA records related to the monitoring, sampling, inspecting and testing specified in the CQA Plan.

Requirements for control of the CQA Plan and for filing of project records are presented in Section 11.0.

2.4 Testing and Monitoring Firms

The testing and monitoring firms, under the direction of the CQA Officer (see Figure 2.1), shall be responsible for conducting the quality assuranace sampling, inspection and testing required by Section 6.0 of the CQA Plan except that only monitoring and limited (independent) sampling and testing shall be required for the geosynthetics (i.e., geomembranes, geothensytic clay liners and

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geotextiles). The suppliers and installers shall be responsible for all the sampling and testing required by Section 6.0 for the geosynthetics (see Section 2.6).

2.4.1 Soil/Concrete Testing (Lab and Field)

One or more soil/concrete testing firms that has been qualified by the Illinois Department of Transporation (IDOT) will be retained to perform the field and laboratory sampling and testing required by the CQA Plan. Materials sampled and tested will include fine-grained soils, coarse grained soils, aggregates, rip rap and concrete.

Each firm shall be required to provide "certificates of calibration" (or other proof of calibration) to the CQA Officer for each of the measuring and/or test equipment used in the laboratory or field; except that such certificates are not required for commercial grade equipment such as rulers, tape measures or other devices that provide adequate accuracy for their intended purpose.

All field and laboratory forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise shall be modified to meet the intent of the CQA Plan.

2.4.2 Surveyor

One or more surveyors will be retained to verify attainment of specified elevations, slopes and grades within the tolerances required by the CQA Plan. The firm(s) selected shall have the capacity to complete all work by or under the supervision of an Illinois Professional Land Surveyor.

Each surveyor will be required to provide "certificates of calibration" (or other proof of calibration) to the CQA Officer for each surveying device used; except that such certificates are not required for commercial grade equipment such as rulers, tape measures or other devices that provide adequate accuracy for their intended purpose.

All field forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise unacceptable shall be modified to meet the intent of the CQA Plan.

2.4.3 Geosynthetics Monitor and Geosynthetics Testing Laboratory

A geosynthetics monitoring firm will be retained to conduct oversight of the quality assurance inspections, testing and sampling carried out in the field by the suppliers and installers for the geosynthetics (see Section 2.5) to ensure that the requirements of the CQA Plan are met including directing additional inspection, sampling and testing as may be deemed necessary by the monitoring firm. The monitoring firm will also collect its own representative samples of the geosynthetics for independent testing by a geosynthetics testing laboratory. The monitoring firm shall have previous experience in installation oversight of at least 10,000,000 sq. ft. of similar geosynthetic materials.

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The laboratory will be independent of both the manufacturer and the installer of the geosynthetics and will be required to have its own QA plan for the project work. The QA Plan shall be subject to review by Ameren prior to start of services.

All field and laboratory forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise unacceptable shall be modified to meet the intent of the CQA Plan.

2.5 Contractors, Suppliers and Installers

The contractor, subcontractors, suppliers and installers are responsible for completing their portions of the work within specified schedules and in accordance with the requirements of the plans and specifications. They additionally shall accommodate the monitoring, sampling, inspections and testing that are the responsibility of the CQA Officer under the QCA Plan.

The geosynthetic Suppliers and Installers shall provide the quality assurance inspection, sampling and testing as required by Section 6.0 of the CQA Plan. Additionally, the geosynthetic suppliers shall be required to submit "certificates of acceptance" for certain items of work that precede their construction activities. The "certificates" are more specifically discussed in Section 4.0.

3.0 PROJECT MEETINGS

Periodic meetings will be held during the life of the project to enhance coordination among the various parties involved. Meetings will include preconstruction meetings, routine progress meetings and, as needed, problem or work deficiency meetings.

3.1 Preconstruction Meetings

Preconstruction meetings shall be held at the site for the major earthwork, items and geosynthetic installations. At a minimum, the Ameren Construction Manager, the CQA Officer, representatives of the testing firms, and the earthwork contractor or geosynthetic installer should attend. In addition to the topics for discussion as listed in the project specifications, the following CQA items will be covered:

- Discuss the established protocol for inspections, tests and sampling including use of form CQAP 8.1 *Daily Inspection Report* (see Section 8.0).
- Discuss items of work requiring CQA Officer certification or Installer acceptance before subsequent work items can be initiated (see Section 4.0), and
- Discuss the established protocol for handling construction deficiencies, corrective measures, and retesting (see Section 7.0).

The meeting shall be conducted by the Ameren Construction Manager or CQA Officer and will be documented by CQA personnel with distribution to all attendees. Meeting minutes will be filed as project records in accordance with Section 11.0.

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3.2 Progress Meetings

At the discretion of the Ameren Construction Manager or the CQA Officer, brief progress meetings will be scheduled to discuss on-going and up-coming construction activities. The meeting will be attended by the Ameren Construction manager, the CQA Officer, and the appropriate site foreman (i.e. when earthwork is being performed, the earthwork foreman will be present; when geosynthetics are being installed, the installer foreman will be present, etc.). In addition to the CQA Officer topics of discussion regarding progress, the following CQA items should be reviewed:

- Discuss the established protocol for inspections, tests and sampling including use of form CQAP 8.1 *Daily Inspection Report* (see Section 8.0),
- Discuss items of work requiring CQA Officer certification or Installer acceptance before new work items can be initiated (see Section 4.0), and
- Discuss the established protocol for handling construction deficiencies, corrective measures, and retesting (see Section 7.0).

These meetings will be documented by the CQA Officer with distribution to all attendees including the Ameren Project Manager. Meeting minutes will be filed as project records in accordance with Section 11.0.

3.3 Problem or Work Deficiency Meetings

Special meetings will be approved by the CQA Officer when a problem or work deficiency is present (or is likely to occur) that is (or could be) of a serious nature. At a minimum, the meeting should be attended by theAmeren Construction Manager, earthwork or installer foremen as appropriate, and the CQA Officer. The Ameren Project Manager should attend those meetings that include discussions of severe and/or recurring problems or deficiencies. The purpose of these meetings is to define and resolve the problem or work deficiency in the following manner:

- Define the problem or deficiency and its probable causes,
- Discuss alternative actions to address the problem or deficiency ,
- Implement the selected action to resolve the problem or deficiency, and
- Verify that the implemented action has been effective.

The meeting will be documented by the CQA Officer with distribution to all attendees including the Ameren Project Manager. Meeting minutes will be filed as project records in accordance with Section 11.0.

4.0 IN-PROGRESS ACCEPTANCE OF WORK

4.1 Introduction

It is very important during placement of the geosynthetics not to entrap fugitive clay, stones, sand, etc. that could damage the geosynthetic, cause clogging of drains or filters, or hamper seaming of the geosynthetic. The geosynthetic installers shall accept responsibility for inspecting

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the substrate (on a daily basis) to ensure such entrapments are not present within the substrate area to be covered each day. When found acceptable, the installer shall complete and sign form CQAP-4.1 *Installer Certificate of Acceptance* that documents (on a daily basis) acceptance of the substrate for geosynthetic placement. The Installer shall provide the original signed document to the CQA Officer for his signature of receipt.

Completed and signed forms CQAP-4.1 shall be filed as project records in accordance with the provisions of Section 11.0.

4.2 Elements of Work Requiring Prior Acceptance

The following table cites the elements of work that shall require daily "certificates of acceptance" for the substrate including the installer responsible for providing the certification. Any other areas of geosynthetic installation not included in the table shall still be subject to the requirements of this section.

Table 4.1 Installer Certifications for Acceptance of Work

Substrate to Be Accepted by Installer	Installer
1. Surface of Low Permeability Soil Liner	Geosynthetic Clay Liner (GLC) Installer
2. Surface of Geosynthethic Clay Liner (GCL)	Geomembrane Installer
3. Surface of Geomembrane	Geotextile Cushion Installer
4. Surface of Drainage Layer	Geotextile Filter Installer
5. Surface of Cushion Dirt	Geomembrane Installer

5.0 TEST SOIL LINER

5.1 Introduction

A compacted low permeability soil test liner shall be constructed within the footprint of the proposed soil liner prior to any work being initiated on the full scale construction. The purpose of the test liner is to verify that the materials and methods of construction proposed for the full scale liner will provide the quality of construction required by the CQA Plan. Additional soil test liners shall be constructed for each time the material properties from a new borrow source are found to be significantly different or there is a significant change in the methods of construction and/or equipment.

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The test liner will be constructed on a competent foundation from the same prequalified soil material sources, to the same design specifications, and with similar equipment and procedures as are proposed by the contractor for the full scale liner. The foundation (subgrade) for the soil test liner shall be subject to the requirements of Section 6.2.1 and sampling/testing for material prequalification and placement shall be that provided in Section 6.2.2 except that:

1. The survey grid for foundation grade verification and for liner thickness verification shall be as established by the CQA Officer.

2. The frequencies for placement testing shall be as established by the CQA Officer.

3. The testing for hydraulic conductivity shall be as provided in Section 5.2.

5.2 Sampling and Testing Program

The soil test liner shall be sampled and tested under the direction of the CQA officer as described below for each of the physical properties listed.

1. At least five (5) two-stage field tests (ASTM designation D 6391-06) shall be used on the test liner to determine the hydraulic conductivity. Both the vertical hydraulic conductivity (k1) and the horizontal hydraulic conductivity (k2) shall be calculated.

2. Undisturbed samples (Shelby tubes) will be tested in the laboratory for vertical hydraulic conductivity to determine if there is a statistical correlation to the field testing results. At least two (2) samples should be tested.

3. The determination of other engineering parameters including, but not limited to, particle size analysis, liquid limits, plastic limits, water contents, and unconfined compressive strengths that are needed to evaluate the full scale liner shall be as directed by the CQA Officer.

5.3 Requirements for CQA Certification of Test Soil Liner for Landfill Construction

1. At least four of the five field hydraulic conductivity tests shall result in a measured vertical hydraulic conductivity of 5.0×10^{-7} cm/sec or less. No test shall have a hydraulic conductivity greater than 1.0×10^{-6} cm/sec.

2. The laboratory hydraulic conductivity tests shall indicate a measured vertical hydraulic conductivity of 1.0×10^{-6} or less.

5.4 Requirements for CQA Certification of Test Soil Liner for Gypsum Stack

1. At least four of the five field hydraulic conductivity tests shall result in a measured vertical hydraulic conductivity of 5.0×10^{-5} cm/sec or less. No test shall have a hydraulic conductivity greater than 1.0×10^{-4} cm/sec.

3. The laboratory hydraulic conductivity tests shall indicate a measured vertical hydraulic conductivity of 1.0×10^{-5} or less.

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5.5 Report of Results and Certification

The CQA Officer shall prepare reports describing the test programs carried out and the results obtained. The reports shall be filed as project records in accordance with Section 11.0.

The CQA Officer shall review the sampling and test results for the test soil liners and, if found in agreement with requirements, provide certification for the work using form CQAP 2.1.

6.0 SAMPLING AND TESTING REQUIREMENTS

6.1 Introduction

Prequalification and placement sampling/testing requirements for the various materials and construction activities are as summarized in Table A.1. Frequencies for material placement testing listed in Table A.1 are based on the volume of material used in construction and are to be considered minimums. The CQA Officer shall select the specific locations for testing on a random basis exercising professional judgment to ensure that testing and sampling fairly represent the construction.
The testing firms under the direction of the CQA Officer shall be responsible for the sampling and testing listed in Table A.1 for: (1) the Soils Prequalification and Placement Testing, (2) the Drainage Media Prequalification and Placement Testing, and (3) the Other Material Placement Testing. The geosynthetic installers shall be responsible for the sampling and testing listed in Table A.1 for the Geosynthetics Prequalification and Placement Testing with daily overview (and some independent laboratory testing) by the geosynthetic firms and the CQA Officer.

The results of the sampling and testing shall be documented on a daily basis by each agency or installer providing the quality assurance activities and the originals of the sampling and testing results provided to the CQA Officer. The CQA officer shall complete form CQAP 8.1 *Daily Inspection Report* (see Section 8.0) for each of the testing firms or installer proving results and attach the results to the form. The completed form CQAP 8.1 and attached results shall be incorporated into the *Daily Summary Report* (see Section 8.0).

6.2 Soils

6.2.1 Foundation (Subgrade) – Low Permeability Soil Liner

6.2.1a. Foundation Grade Verification

Following excavation for the low permeability soil liner, the CQA Officer shall direct the surveyor to verify that actual depths and grades of the foundation (subgrade) are in accordance with the plans and specifications. Elevations shall be surveyed on a 100 ft grid pattern for the bottom of the cell. The points surveyed for side slopes will be at the top, midpoint, and toe. In addition, all breaks in grade will be surveyed. Foundation excavation grading shall meet a control tolerance requirement of 0 ft to -0.4 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

The CQA Officer shall review the survey data for conformance to requirements and, if found in agreement with requirements, provide certification for the work using form CQAP 2.1.

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6.2.1b. Foundation Fill

Foundation (subgrade) materials not meeting the requirements of the plans and specifications are required to be excavated and replaced with suitable foundation fill to develop a stable foundation for the landfill. The CQA Officer shall make a foundation inspection with the soil testing firm and direct any sampling and testing necessary to identify areas requiring removal and replacement. The CQA Officer shall inform the earthwork contractor of unsuitable areas requiring removal and replacement.

Foundation fill used by the contractor for replacement shall be sampled and tested by the soil testing firm to check compliance with the prequalification and placement requirements listed in Table A-1. The CQA Officer shall direct the surveying firm to determine the locations and extent of all removal and replacement activity and to document all such information on "as built" drawings to be furnished to the CQA Officer.

The CQA Officer shall review the sampling and test results for the foundation fill and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1. The certification for foundation fill may be provided on the same form providing the certification for foundation grade.

6.2.2 Low Permeability Soil Liner

6.2.2a. Prequalification Testing

Table 1.1 requires that prequalification testing for each soil type being used for liner construction at the landfill include the development of an "acceptable zone" of moisture-density for the compacted soil that will result in a liner with a minimum hydraulic conductivity of 1.0×10^{-6} cm/sec. The resulting "acceptable zone" then serves as the major control for material placement during construction.

The CQA officer shall direct the soil testing agency to determine the "acceptable zone" for each soil type to be used for landfill liner construction and provide the results in a written report to be available for comparisons with the material placement testing results. The determination of the "acceptable zone" shall be in accordance with Appendix B or other published methodology used in the profession. The report will be filed as a project record in accordance with Section 11.0.

There is no prequalification testing required for the soil materials to be used for the gypsum stack liner construction except that the materials selected shall have sufficient fines to achieve the in-place hydraulic conductivity specified in Section 5.4.

6.2.2b. Material Thickness Testing

The CQA Officer shall direct the survey agency to determine elevations at the foundation of the soil liner and at the final constructed surface using a 100 ft grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify liner thickness, all horizontal survey coordinates shall be the same for the foundation and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points.

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The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor agency.

6.2.2c. Moisture/Density Testing

Moisture/density testing of the compacted soil liner shall be conducted by the soil testing agency under the requirements and at the frequencies specified in TableA.1. During construction of the soil liner the CQA Officer shall confirm the following:

- Use of the same construction equipment as used in the test soil liner.
- Use of same procedures, such as number of passes and speed,
- Uniformity of coverage by compaction equipment,
- Consistent achievement of density, water content and permeability of each successive lift,
- Use of methods to bond successive lifts together,
- Achievement of liner strengths on sidewalls,
- Contemporaneous placement of protective covering to prevent drying and desiccation, where necessary,
- Prevention of placement of frozen material or the placement of material on frozen ground,
- Prevention of damage to completed liner sections, and
- That construction proceeds only during favorable climatic conditions.

6.2.2d. Hydraulic Conductivity Testing

Samples of the in-place liner shall be obtained and tested for hydraulic conductivity under the requirements and at the minimum frequency as specified in Table A.1. Multiple samples may be collected at a given test location for the purpose of retesting in the event of unacceptable hydraulic conductivity results from the initial sample.

Boreholes, excavations or other disturbances to the soil liner resulting from the obtainment of samples shall be backfilled as directed by the CQA Officer.

6.2.2e. Certification of Work

The CQA Officer shall review the sampling and test results for the low permeability soil liner and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.2.3 Berms

6.2.3a. Landfill Containment Berms

The CQA Officer shall direct verification of excavated foundation (subgrade) depths and grades as specified in Section 6.2.1a except that the foundation grid shall be as directed by the CQA Officer. Foundation fills shall be as specified in Section 6.2.1b.

Prequalification testing for material sources shall meet the requirements in Table A.1.

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The CQA Officer shall direct the soil agency to conduct the following inspection activities during berm construction:

- Observation of fill material characteristics.
- Observation of loose lift thickness.
- Observation of clod size reduction and material homogenization, and
- Placement testing as specified in Table A.1.

Documentation of construction on "as-built" plans shall be as specified in Section 6.5.2.

The CQA Officer shall review the sampling and test results for the landfill containment berms and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.2.3b Temporary Cell Separation Berms

The CQA Officer shall direct verification of excavated foundation (subgrade) depths and grades as specified in Section 6.2.1a except that the foundation grid shall be as directed by the CQA Officer. Foundation fills shall be as specified in Section 6.2.1b.

Prequalification testing for material sources shall meet the requirements in Table A.1.

The CQA Officer shall direct the soil agency to conduct the following inspection activities during berm construction:

- Observation of fill material characteristics,
- Observation of loose lift thickness.
- Observation of clod size reduction and material homogenization,
- Placement testing as specified in Table A.1, and
- Measurements of berm slopes.

6.3 Geosynthetics

6.3.1 Geosynthetic Clay Liner (GCL)

6.3.1a. Prequalification Testing

The geosynthetic clay liner (GCL) installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the GCL for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

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The results of laboratory testing shall meet the GCL manufacturer's specifications as shown in the following table.

GCL Laboratory Testing Methods/Minimum Values Required	
Test Method	Minimum Value
Bentonite Mass/Area (ASTM D5993)	0.75 lb./ft^2
GCL Grab Tensile Strength (ASTM D4632)	90 lb.
GCL Peel Strength (ASTM D4632)	15 lb.

The installer shall direct the test laboratory to submit the results of all laboratory test results and certification to the Document Controller for filing as project records in accordance with Section 11.0.

6.3.1b. Installer Certification of Placement Surface

Prior to daily clay liner placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the GCL installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.1c Deployment

The CQA Officer shall direct the geosynthetic QA monitor firm to oversee activities of the installer during placement and field testing of the GCL.

Incoming rolls of GCL shall be inventoried and inspected by the installer. Manufacturer's certifications will be inspected for conformance with the requirements of this plan. Holes or other visible defects shall be recorded in the CQA Officer's daily report and clearly marked on the GCL roll for identification of necessary repairs or rejection of the roll.

GCL shall be placed such that all seams run parallel to the slope. GCL should be dry when installed. Wet or hydrated GCL shall not be used. GCL panels shall be laid with a minimum 6 in. overlap on longitudinal seams and a minimum 12 in. overlap on panel end seams. Seam overlaps shall be placed such that the direction of flow is from the top panel to the underlying panel to form a shingle effect. Direct contact with GCL shall be minimized.

6.3.1d. Seaming

The GCL shall be sealed in accordance with the recommendations of the GCL manufacturer. Dry bentonite having the same chemical and material properties as the GCL shall be evenly dispersed from the panel edge to the lap line continuously along the seam or overlap areas. All dirt, gravel, or other debris shall be removed from the seam or overlap areas.

Prior to covering the GCL, the installer shall verify all exposed seams or overlaps and examine the GCL for any defects. At the judgment of the installer, a panel or section that becomes seriously damaged or hydrated shall be replaced. All repairs shall be made by placement of a

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patch of the same material over the damaged area at least 1 ft beyond the repair area. The GCL will be immediately covered and protected from precipitation by the overlaying geomembrane.

6.3.1e. Shear Strength Conformance Testing

Shear strength conformance tests shall be performed on the GCL to verify the interface shear strengths of the GCL with the appropriate material (HDPE geomembrane or compacted clay). The results of the shear strength conformance tests will be used to confirm that the actual interface shear strengths are equal to or greater than the interface shear strengths used in the stability analyses. Shear strength conformance tests on subsequent phases and/or cell development need not be performed if the same manufacturer and materials are used in the construction of the subsequent phase and/or cell. Conformance testing shall be in accordance with ASTM D 5321 or other suitable method.

6.3.2 Geomembrane

6.3.2a. Prequalification Testing

The geomembrane installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the geomembrane for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

The installer shall direct the test laboratory to submit the results of all laboratory results and certification to the Document Controller for filing as project records in accordance with Section 11.0.

6.3.2b. Installer Certification of Placement Surface

Prior to daily geomembrane placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the geomembrane installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.2c. Placement Testing for Seam Overlap

The contractor and installer shall arrange geomembrane sections such that the use of field seams is minimized and that horizontal seams are not used on side slopes. Seam overlaps shall be field measured by the installer to verify the requirement in Table A.1 is met for all seams within the geomembrane footprint. The CQA Officer shall direct the geosynthetics QA monitor firm to

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make independent measurements of a representative number of seam overlaps for additional verification of the requirement in Table A.1.

At completion of geomembrane placement, the installer shall provide the CQA Officer with "as-built" drawings of the geomembrane installation showing all seam locations and seam measurement locations.

6.3.2d. Placement Non-Destructive Testing

The installer shall conduct non-destructive testing of seams at the frequency specified in Table A.1. All seams shall be nondestructively tested over their full-length using a vacuum test unit, air pressure test or other method approved by the CQA Officer. Continuity testing will be completed as the seaming progresses.

The CQA Officer shall direct the geosynthetics QA monitor firm to monitor all non-destructive testing carried out by the installer.

The installer shall submit all non-destructive field testing results to the CQA Officer for filing as project records in accordance with Section 11.0.

Vacuum testing and air pressure testing procedures shall be as given in the following sections.

Vacuum Testing (Extruded Welds)

The following procedures are applicable to those processes which produce an extruded weld.

Equipment

The following equipment shall be used when conducting vacuum tests:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a port hole or valve assembly, and a vacuum gauge,
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections,
- A rubber pressure/vacuum hose with fittings and connections,
- A bucket, and
- A soapy solution.

Procedures

The following procedures will be followed:

1. Energize the vacuum pump and reduce the tank pressure to approximately minus 5 psi (10 in. of Hg) gauge.
2. Wet a strip of geomembrane approximately 12 in. wide by 48 in. long (an area larger than the coverage size of the vacuum box) with the soapy solution.
3. Place the box over the wetted area.
4. Close the bleed valve and open the vacuum valve.
5. Verify that a leak tight seal is created.

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6. For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
7. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area, repeat the process.
8. All areas where soap bubbles appear will be marked and repaired and then retested until passing test results are obtained.

Air Pressure Testing (For Double Fusion Seam Only)

The following procedures are applicable to those processes which produce a double seam with an enclosed space.

Equipment

The equipment will be comprised of the following:

- An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 psi to 30 psi and mounted on a cushion to protect the geomembrane,
- A rubber hose with fittings and connections, and
- A sharp hollow needle, or other approved pressure feed device.

Procedures

The following procedures will be observed:

1. Both ends of the seam to be tested will be sealed.
2. A needle or other approved pressure feed device will be inserted into the tunnel created by the fusion weld.
3. A protective cushion will be inserted between the air pump and the geomembrane.
4. The air pump will be energized to a pressure between 25 psi and 30 psi. The valve will be closed, and the pressure will be sustained for approximately 5 minutes.
5. If loss of pressure exceeds 3 psi or does not stabilize, the faulty area will be located, then repaired and retested until passing test results are obtained.
6. At the conclusion of a passing air pressure test, the opposite end of the seam will be slit and subsequent drop in pressure will be monitored. This will ensure that the entire seam was completely tested.
7. Remove needle or other approved pressure feed device and seal.

6.3.2e. Placement Destructive Testing

General

Destructive seam tests shall be performed at randomly selected geomembrane locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

The CQA Officer shall direct the geosynthetics QA monitor firm to monitor all destructive testing carried out by the installer.

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The installer shall submit the results of all destructive testing to the CQA Officer for filing as project records in accordance with Section 11.0.

Location and Frequency

The installer shall select locations where seam samples will be cut out for testing. Those locations shall be established as follows:

1. Selection will be at a minimum frequency of one test location per 500 ft of seam length. This minimum frequency is to be determined as an average taken throughout the entire area of placement.

2. Test locations will be determined during seaming at the installer's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The CQA Officer shall direct the geosynthetics QA monitor firm to select and cut out a representative number of additional samples for independent laboratory testing.

Sampling Procedure

Samples will be cut as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The installer shall:

- Assign a number to each sample, and mark it accordingly,
- Record sample location on layout ("as-built") drawing, and
- Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired. The continuity of the new seams in the repaired area shall be vacuum tested.

Field Testing

The installer shall test in the field, by tensiometer, two 1 in. wide sample strips from the samples identified for destructive testing; one for peel and one for shear. This testing shall include the independent samples obtained by the geosynthetics QA monitor firm. Field testing will prequalify samples for laboratory testing. The requirements and frequency for field testing shall be as provided in the table at the end of this section.

The installer shall conduct all field tests and mark all samples and portions with their number. The installer shall also log the date, time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

Geosynthetic Quality Assurance Laboratory Testing

Prequalifying field tests shall identify samples for laboratory testing. The installer's quality assurance laboratory shall be as selected by the installer with concurrence of the CQA Officer.

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Testing shall include shear strength and peel adhesion. At least five specimens shall be tested by the installer's laboratory for each method. Specimens shall be selected alternately by test from the samples (i.e., peel, shear). All laboratory testing shall be accordance with ASTM D 4437.

The CQA Officer shall direct the geosynthetic QA monitor firm to have additional samples tested for peel and strength by the monitor's independent geosynthetics laboratory as deemed necessary.

Procedures for Destructive Test Failure

The following procedures will apply whenever a sample fails a destructive test, whether the test was conducted in the laboratory or by field tensiometer. The installer has two options:

1. The installer may reconstruct the seam between any two passed test locations.

2. The installer may trace the welding path to an intermediate location at least 10 ft from the point of the failed test in each direction, and take a small sample for an additional field test at each location. If these additional samples pass the tests, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

All acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 ft of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing.

The installer will document all actions taken in conjunction with destructive test failures.

Geomembrane Destructive Seam Tests and Frequency

Property	Test Method	60-mil HDPE	40-mil HDPE	40-mil LLDPE	Frequency
Seam Shear Strength	ASTM D 4437	120 ppi	80 ppi	44 ppi	See Note 1
Seam Peel Strength (hot wedge fusion)	ASTM D 4437	78 ppi	52 ppi	40 ppi	See Note 1
Seam Peel Strength (fillet extrusion)	ASTM D 4437	72 ppi	45 ppi	40 ppi	See Note 1

Notes:
1. Destructive testing of seams shall occur at a minimum frequency of once per 500 ft of seam length.
2. Values apply for both smooth and textured geomembranes.

6.3.3 Geotextile

6.3.3a. Prequalification Testing

The geotextile installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal

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shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the geomembrane for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

The installer shall submit the results of all laboratory results and certification to the CQA Officer for filing as project records in accordance with Section 11.0.

6.3.3b. Installer Certification of Placement Surface

Prior to daily geotextile placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the geotextile installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.3c. Deployment

Incoming rolls of geotextile shall be inventoried and inspected by the installer. Manufacturer's certifications will be inspected for conformance with the requirements of this plan. Holes, tears, or other visible defects will be recorded in the CQA Officer's daily report and clearly marked on the synthetic for identification of necessary repairs.

The installer shall check that the geosynthetic installation conforms to the construction requirements and manufacturer's recommendations. The CQA Officer shall direct the geosynthetics QA monitor firm to oversee the inspections by the installer.

On slopes steeper than 10H:1V, all geotextiles shall be continuously sewn. Geotextiles shall be overlapped a minimum of 3 in. prior to seaming. This requirement does not apply to the leachate system filter fabric. All sewing shall be done using thread with physical, chemical, and ultraviolet high resistance properties equal to or exceeding those of the geotextile. The CQA Officer shall direct the geosynthetics QA monitor firm to make independent measurements of a representative number of seam overlaps for additional verification of the requirement in Table A.1.

The 10-oz. cushion geotextile (immediately above the geomembrane liner and beneath the drainage layer) shall be placed with vertical seams running up the slopes and into the anchor trench. Horizontal seams (perpendicular to the slope) shall be allowed on side slopes for the 4-oz. filter geotextile overlaying the drainage layer to facilitate staged construction of the drainage layer going up the slope. All overlaps shall be "shingled" so that water or other material can not run down the slope between the geotextile seams.

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6.4 Drainage Media

6.4.1 Granular Drainage Layer

6.4.1a. Prequalification Testing

Each source of material for the drainage layer shall be tested for hydraulic conductivity and grain size analyses in accordance with Table A.1 to determine suitability of the source.

6.4.1b. Material Thickness Testing During Placement

The CQA Officer shall direct the survey firm to determine elevations at the top of the geotextile cushion and at the final constructed surface of the granular drainage layer using a 100 ft grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify liner thickness, all horizontal survey coordinates shall be the same for the top of the cushion and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points.

The CQA officer may approve the use of thickness plates as an alternative method to surveying.

In no instance shall the field determined thickness be less than 1.0 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

6.4.1c. Gradation and Hydraulic Conductivity Testing During Placement

The CQA officer shall direct the soil test firm to take an initial sample of the granular drainage layer within the first 100 cu. yds. of material placement and test for hydraulic conductivity and grain size to confirm suitability of the source. Continuing sampling and testing shall be completed at the frequencies specified in Table A.1.

Compaction of the drainage layer shall not be allowed during placement to avoid breakdown of materials

Gradation tests may be considered passing provided the hydraulic conductivity requirements are met and the specified percentage of fines is not exceeded.

6.4.d. Certification of Work

The CQA Officer shall review the sampling and test results for the granular drainage layer and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.4.2 Coarse Aggregate

6.4.2a. Prequalification Testing

Each source of material for the coarse aggregate shall be tested for hydraulic conductivity and grain size analyses in accordance with Table A.1 to determine suitability of the source.

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6.4.2b. Material Placement

The CQA Officer shall direct that inspection of piping as provided in Section 6.5.1 be completed prior to placement of coarse aggregate around the piping. Compaction of the coarse aggregate shall not be allowed during placement to avoid breakdown of materials.

The CQA officer shall direct the soil test firm to take an initial sample of the coarse aggregate within the first 100 cu. yds. of material placement and test for hydraulic conductivity and grain size to confirm suitability of the source. Continuing sampling and testing shall be completed at the frequencies specified in Table A.1.

Gradation tests may be considered passing provided the hydraulic conductivity requirements are met and the specified percentage of fines is not exceeded.

6.4.2c. Certification of Work

The CQA Officer shall review the sampling and test results for the coarse aggregate and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.5 Other Material Placement Testing

6.5.1 Placement testing of Leachate Piping System

The CQA Officer shall direct the surveyor to check the invert elevations and plan coordinates for the constructed piping system at the locations and frequencies specified in Table A.1.

The CQA Officer or other CQA staff shall inspect pile size, materials and connections including all components of the leachate collection and management systems to verify compliance with plan and specification requirements.

The measured grades and coordinates shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

The CQA Officer shall review the survey results for the leachate piping system and management systems and, if found in agreement with the placement requirements, provide certification for the work using form CQAP 2.1.

6.5.2 Placement Testing of Surface Water Management System

The CQA Officer shall direct the survey agency to determine the elevations and grades of the constructed berms and channels in accordance with the requirements and frequency specified in Table A.1.

The measured elevations and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

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6.5.3 Placement Testing of Concrete

The CQA Officer shall direct the soil test firm to carry out placement testing for concrete in accordance with the requirements and frequency specified in Table A.1.

The contractor shall submit proposed concrete mix designs to the CQA Officer for review prior to ordering of concrete.

The CQA Officer shall review the concrete testing results and, if found in agreement with the placement requirements, provide certification for the work using form CQAP 2.1.

7.0 CORRECTIVE MEASURES

The CQA Officer shall reject and require replacement of all materials for which sampling, testing or inspection results show that prequalification requirements are not met. The CQA Officer shall also reject workmanship (and require corrective rework) for which sampling, testing or inspection results show that material placement requirements are not met. The lateral and/or vertical extent of corrective measures for rework shall be based on the frequency of testing and judgment of the CQA Officer.

The CQA Officer may neglect the occasional occurrence of failed moisture/density tests or laboratory hydraulic conductivity tests carried out for the low permeability soil liner provided the failed tests can be shown to be outliers and are not concentrated in one area or lift. The CQA officer shall provide written justification in the Daily Summary Report for assignment of failed tests as outliers.

8.0 DOCUMENTATION OF SAMPLING AND TESTING

8.1 Daily Summary Reports

A daily summary report shall be prepared by the CQA Officer, or under the direct supervision of the CQA Officer, during each day of activity. Form CQAP 8.1 *Daily Summary Report* shall serve as the base document to which the daily inspection reports (see Section 8.2) are to be attached.

Each report shall be signed and dated by the CQA Officer and CQA Officer-in-absentia. The original report (and attachments) shall be submitted to the Document Controller and filed as a project record in accordance with Section 11.0.

8.2 Daily Inspection Reports

A daily inspection report shall be prepared by the CQA Officer, or under the direct supervision of the CQA Officer. for each day that materials, or placement of materials, are being inspected, sampled or tested. Form CQAP 8.2 *Daily Inspection Report* shall serve as the base document to which the test data, photographic records, test results, etc. are to be attached.

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Each report shall be signed and dated by the CQA Officer or CQA Officer-in-absentia. The original report (and attachments) shall be submitted to the CQA Officer who shall incorporate the report into the daily summary report.

8.3 Photographs

Photographs may be incorporated into the daily inspection report or daily summary report to provide a visual record of work progress, inspection/testing activity, construction work, or other items considered important to the report. The photographs, at a minimum, shall be furnished with the following information:

- The location, date and time of the photograph,
- A description of the item photographed including direction of view (N,S,E or W),
- Personnel, testing agencies, installers or contractors present, and
- Name of photographer.

9.0 FINAL CERTIFICATION REPORT

Upon completion of the construction contract (but before the landfill or gypsum stack is placed into service), the CQA Officer shall submit an acceptance report to the Illinois Environmental Protection Agency. The acceptance report shall contain the following:

- A certification by the CQA officer that the construction has been prepared and constructed in accordance with the engineering design.
- As-built drawings as specified herein, and
- All daily summary reports.

10.0 CONSTRUCTION MANAGEMENT ACTIVITIES

10.1 Requests for Information (RFIs)

The general contractor or installer may, after exercising due diligence to locate required information, request from the CQA Officer clarification or interpretation of the contract documents. The general contractor or installer shall make specific reference to the contract drawing(s) or specification(s) in question and include estimates of any cost or schedule impacts that could possibly be associated with the requested clarification or interpretation.

The general contractor or installer shall initiate the RFI in a timely manner using form CQAP-10.1 *Request for Information*. The CQA Officer shall, with reasonable promptness, respond to the RFI on the same form CQAP-10.1 and return a copy of the completed form to the party making the request as final disposition of the matter.

Additional copies of the completed form shall be distributed as directed by the CQA Officer. All RFI's shall be filed as project records in accordance with Section 11.0.

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10.2 Review of Contractor Submittals

The Contractor shall submit shop drawings, product data and samples to the CQA Officer in accordance with the requirements of the project specifications and with such promptness as to cause no delay of the work. The Contractor shall not authorize purchase, fabrication, erection, processing or shipping of any items associated with the submittal until review of the shop drawings, product data or samples has been completed by the CQA Officer and no resubmittals are required by the CQA Officer.

All submittals from subcontractors shall be reviewed first by the Contractor to satisfy the contractor's responsibilities for lengths, dimensions, quantities, means and methods, and other such items.

The CQA Officer and/or Design Engineer shall review the submittals for conformance with design concepts and conformance with the information shown in the contract documents. Upon completion of review, the CQA Officer shall return the submittal to the Contractor with one of the following notations for each item in the submittal:

- No exceptions taken.
- Furnish as corrected,
- Revise and resubmit,
- Submit specified item, or
- Rejected.

The Contractor shall resubmit corrected shop drawings, product data or samples for those items noted as requiring revision or submission or noted as rejected.

The CQA Officer shall maintain copies of all submittals and a log documenting submittal descriptions, dates of receipt, dates of return, review personnel, and actions taken on the submittals. Copies of submittals and the log shall be filed as project records in accordance with Section 11.0.

10.3 Field Change Order Process

The Contractor shall be responsible for preparing requests for field change order (FCO) in accordance with AREG procedures and submitting the FCO requests on the appropriate AREG FCO form to the CQA Officer.

The CQA Officer shall be responsible for reviewing the FCO with the Design Engineer, determining agreement or non-agreement with the requested change, and submitting the documented decision to the Contractor on the appropriate AREG CFO form with copies to the Ameren Project Manager. Agreement to the FCO shall require signature approval of the Ameren Project Manager.

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The CQA Officer shall maintain an on-going log of authorized FCOs and running balance of project costs. Copies of the FCOs and log of authorized FCOs shall be retained as project records in accordance with Section 11.0.

11.0 DOCUMENT CONTROL AND PROJECT RECORDS

11.1 CQA Plan

The CQA officer shall control the preparation, issue and revisions of the CQA Plan so that correct documents are being employed by the project participants. The CQA Plan, including all changes thereto, shall be reviewed for adequacy and approved for release by the CQA Officer and Ameren Project Manager.

The Document Controller shall issue controlled copies of the CQA Plan and maintain all records associated with its preparation, issue and revisions.

11.2 Project Records

The maintenance of project records during construction of the landfill shall be the responsibility of the Document Controller and shall be protected against damage, deterioration, and loss. Records shall be maintained in a manner as to be readily identifiable and retrievable.

Control of CQA documents and samples during the construction process shall be as shown in Figure 11.1. All original CQA documents from both the field and laboratories shall be ultimately furnished to the Document Controller for filing and maintenance. Samples may be discarded after testing and documentation of results is complete.

Project records shall be made available to the Ameren Project Manager as requested during construction and, when requested, shall be turned over to AERG at completion of the construction contract.

Records shall include, but not be limited to, the following:

- CQA Plan (all revision levels),
- CQA Plan documentation (reviews, issuance and revisions),
- Meeting minutes,
- Daily inspection reports (form CQAP 8.1),
- Daily summary reports (form CQAP 8.2),
- Certificates of acceptance by geosynthetic installers,
- CQA certifications (form CQAP 2.1),
- Certificates of calibration for inspection, measuring and test equipment,
- Report for test soil liner,
- Report for compacted soil liner "acceptable zone",
- "As-built" drawings,
- Laboratory test results for soils, drainage media, and concrete,
- Laboratory test results for geosynthetics,
- Laboratory certifications of manufacturer's guaranteed properties for geosynthetics,
- Contractor Requests for Field Change Order (AERG FCO form),

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- Log of Authorized Field Change Orders,
- Shop drawing submittals,
- Log of shop drawing submittals,
- Requests for information from contractor/installers,
- Responses to requests for information, and
- Final certification report.

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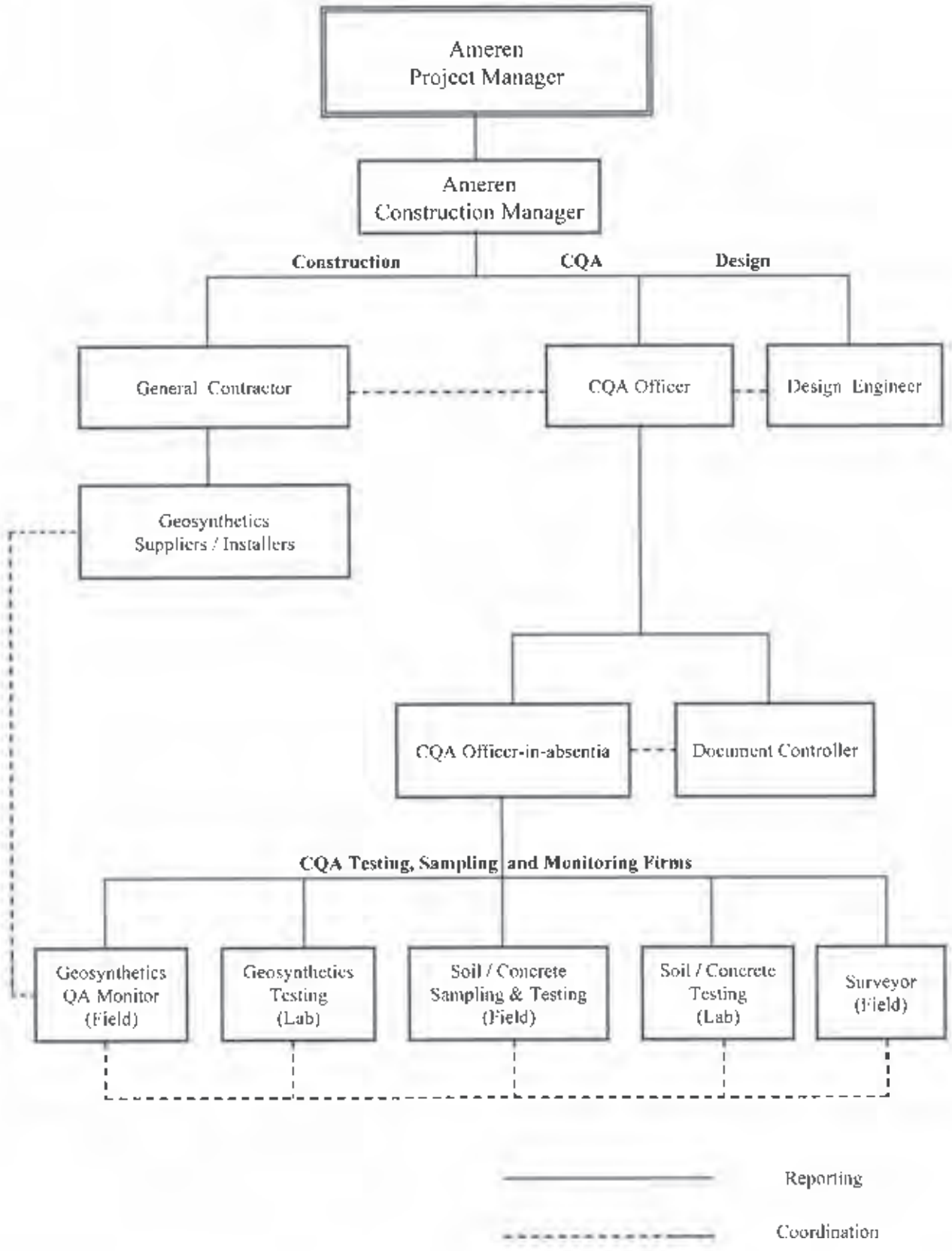

Figure 2.1 Project Organization Chart

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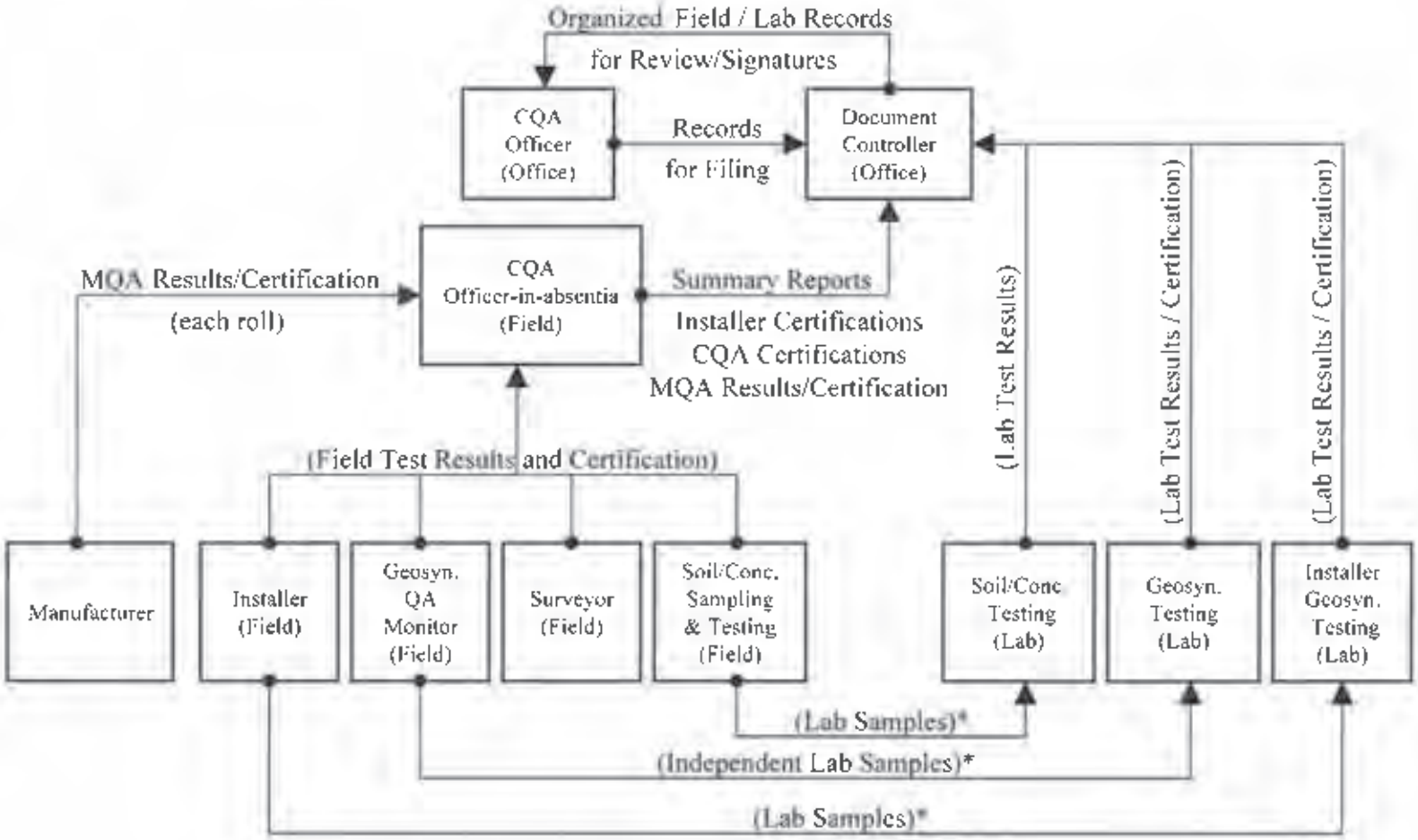

Figure 11.1 Control of CQA Documents and Samples

* Transmittal letters shall direct the original lab test results/certifications to be sent to Document Controller with copies to submitting installer or testing/monitoring agency.

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Appendix A

Material Testing and Frequency

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
SOILS - PREQUALIFICATION TESTING			
FOUNDATION FILL & BERMS			
Standard Proctor Curve - ASTM D698		Per soil type (See Note 2)	CQA Officer
Atterberg Limits - ASTM D4318	PI > 5, LL > 20%	Per soil type	
Grain Size Analysis - ASTM D422	200 Sieve > 50%	Per soil type	
Hydraulic Conductivity - ASTM D5084	See Note 1	Per soil type	
		Per soil type	
SOIL LINER			
Standard Proctor Curve - ASTM D698	"Acceptable Zone" see Appendix B	Per soil type	CQA Officer
Atterberg Limits - ASTM D4318	USCS Classification	Per soil type	
Grain Size Analysis - ASTM D422	USCS Classification	Per soil type	
Hydraulic Conductivity - ASTM D5084	1.0×10^{-7} cm/sec	Per soil type	
Develop "Acceptable Zone"	"Acceptable Zone" see Appendix B	Per soil type	
PROTECTIVE FINAL SOIL COVER			Not Applicable to this Contract
Standard Proctor Curve - ASTM D698*	"Acceptable Zone" see Appendix B	Per soil type*	
Atterberg Limits - ASTM D4318*	USCS Classification	Per soil type*	
Grain Size Analysis - ASTM D422*	USCS Classification	Per soil type*	
Hydraulic Conductivity - ASTM D5084	See Note 1	Per soil type*	
Develop "Acceptable Zone"*	"Acceptable Zone" see Appendix B	Per soil type*	
Suitable for Vegetation	Visual Acceptance	Per soil type	

* On the first two feet of the protective layer only. (The third foot is topsoil.)

Note 1: There is no specific requirement for hydraulic conductivity for the foundation, berms and final cover soils as they are not part of the liner system. However, insitu materials on the site generally exhibit hydraulic conductivities in the range of 1×10^{-4} cm/sec to 1×10^{-5} cm/sec. The construction contractor will attempt to utilize the most impermeable materials available (as identified visually) when constructing foundation fill and berms. For purposes of a complete construction record, hydraulic conductivity of placed foundation fill and side berms will be field tested at a rate of 1 test per each 10,000 cubic yards of material placed, although no specific threshold values are required.

Note 2: "Soil Type" refers to differences in soil color and/or textural consistency that would be indicative of differences in soil characteristics.

Note for Geosynthetics: See Section 6.0 of the CQA Plan for additional GCL and geomembrane testing requirements.

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
SOILS - MATERIAL PLACEMENT TESTING			
FOUNDATION			CQA Officer
Survey	0 to -0.5 feet Design Grade	100-foot grid	
FOUNDATION FILL & BERMS			CQA Officer
Density/Moisture - ASTM D2922 & D3017	90% Standard Proctor Density and -1% to Optimum Moisture Content	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Strength	0.5 tsf (hand-held penetrometer)	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Hydraulic Conductivity - ASTM D5084	See Note 1	1 per 10,000 cubic yards	
Sieve and Hydrometer Analysis of Soils - ASTM D422	200 Sieve > 50%	Per Soil Type	
Liquid Limit, Plastic Limit and Plasticity Index (Atterberg Limits) - ASTM D4318	PI > 5, LL > 20	Per Soil Type	
SOIL LINER			CQA Officer
Thickness	5 feet minimum thickness (base), 1 foot minimum thickness (cover), and maintain design grade	100-foot grid	
Density/Moisture - ASTM D2922 & D3017	95% Standard Proctor Density and Optimum to +3% Moisture Content in accordance with "Acceptable Zone" (see Note 3)	1 per acre per lift or 1 per 1,000 cubic yards	
Strength	0.5 tsf (hand-held penetrometer)	1 per acre per lift or 1 per 1,000 cubic yards	
Hydraulic Conductivity - ASTM D5084	See Note 4	1 per 10,000 cubic yards	
PROTECTIVE FINAL SOIL COVER			Not Applicable to this Contract
Thickness	3 feet minimum total thickness including 1 foot of topsoil - maintain design grade	100-foot grid	
Density/Moisture* - ASTM D2922 & D3017	90% Standard Proctor Density and -3% to Optimum Moisture Content	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Strength*	0.5 tsf (hand-held penetrometer)	1 per 10,000 cubic yards (minimum 1 per compacted lift)	

* On the first two feet of the protective layer only. (The third foot is topsoil.)

Note 1 There is no specific requirement for hydraulic conductivity for the foundation, berms and final cover soils as they are not part of the liner system. However, insitu materials on the site generally exhibit hydraulic conductivities in the range of 1×10^{-4} cm/sec to 1×10^{-5} cm/sec. The construction contractor will attempt to utilize the most impermeable materials available (as identified visually) when constructing foundation fill and berms. For purposes of a complete construction record, hydraulic conductivity of placed foundation fill and side berms will be field tested at a rate of 1 test per each 10,000 cubic yards of material placed, although no specific threshhold values are required.

Note 3 Acceptable Zone" restriction applies only to the soil liner for the landfill. The gypsum stack soil liner shall only be required to meet the compaction and moisture content specification.

Note 4 The hydraulic conductivity for the landfill soil liner is 1.0×10^{-7} cm/sec(maximum) and for the gypsum stack soil liner is 1.0×10^{-6} cm/sec (maximum).

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
GEOSYNTHETICS - PREQUALIFICATION TESTING			
GEOMEMBRANES (60 mil smooth, 60 mil textured, 40 mil reinforced)			Installer
Raw Materials	Manufacturer's List of Guaranteed Properties	All rolls	
Geomembrane Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Puncture Resistance - ASTM D4833	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Tear Resistance - ASTM D1004	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Thickness - ASTM D5199/D5994	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Tensile Strength and Elongation - ASTM D638 (Modified) or D6693	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
GEOTEXTILES (Non-Woven, 4 ounce, 10 ounce, 16 ounce)			Installer
Geotextile Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Mass per Unit Area - ASTM D3776	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Grab Tensile Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Trapezoidal Tear Strength - ASTM D4533	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Apparent Opening Size - ASTM D4751	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Puncture Resistance - ASTM D3787	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Permittivity - ASTM D4491	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
GEOSYNTHETICS - PREQUALIFICATION TESTING			
GEOSYNTHETIC CLAY LINER (GCL)			Installer
GCL Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Bentonite Mass/Area - ASTM D5993	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Grab Tensile Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Peel Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
GEOSYNTHETICS - MATERIAL PLACEMENT TESTING			
GEOMEMBRANES (60 mil smooth, 60 mil textured, 40 mil textured)			Installer
Seam Overlap	3" to 4"	All Seams	
Non-Destructive Testing	As per Section 6.3.2e of CQA Plan	All Seams	
Destructive Testing	As per Section 6.3.2e of CQA Plan	Maximum One Every 500 Feet	
GEOTEXTILES (NonWoven, 4 ounce, 10 mil, 26 ounce)			Installer
Seam Overlap	3" to 4"	All Seams	
Installation	Physical Installation per Section 6.3.1c of CQA Plan	None	
GEOSYNTHETIC CLAY LINER (GCL)			Installer
Seam Overlap	As per Section 6.3.1d of CQA Plan	All Seams	
Installation	Physical Installation per Section 6.3.1c of CQA Plan	None	

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
DRAINAGE MEDIA - PREQUALIFICATION TESTING			
GRANULAR DRAINAGE LAYER			
Hydraulic Conductivity - ASTM D2434	1.0×10^{-3} cm/sec (Minimum)	One Test per Source	CQA Officer
Grain Size Analysis - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200<5%)	One Test per Source	
COARSE AGGREGATE			
Hydraulic Conductivity - ASTM D2434	1.0×10^{-1} cm/sec (Minimum)	One Test per Source	CQA Officer
Grain Size Analysis - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200<5%)	One Test per Source	
DRAINAGE MEDIA - MATERIAL PLACEMENT TESTING			
GRANULAR DRAINAGE LAYER			
Thickness	One Foot Minimum Thickness	100 Foot Grid	CQA Officer
Gradation - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200 < 5%)	1 per 3,000 cubic yards	
Hydraulic Conductivity - ASTM D2434	1.0×10^{-3} cm/sec (Minimum)	1 per 10,000 cubic yards	
COARSE AGGREGATE			
Gradation - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200 < 5%)	1 per 3,000 cubic yards	CQA Officer
Hydraulic Conductivity - ASTM D2434	1.0×10^{-1} cm/sec (Minimum)	1 per 10,000 cubic yards	

TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
OTHER MATERIAL PLACEMENT TESTING REQUIREMENTS			
LEACHATE PIPING SYSTEM ELEVATIONS & LOCATIONS			
Survey	Elevation +/- 0.1 feet with no adverse slopes. Plan location +/- 0.5 feet.	Every 100 feet and connections	CQA Officer
Welds and Connections	Visual Inspection	Each connection	
SURFACE WATER MANAGEMENT SYSTEM			
Survey	Field established for positive drainage (+/- 0.4 feet)	Inlet and Outlet and every 100 lineal feet along ditch channel	CQA Officer
CONCRETE			
Slump - ASTM C143	2" to 4" at time of placement	1 per 25 cubic yards or minimum 1 per day	CQA Officer
Air Entrainment - ASTM C231	5% to 7% at time of placement	1 per 100 cubic yards or minimum 1 per day	
Compressive Strength - ASTM C31 and C39	3,500 psi at 28 days	2 cylinders per 50 cubic yards or minimum 2 cylinders per day	
Delivery Time - ASTM C94	Total Mixing and Delivery Time less than 1.5 Hours	Each Delivery	

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Appendix B

Acceptable Zone Procedure

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PROCEDURE FOR DETERMINATION OF SOIL LINER ACCEPTABLE ZONE OF COMPACTION AND MOISTURE CONTENT

INTRODUCTION

One of the most significant factors affecting the performance of compacted soil liners is the adequate control of water content and dry unit weight during construction. A carefully written compaction specification will result in a compacted soil liner achieving the required hydraulic conductivity while also satisfying other factors affecting performance such as strength, compressibility, and resistance to desiccation. Because a soil liner is meant to be a hydraulic barrier, hydraulic conductivity requirements are the primary factor affecting the criteria of a compaction specification. The specification should be then tightened as necessary to meet other performance standards.

For this project, the specification will require that the soil be compacted to at least 95 percent maximum dry density as obtained from the Standard Proctor test per ASTM D 698, with a moisture range of optimum to 5 percentage points wet of optimum. Testing of the proposed liner soils will be performed to determine its acceptable density and moisture content zone for a maximum hydraulic conductivity of 1.0×10^{-6} cm/sec for the final cover and base liner. Research work performed by Benson and Daniel (1990) shows that the acceptable zone can be expected to parallel a "line of optimums." This procedure should be run when a new source of soil is selected for liner construction or when the Proctor density changes by 10 pcf or more.

PROCEDURE

The following steps will be performed during prequalification of a soil source for liner construction. The source investigation will identify consistency of the soil and have completed soil index tests including grain size distribution and Atterberg Limit determinations. Once the initial index testing is complete, a proper value for Proctor density can be selected, and then the following steps can be followed.

- Compact three samples at a controlled moisture of ±1 percent of optimum moisture at approximately 97 percent to 93 percent of standard Proctor maximum dry density. These samples should be tested for hydraulic conductivity using ASTM D 5084. If all samples pass, it can be assumed as confirmation that the specified 95 percent of maximum dry density is an appropriate lower density range.

- If all three initial hydraulic conductivity test results are $\leq 1.0 \times 10^{-6}$ cm/sec for the base liner and the final cover, then three more samples shall be prepared to confirm the moisture content range. Using approximately 93 percent to 95 percent dry density, prepare one sample at -1 points (dry of optimum), one at +3 points and one at +8 points of optimum moisture content. Test these new samples for hydraulic conductivity using ASTM D 5084. If all samples pass, it can be assumed as confirmation that the optimum to +5 percentage points is an appropriate moisture content range.

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- If the first two steps do not confirm the permeability window, the CQA Officer will determine if the soil will be used for construction. If it will be used, then further testing can be performed to define a smaller acceptable zone.

- In some cases, the borrow sources may be so variable that composting of the soil will be required for testing. In these cases, three or four Proctor tests should be performed to determine the range of maximum dry density. If the range of maximum dry densities is less than 10 pcf, a composite can be tested as outlined above. If the range of maximum dry densities is greater, the highest and lowest soil values should be tested to determine an acceptable range.

Selection of density value shall be based on inspector's identification of soil percentages. Prequalification testing will assure the conformance of permeability.

USE OF THE ACCEPTABLE RANGE

During construction, the acceptable window will be verified by the specified interval of construction sample testing. Each sample will be tested for density, moisture, grain size, and Atterberg Limits when submitted for hydraulic conductivity testing. The results can then be compared to prequalification testing to verify soil consistency and passing hydraulic conductivity. These tests can also be plotted on the Proctor curve as documentation of acceptable zone or as a demonstration that the zone can be enlarged.

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Appendix E: Operation and Maintenance Manual, Duck Creek Energy Center, Gypsum Management Facility

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Operation and Maintenance Manual
Illinois Power Resources Generating, LLC
Duck Creek Energy Center
Gypsum Management Facility
Fulton County, Illinois

Prepared For:

Illinois Power Resources Generating, LLC
Duck Creek Energy Center
Fulton County, Illinois

Prepared By:

HANSON PROFESSIONAL SERVICES INC.
1525 South Sixth Street
Springfield, Illinois 62703

Revised August 2014

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OPERATION AND MAINTENANCE MANUAL
DUCK CREEK ENERGY CENTER
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS

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SECTION 1.0
GENERAL

This operation and maintenance (O&M) manual outlines objectives, proposed policies, responsibilities, and procedures for Illinois Power Resources Generating, LLC (IPRG) and Contractor personnel who are responsible for the management of the Duck Creek Energy Center Gypsum Management Facility (GMF). The GMF incorporates two reservoirs, the Gypsum Stack and the Recycle Pond, for processing and storing gypsum.

1.1 REASONS FOR DEVELOPMENT OF THE O&M MANUAL

In addition to providing guidance to the IPRG and Contractor personnel who are responsible for the operations and maintenance of Duck Creek GMF, this manual has been prepared in accordance with state regulations. The State of Illinois Rivers, Lakes and Streams Act, (615 ILCS 5) Paragraph 23a includes the statement "The Department is authorized to carry out inspections of any dam within the State, and to establish standards and issue permits for the safe construction of new dams and the reconstruction, repair, operation and maintenance of all existing dams." (emphasis added).

Part 3702 of the 17 Illinois Administrative Code, Chapter I entitled the "Construction and Maintenance of Dams" details the requirements to obtain a permit for the construction, operation, and maintenance of a dam. Section 3702.40 b) includes the following statement:

> "5) As a condition of each permit, the dam owner shall submit a maintenance plan detailing the procedures and schedules to be followed to maintain the dam and its appurtenances in a reasonable state of repair."

Thus it is a requirement of all dam owners who have dams which fall under the jurisdiction of the Illinois Department of Natural Resources to operate and maintain them safely.

As a dam owner, IPRG is responsible for the safety of the public and for maintaining the structures at the facility for both safety and economy. The overall public interest is served by providing a document to serve as a basis for the safe and economical operation and maintenance of the dam during both emergency and day-to-day conditions.

1.2 GENERAL RESPONSIBILITIES CONCERNING DAMS

IPRG is responsible for the operation and maintenance of the Gypsum Stack Dam and the Recycle Pond Dam. These responsibilities include general maintenance (mowing, removing debris from decants, placing riprap where needed, etc.), operation, inspection and emergency action decisions. IPRG plans to enter into an agreement with an independent contractor to perform certain aspects of the operation and maintenance of the GMF.

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SECTION 2.0
DEFINITIONS

Abutment - That part of the valley side or concrete walls against which the dam is constructed. Right and left abutments are those on respective sides of an observer when viewed looking downstream.

Appurtenant Works - The structures or machinery auxiliary to dams which are built to operate and maintain dams; such as outlet works, spillways, gates, valves, channels, etc.

Boil - A stream of water discharging from the ground surface downstream of the dam carrying with it a volume of soil which is distributed around the hole formed by the discharging water.

Berm - A horizontal step or bench in the sloping profile of an embankment dam.

Breach - A break, gap, or opening (failure) in a dam which releases impoundment water.

Dam - A barrier built for impounding or diverting the flow of water.

Dike (Levee) - An embankment, usually applied to embankments or structures built to protect land from flooding.

Drain, Layer or Blanket - A layer of pervious material in a dam to facilitate the drainage of the embankment including such items as a toe drain, a weephole, and a chimney drain.

Drawdown - The resultant lowering of the water surface level due to the release of water from the impoundment.

Duck Creek Plant Datum - the Duck Creek Station horizontal and vertical coordinate system ("Plant System") on which the design and construction survey information, and elevations used in this document is based. Reference the control points shown on the construction drawings (Drawing C180-C102-04, Rev 3, or later) for horizontal and vertical control information.

Embankment - Fill material, usually rock or earth, placed with sloping sides.

Earthen Dam - Any dam constructed of excavated natural materials.

Failure - An incident resulting in the uncontrolled release of water from the dam.

Freeboard - The vertical distance between a stated water level and the top of the dam.

Gate or Valve - In general, a device in which a leaf or member is moved across the waterway to control or stop the flow.

Groin - The junction of the upstream or downstream face of the dam with the valley wall.

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Maintenance - The upkeep, involving labor and materials, necessary for efficient operation of dams and their appurtenant works.

Operation - The administration, management, and performance needed to operate the dam and appurtenant works.

Operation and Maintenance Inspection - Inspections conducted by the dam Operator. These inspections are frequent visual "Walk-around" inspections of the dam surface and appurtenant works.

Outlet - An opening through which water can freely discharge for a particular purpose from an impoundment.

Phreatic Surface - The upper surface of saturation in an embankment.

Piping - The progressive development of internal erosion by seepage, appearing downstream as a hole or seam, discharging water that contains soil particles.

Riprap - A layer of large stones, broken rock or precast blocks placed in a random fashion usually on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel as a protection against wave and ice action.

Silt/Sediment - Soil particles and debris in an impoundment.

Slump/Slide Area - A portion of earth embankment which moves downslope, sometimes suddenly, often with cracks developing.

Spillway System - A structure or structures over or through which flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway. If the elevation of the spillway crest is the only control of the flows, it is considered an uncontrolled spillway.

Emergency Spillway - A spillway designed to operate very infrequently, only during exceptionally large floods, usually constructed of materials expected to erode slowly.

Principal Spillway - The main spillway which controls both normal and flood flows and is usually constructed of non-erodable materials.

Auxiliary Spillway - A spillway which works in conjunction with the principal spillway to control flood flows and is usually constructed of non-erodable materials.

Stilling Basin - A basin constructed to dissipate the energy of fast flowing water, such as from a spillway, and to protect the streambed from erosion.

Toe of Embankment - The junction of the face of the dam with the ground surface in the floodplain upstream or downstream of the dam.

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SECTION 3.0
INFORMATION ABOUT THE DAMS

3.1 LOCATION

The Gypsum Stack and Recycle Pond Dams are located in the NW 1/4 of Section 18, Township 6 North, Range 5 East of the Forth Principal Meridian in Fulton County, Illinois. More specifically, the dams are located east of Bethel Cemetery Road approximately 2 miles southeast of Canton, Illinois. A map showing the location of the dams is included in Appendix A.

3.2 DESCRIPTION OF DAM AND APPURTENANCES

The gypsum stack dam has a maximum earthen embankment height of 32 ft and a maximum impounding capacity of 773 acre-ft, measured at the top of the earthen dam elevation of 620 ft per Duck Creek Plant Datum (EL 620). However, due to the "stacking" of gypsum above the top of the earthen dam, the total volume within the completed gypsum stack will be approximately 2256 acre-ft. The recycle pond dam has a maximum embankment height of 41 ft and a maximum impounding capacity of 150 acre-ft (measured at the top of dam elevation of 615 ft).

The gypsum stack dam has a single high density polyethylene (HDPE) lined spillway (transfer channel) which discharges to the recycle pond. The transfer channel is a trapezoidal channel with 3H:1V side slopes. The transfer channel transitions from a 16-ft bottom width at an invert elevation of 614.0 ft at the upstream end, to a 35-ft bottom width at an invert elevation of 609.0 ft at the downstream end. A 2-ft tall HDPE covered concrete weir, located near the upstream end of the transfer channel, is fitted with stop logs capable of raising the discharge control elevation to 616.0 ft. To protect the HDPE liner from abrasion during flows, the transfer channel and a portion of the recycle pond dam incorporate an additional sacrificial layer of HDPE at the location where the transfer channel discharges to the recycle pond.

The emergency spillway for the recycle pond consists of four 42-inch diameter HDPE pipes which discharge into a riprap lined plunge pool. The upstream inverts of the pipes are at EL 610.0 and the downstream inverts are at EL 607.0. The emergency spillway has been provided in the event of an accidental overfilling of the recycle pond or catastrophic rainfall only. It is not expected to be activated during the life of the facility.

Pertinent data about the dams, appurtenant works, and reservoirs are presented in Appendix B.

3.3 SIZE CLASSIFICATION

The gypsum stack earthen dam has a maximum embankment height of 32 ft and a maximum impounding capacity of 773 acre-ft (measured at the top of dam elevation of 620 ft). Based on IDNR criteria, the gypsum stack earthen dam is classified as a small-size dam. However, since the gypsum stack is planned to ultimately meet or exceed 100 ft in height, the gypsum stack will eventually be classified as a large-size dam.

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The recycle pond dam has a maximum embankment height of 41 ft and a maximum impounding capacity of 150 acre-ft (measured at the top of dam elevation 615 ft). Since the recycle pond dam embankment exceeds 40 ft in height, it is classified as an intermediate-size dam.

3.4 HAZARD CLASSIFICATION

The breach wave resulting from a failure of either dam is expected to be contained within the Duck Creek Reservoir located immediately downstream. Considering the low probability for causing loss of life or economic loss to adjacent landowners, both dams are classified as CLASS III, LOW HAZARD POTENTIAL dams.

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SECTION 4.0
OPERATIONS ACTIVITIES

The operations plan describes the proposed operation of the Duck Creek Gypsum Management Facility (GMF) which includes the gypsum stack and the recycle pond.

4.1 SITE OPERATIONS

The GMF will receive flue gas desulfurization sludge (gypsum) from the Duck Creek Energy Center (the Plant). Gypsum will be transported to the GMF in slurry form (approximately 20 percent solids) and allowed to settle. Clarified process water will then be siphoned or decanted to the recycle pond and returned to the Plant for reuse via pipeline.

The GMF will potentially receive gypsum slurry 24 hours per day, seven days per week. Routine operation and maintenance activities are expected to be conducted during day shift hours. The filling times and staging chronology included in this document are calculated from gypsum production rates estimated at 23,500 tons per month, which is based on the plant burning high sulfur coal (6.8 lbs of SO_2 per million BTU) at a 90% capacity factor. The sluice and process water return rates referenced in this document are per the Hitachi Power Systems America, Ltd. MATERIAL BALANCE Case Study: 4,131 mmBtu/hr Drawing No. 0013-361-110-0381 Rev. B dated 3-19-07. Variations in these parameters would result in variations in the estimated chronology and flow rates.

The Plant is a restricted access location. A series of fences and gates exist to prevent unauthorized access to the property. The proposed GMF is located within the restricted plant confines, and is, therefore, not accessible to the general public.

4.2 PERSONNEL

The proposed GMF will be owned and operated by IPRG. Corporate offices are located in Houston, Texas. IPRG plans to enter into an agreement with an independent Contractor to perform certain aspects of the operation and maintenance of the GMF. The contractual operator (Operator) of the gypsum stack will be responsible for daily operation and maintenance of the gypsum stack, recycle pond and peripheral areas.

4.3 OPERATION OF VAULTS AND VALVES

IPRG personnel will be responsible for the operation of the valves which control the flow of slurry and water between the Plant, recycle pond and gypsum stack to the first valve vault located at the recycle pond entrance road. Beyond that point, the Operator will be responsible for distribution of gypsum slurry to various areas of the gypsum stack (this includes the valve vaults on the mid-western side of the gypsum stack and the north side of the gypsum stack). Two redundant pipes will carry the gypsum slurry from the plant. Although only one pipe will be in use at any time, conditions at the plant may result in a discharge pipe switch at any time. BOTH PIPES MUST BE AVAILABLE TO DISCHARGE GYPSUM AT ALL TIMES WHEN

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THE PLANT IS OPERATING. Valves to both pipes must be open, and the ends of both pipes must be positioned so that there would be no restrictions to gypsum discharge at any time.

4.4 GYPSUM MANAGEMENT FACILITY STARTUP

The major components of the GMF consist of:

- The gypsum stack;
- The recycle pond;
- The HDPE-lined earthen transfer channel that connects the two structures, and through which clarified process water will be decanted from the gypsum stack into the recycle pond; and
- The recycle pond decant system and pump-house, through which process water will be returned to the Plant for reuse.

Upon completion of the recycle pond construction, the recycle pond will be partially filled with water pumped from the Plant or from Duck Creek Reservoir. The recycle pond pumps will be commissioned and then shut off pending the introduction of slurry into the gypsum stack. Procedures for these operations are discussed in the following sections.

4.4.1 Siphon Installation and Operation

The bottom of the gypsum stack is approximately 29 ft below the transfer channel invert elevation of 614 ft. During the period when the gypsum sluicing and stacking operations are conducted below the transfer channel elevation, clarified water must be siphoned from the gypsum stack to the recycle pond. Based on a slurry discharge rate of 653 gal/minute (gpm), and an average reclaim water return rate of 626 gpm, a minimum of two redundant (2) 10-inch diameter HDPE siphons should be primed and operable at all times. Installation of the siphon pipes and valves is included in the original GMF construction.

Each of the siphon pipes will pass through the transfer channel and the outlet end of the siphon pipes shall be laid on the bottom of the recycle pond at elevation 590 ft. Ballast will be required at the outlet of the pipe to prevent the pipes from potentially floating to the surface and breaking the siphon. Ballast or other means of restraint may also be required in the transfer channel to hold the pipes in place. For a 300 ft long, 10-inch diameter HDPE siphon, the water level in the gypsum stack will need to be approximately 4.5 ft higher than the water level in the recycle pond in order to pass the equilibrium process water return rates discussed above.

4.4.2 Initial Filling of Recycle Pond With Water

The recycle pond will initially be partially filled with water pumped from Duck Creek Reservoir or the plant. The recycle pond will be filled to a water surface elevation of 598 ft in order to accommodate proper pump functioning during commissioning and startup of the slurry discharge to the gypsum stack. Duck Creek plant personnel will monitor and regulate the water level in the recycle pond.

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4.4.3 Commissioning the Pumps and Siphons

Once the recycle pond and gypsum stack have operational levels of water, the siphons, the recirculation pump system (recycle pond to gypsum stack), and the recycle pump system (recycle pond to plant) will be primed and tested. IPRG will be responsible for operation and maintenance of the recycle / recirculation pumps.

4.5 GYPSUM MANAGEMENT FACILITY OPERATION

The gypsum slurry (approximately 20 percent solids) will be pumped from the Plant to the gypsum stack via piping. Piping will be HDPE with a pressure rating for the design hydraulic and static head. The HDPE pipe will discharge the slurry into the gypsum stack, and the gypsum will settle by gravity.

The water level in the recycle pond should be maintained at a minimum elevation of 598 ft in order to insure uninterrupted pumping of water back to the plant. However, at times, there will be intermittent outages at the plant. During an outage, bottom drains in the gypsum stack will continue to discharge water to the recycle pond and the recycle pumps will continue to recirculate water from the recycle pond to the gypsum stack. The recirculation of water is required during outages in order to utilize the water storage capacity of the gypsum to help maintain sufficient storage capacity in the recycle pond to accommodate all precipitation runoff from the entire gypsum stack/recycle pond area during an expected maximum 12-week maintenance outage at the Plant.

At a placement rate of 23,500 tons per month, it will take approximately 3 years to fill the gypsum stack with gypsum to the invert of the HDPE-lined transfer channel at EL 614. Until that time, clarified return water will be siphoned into the recycle pond using one of two redundant 10-inch diameter siphon pipelines. Water that flows from the gypsum stack to the recycle pond will be pumped back to the Plant for reuse, or recirculated to the top of the gypsum stack during periods when the plant is shutdown.

In order to stack the gypsum material with the required factors of safety for slope stability, a system of strategically placed perimeter ditches and dikes must be constructed. Interior dikes will also need to be constructed to accommodate the installation of ring drains and the development of cells located within the gypsum stack. Key components of the gypsum stacking process are described in the following sections to highlight the effort required to successfully stack gypsum with the required factors of safety against slope failure.

4.5.1 Initial Filling With Gypsum Slurry

There are two redundant gypsum slurry pipelines which will be capable of discharging midway along the north side or west side of the of the gypsum stack at a maximum rate of 1.5 cfs (675 gal/min). The initial construction of the GMF includes a ring drain system on the HDPE liner on the bottom of the gypsum stack. When gypsum slurry is initially discharged into the gypsum stack, **extreme care must be taken to prevent any erosion of the sand layer over the ring drain**. **Any displacement of sand may impair the function of the ring drain.** If necessary, the sand layer may be protected with a layer of larger aggregate or temporarily

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covered with an approved geotextile wherever necessary to prevent erosion of the sand layer. It may be preferable to use a flange-connected pipe extension to extend the slurry discharge line to the interior side of the ring drain so that the bottom troughs will collect the water and prevent erosion of the sand layer. The pipe extension can be removed when the ring drains are covered and protected by settled gypsum. If any ring drain sand is displaced, the Operator shall immediately notify Ameren so that an appropriate response and repair method can be determined. Please see Figure A for details and a general depiction of the ring drain assembly.

Settled gypsum will gradually create a plane of material (gypsum beach) sloping gently towards the south end of the gypsum stack. Please see Figure B for a depiction of the gypsum beach. Clarified water will collect in the south end of the gypsum stack and will be siphoned into the recycle pond when it reaches EL 602.5, the level necessary to provide the head to siphon the process water at the system equilibrium rates. The GMF Operator will be responsible for operation and maintenance of the siphons. At the design flow rates, it will take approximately 95 days of operation in order for the water in the gypsum stack to reach this level.

4.5.2 Gypsum Dike and Cell Construction

The bottom slope of the gypsum stack liner, and the siphoning of water from the gypsum stack to the recycle pond, will partially drain the gypsum to allow for "early stacking" of material below the crest of the earthen dam. This is advantageous for several reasons. One reason is that the construction of compacted dikes at a lower elevation may improve foundation conditions for the remainder of the stack. Employing stacking procedures at a lower elevation also affords the opportunity for the Operator to become familiar with the material and develop confidence in a construction routine which will maximize stability when stacking the material above the top of the earthen embankment. Early stacking also allows Ameren the opportunity to complete preliminary testing on proposed piezometer locations for development of a piezometer installation and monitoring plan, as discussed in Section 4.5.8, which will be refined prior to stacking above the top of the earthen embankment.

The procedures for controlling the deposition of gypsum will begin once the gypsum beach at the north end of the gypsum stack reaches an elevation of approximately 605 ft, NGVD, which is 10 ft above the HDPE liner (7.5 ft above the top of the ring drain assemblies). Based on an assumed deposited gypsum slope of 0.3%, and a water level of 602.5 ft, the gypsum beach which will be visible above water is predicted to span half the length of the gypsum stack (reference Figure B). At full production (16.7 acre-ft deposited per month), the time required for the gypsum beach to reach this configuration is estimated at five to six months. .

The first procedural steps in controlling the deposition of (stacking) gypsum are the construction of a perimeter ditch, a perimeter dike, a rim ditch, and a rim dike. The perimeter ditch is the ditch which will be formed between the earthen embankment and the gypsum. The perimeter dike is the gypsum dike on the interior side of the perimeter ditch. The rim ditch is a ditch which will be formed on the interior side of the perimeter dike. The rim dike is a gypsum dike which will be formed on the interior side of the rim ditch. These basic components of the gypsum stack are illustrated in Figure C. Specific details pertaining to the ditches are provided in Sections 4.5.3 and 4.5.4.

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During the initial stages of stacking, the perimeter ditch, perimeter dike, rim ditch and rim dike will be constructed simultaneously. They will be constructed by building two elevated dikes on the gypsum beach beginning at the middle of the north side and proceeding both clockwise and counterclockwise around the perimeter of the gypsum beach (see Figure D). Access to the beach will be provided by carefully pushing an approved fill material onto the beach from the crest of the earthen embankment to create an access pad. The thickness of the fill layer will need to be at least 24-inches over the geomembrane liner to avoid damage to the liner, and will need to be at least 36-inches over the gypsum beach. Once the fill material has been placed far enough out onto the beach to allow excavation of the gypsum without damaging the liner, the access pad can be completed using gypsum excavated from the beach (see Figure E).

Gypsum excavated from the beach is expected to be soft and saturated and must be windrowed and allowed to dewater before it can be spread and compacted to form the roadway. The gypsum is expected to dewater sufficiently in 24 hours to allow spreading and compacting. Adequate compaction is expected to be achieved by tracking with a D-6 dozer or similar equipment.

After construction of the dikes and ditches has begun, the slurry discharge lines should be relocated to discharge to the rim ditch. This will allow the rim ditch to be refilled each day to provide gypsum for raising the roadway as the excavator retreats from the most recently placed windrow. The rim ditch will also serve as the primary means of diverting slurry around the stack to the location where deposition is desired.

When the initial perimeter dike is completed, the top of the perimeter dike should be at least 30 ft wide, at least 10 ft above the beach and the side slopes graded to be 3.0H:1.0V (see Detail A on Figure B). The top of the initial rim dike should be at least 3.5 ft above the beach. Additional interior dikes may also be constructed as needed to create cells which facilitate the settling process. The exterior side slope of the rim dike shall be 3.0H:1.0V. The interior side slope of the rim dike and the side slopes on any interior dikes may be allowed to form at the angle of repose for the gypsum material. **A minimum freeboard of 3.5 ft must be maintained between the slurry level in the rim ditch and the crest of the perimeter dike. Subsequently, the perimeter dike must always be maintained at an elevation at least 3.5 ft higher than the rim dike or any other interior dike.**

The rim and perimeter dikes should be raised in lift increments of approximately 1 foot and may be moved laterally each lift as needed to maintain the required design slopes of 3.0H:1.0V on the perimeter dike. The slopes can be graded with a smooth-edged excavator bucket, e.g., a finish or cleanup bucket. **Under no circumstances should the slopes of the gypsum stack be graded using a toothed excavator bucket**.

Clarified water will be transferred from the rim ditch to the perimeter ditch where it will be carried to the transfer channel for discharge to the recycle pond. The GMF construction included installation of a stop log system for the transfer channel. The stop logs may be used for **temporary** reductions in flow to the Recycle Pond and increases in water levels in the gypsum stack for water balance purposes during operation. During the initial stacking process, when a siphon must be used to transfer water to the recycle pond, the transfer of water from the rim ditch

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to the perimeter ditch may be achieved with an open cut through the perimeter dike. However, once the perimeter dike rises above elevation 614 ft (the invert of the transfer channel), decants, stilling wells and splash pads (see Sections 4.5.5 and 4.5.7) are required for the purpose of transferring clarified water from the rim ditch to the perimeter ditch.

4.5.3 Perimeter Ditch

Throughout the stacking operations, a perimeter ditch must be constructed and maintained around the toe of the gypsum stack. The perimeter ditch will be located between the perimeter dike (outer gypsum slope) and the HDPE lined earthen embankment. This ditch will collect water from the ring drains, decants and rainfall runoff, and convey it to the transfer channel where it will be discharged to the recycle pond. The perimeter ditch shall be constructed by covering the HDPE liner with a 2 ft thick protective layer of gypsum and shaping the channel to the required dimensions. The perimeter ditch is required to have a maximum invert elevation of 614 ft (6 ft below the top of the earthen perimeter dam) and a bottom width of at least 5 ft. A larger ditch bottom width may be utilized to reduce the frequency of any dredging necessary to maintain the minimum required dimensions.

4.5.4 Rim Ditch

The rim ditch will be the primary means of diverting slurry from the slurry discharge pipes to the desired deposition area. The rim ditch will also transport clarified water to the decant structures so the water can be discharged to the perimeter ditch. Consequently, the width of the rim ditch will vary according to the needs at any particular location on the gypsum stack. There may also be cases were blocking the rim ditch is desirable to divert water into a particular cell. There are only two primary constraints on the construction of the rim ditch: (1) the outer slope shall not be steeper than 3.0H:1.0V (this is the inner slope of the perimeter dike); and (2) the normal operating water level shall be at least 3.5 ft below the top of the perimeter dike.

4.5.5 Installation and Operation of Decants and Stilling Wells

The progressive stacking of gypsum will require the installation of at least four (4) decant structures (2 redundant sets of 2) in the rim ditch to convey water to the lower perimeter ditch without eroding the gypsum stack slopes. A minimum of two (2) decant structures are required in order to maintain the water level in the rim ditch and provide adequate discharge capacity for design precipitation events. An additional redundant set of two (2) decant structures will also be required to be installed. The decant structures will consist of 16-inch diameter solid wall HDPE IPS DR 11 pipe sections with 12-inch diameter screw-capped tees installed at 6 ft intervals along the length of the pipe. (When installed on a 3H:1V slope, the tees at 6 ft intervals will translate to 2 ft elevation intervals.) The decant structures will each discharge to a stilling well located in the perimeter ditch at the toe of the outer gypsum stack slope.

During construction of the first gypsum dike above elevation 614 ft (the invert elevation of the perimeter ditch and transfer channel), a 16-inch diameter solid wall HDPE IPS DR11 pipe will be installed as shown in Figure F**Error! Reference source not found.**. The horizontal portion of the pipe will be approximately 80 ft long with an invert at EL 614. The inlet end of the horizontal pipe will be attached to the first decant pipe section with an 18.4 degree angle

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fitting. Prior to backfilling over the horizontal portion of the pipe, a 20 ft wide geogrid must be installed over the entire horizontal portion of the pipe, to prevent the pipe from potentially floating out of the saturated gypsum layer during the initial stages of the stacking operation.

The outlet end of the decant pipe will be welded to, and discharge into, a 48-inch diameter HDPE stand pipe with a 1-inch thick HDPE plate welded to the bottom. The stand pipe will have a top elevation of 618 ft and a bottom elevation of 611 ft. The stand pipe will be filled with concrete ballast to EL 614 (see Detail A on Figure F). Additionally, a 4-inch diameter low flow drain will be installed in the stand pipe at elevation 614 ft in order to allow for the cleanout of any gypsum which might accumulate in the stand pipe. In order to allow for proper function of the stilling well, the low flow drain pipe should not be installed in line with the 16-inch decant pipe, but rather offset to one side.

Each time the perimeter gypsum dike is raised, a new decant pipe section will be butt welded to the decant structure. The decant pipe section will be supported by the interior 3H:1V slope of the rim ditch. The water level in the rim ditch will be progressively raised through the stacking operation by capping the appropriate tees in the decant pipe sections. As previously stated, the normal water level shall be at least 3.5 ft below the crest of the perimeter gypsum dike.

4.5.6 Installation of Upper Ring Drains

Upon completion of the first gypsum dike above elevation 614 ft, and prior to construction of the next progressively stacked dike, two interior ring drains must be installed concurrent with development and operation of the interior gypsum cells. Additional ring drains will be required as the height of the gypsum stack increases. Final details and specifications for the upper ring drains will be provided by the design engineer at the time of installation. The upper ring drains are required to control the phreatic surface which will develop within the stack. A preliminary design for the upper ring drains is as follows, as shown on Figure C: A 3 ft tall gypsum dike will be constructed along the centerline of the proposed ring drain using the same techniques as for gypsum dike construction. After construction of the dike, a 4 ft deep channel with a 4 ft bottom width will be excavated along the center of the dike. Side slopes on the cut should be no steeper than 1:1. The bottom and sides of the cut should be filled with IDOT FA1 gradation sand to form a layer which is 1 ft thick. After the sand is placed, the channel will then be lined with non-woven geotextile to be specified by the design engineer. The geotextile will be covered with coarse granular material (to be specified) 2 ft wide by 2 ft deep, with a perforated HDPE pipe imbedded in the center. The fabric will then be wrapped over the top of the coarse granular material and covered with an additional 1 ft thick layer of FA1 gradation sand. The gypsum must not be in direct contact with the non-woven geotextile. The upper ring drains will discharge to the perimeter ditch via solid-wall HDPE pipe.

4.5.7 Splash Pads at Ring Drain & Decant Discharge Locations

At each location where a ring drain and/or a decant structure discharges to the perimeter ditch, the ditch shall be lined with a material capable of resisting the erosive velocities. Materials such as concrete, cable stayed concrete blocks or a geogrid backfilled with washed

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aggregate may be acceptable. Operator-proposed methods shall be submitted to Ameren for approval prior to placement. The splash pads shall be installed concurrently with or immediately after construction of the perimeter ditch, ring drain outlets and decant stilling wells.

4.5.8 Piezometer Installation and Monitoring

The side slopes of the gypsum stack will be constructed with 3.0H:1.0V side slopes. (After consolidation of the settled gypsum over time, the final slopes are expected to approach 3.75H:1.0V.) The stability of the gypsum stack slopes is critically dependent on the location of the phreatic surface which will develop within the gypsum stack. Proper installation and functioning of the ring drains will ensure that the phreatic surface is located an adequate distance from the surface of the slope as necessary to maintain a stable slope. In order to monitor the phreatic surface within the gypsum stack, piezometers will be installed on each side of the gypsum stack. A preliminary piezometer detail is included on Figure C. The location and depth of each piezometer will be determined by the design engineer prior to installation, and an installation and monitoring plan will be developed based on information obtained during the initial gypsum stacking operations below the level of the earthen berm. "Critical elevations" corresponding to the anticipated readings at various stages during the progressive raising of the gypsum stack will be established for each piezometer. The water level in each piezometer will be read and recorded in accordance with a specified schedule. If at any time a reading is recorded higher than the "critical elevation" for that stage of operation, Ameren and the design engineer must be contacted immediately for evaluation of the reading. It is imperative that the piezometers are installed and monitored in accordance with the plan and the design engineer's specifications. Depending on the piezometer readings, it may also be necessary to install additional seepage collection drains to maintain the phreatic surface at or below the critical level within the gypsum stack.

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Figure A – Bottom Ring Drain Assembly

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Figure B - Initial Gypsum Dike Construction

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Figure C - Components of Gypsum Stack

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Figure D - Progression of Ditch and Dike Construction

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Figure E - Access Pad Extension onto Gypsum Beach

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Figure F - Decant Pipe and Stilling Well Details

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SECTION 5.0 DAM INSPECTIONS

The inspection program includes two types of dam inspections which are required to be performed in accordance with IDNR/OWR's Rules for Construction and Maintenance of Dams. The first type of inspection is regularly conducted by the dam Operator and is referred to as an Operation and Maintenance Inspection. The second type of inspection, referred to as the Engineering Inspection, is conducted by a qualified engineer approved by Ameren.

Inspections shall be conducted throughout the operating life of the structures. The "operating life of the structure" will be considered to cease upon receipt of written affirmation from IDNR/OWR indicating that the structure is no longer considered a dam. Copies of all inspection reports shall be maintained at the Plant for the operating life of the structures.

5.1 OPERATION AND MAINTENANCE INSPECTION

"Walk-around" inspections of the dams and appurtenant works are to be made by the dam Operator. During these inspections, a checklist of items to be maintained and items to be observed should be recorded. The checklist provided in Appendix B shall be utilized for these inspections. **If any of the following items are found to be unusual or are cause for concern, the Ameren Shift Supervisor should be immediately notified.**

Frequency: Weekly. Also, during and after unusual events such as heavy rainfall or after an earthquake.

Inspection Items: During each inspection the following items should be noted in particular.

1. Water Level - Maximum levels as a result of heavy rainfall should be recorded.

2. Earth Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides, and animal burrows. These are described as follows:

    - Surface Erosion - Removal of vegetative cover by water action or pedestrian or vehicle usage forming deep ruts or gullies.

    - Seepage - The passage of water through and/or underneath the earth embankment abutment and natural groundline or at the contact between the embankment and outlet works. It can be indicated by cattails or other wet environmental vegetation, erosion, channelization, or slumping on the embankment face.

    - Cracks - Deep cracks usually indicate the movement of the dam and/or the foundation and can be in either the longitudinal (along the length of the dam) or transverse (across the dam) directions. Cracking can be an indicator of the

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beginning of slumps. Shallow cracks may develop during the summer when the surface soils of the embankment become severely dried and are usually of no concern in regard to the safety of the dam.

- Settlement - Settlement is indicated by depressions or low spots and can be signs of consolidation of the dam or foundation or the loss of material beneath the settlement area.

- Slumps/Slides - A slow or sudden movement of the earth embankment slope on either face toward the toe of the dam.

- If seepage indicates the presence of soil particles, or if deep cracks, settlement, slumps, or slides are noticed, a qualified engineer should be contacted immediately for consultation.

- Animal Burrows - Animal burrows result in a loss of earth embankment material and can provide seepage paths for water through the embankment.

3. Gypsum Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides and animal burrows. The descriptions for these are the same as for earth embankment.

4. Vegetation - Grass should be a thick vigorous growth to stabilize the earth embankment soils and prevent erosion from occurring. Note the height of the grass; if greater than 1 foot a mowing of the area should be scheduled before the next inspection. There should be NO trees on the earth embankment and NONE within a minimum of 20 ft of the embankment toes or other structures. The gypsum embankment will not be seeded and is not expected to have any vegetation.

5. Gypsum Stack piezometers should be inspected for any damage or loss of function. Damaged piezometers must be promptly repaired or replaced since their function is critical to ensuring stability of the gypsum stack.

6. The water level in each Gypsum Stack piezometer must be measured and recorded. If the water level in any piezometer is above the "critical elevation" as discussed in Section 4.5.8, Ameren should be notified and the **design engineer should be immediately consulted for guidance on an appropriate course of action**.

7. Gypsum Stack LD/LCRS Drains - The change in location or amount of flows discharging from the Leak Detection/Leachate Collection Recovery System (LD/LCRS) should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

8. Gypsum Stack Ring Drains - The change in location or amount of flows discharging from the Ring Drains should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

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9. Gypsum Stack Fixed Decant – Check the alignment and supports for the pipe. Record the amount of flows discharging from the pipe and any erosion or scour around the discharge point.

10. Gypsum Stack Perimeter Ditch – The perimeter ditch should have a consistent prismatic shape for the entire length. Inspect the perimeter ditch for evidence of erosion, sediment deposition and irregularity in channel geometry, especially in the vicinity of siphon, decant or ring drain outfall structures. If irregularities are noted, repairs should be scheduled and completed.

11. Stop Logs - Check to make sure that the stop logs in the transfer ditch are undamaged, and, if installed, are operating well and allowing for the free flow of water over them.

12. Transfer Channel - Check for any debris or other obstructions which may block or restrict the free flow of water. Check for any pools or undulation of the floor of the channel.

13. Recycle Pond Decant - Check for any debris or other obstructions around the Recycle Pond decant which may block or restrict the free flow of water. The emergency dewatering valve should be lubricated. If there is no return water in the pipe, the emergency dewatering valve should be exercised. Record the physical and operating conditions of the system.

14. Recycle Pond Drop Inlet Spillways - Check for any debris or other obstructions around the inlet crest and at the bottom of the drop inlet which may block or restrict the free flow of water. Check for the development of any rusty areas on the concrete, and seepage, cracking, breaking, or spalling of the concrete. Check for settlement or cracking of the crest. Check for any debris in the pipes which may restrict the flow of water. Check for any tears or leaks in the HDPE liner covering the concrete.

15. Recycle Pond Rip Rap Basin - Check for any debris or other obstructions in the riprap basin which may block or restrict the free flow of water. Check to make sure that the rip rap is remaining in a uniform position. Freeze/thaw action or flow over the rip rap may tend to lift or fracture, thus requiring replacement or leveling to maintain the necessary level of protection. NO trees or woody vegetation should be growing through the rip rap.

16. Fences - Check for damage, accumulated debris, operation of gates and locks, and adequacy of locations (this may change with time as people access the area or development occurs in the area).

17. Perimeter - Check the perimeter of the dams for a distance of at least 100 ft beyond the toe for signs of seepage or boils.

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18. HDPE Liner – Wherever exposed, the HDPE Liner should be inspected for tears, gouges, protrusions under the liner and abrasion.

Records: Log books of activities occurring at the dam is to be kept current by the dam Operator. The log books shall be made available for review by the inspecting engineer during the Engineering Inspection. The log books should contain at the least the following documentation:

1. Completed operation and maintenance inspection checklists
2. Readings from all piezometers on the Gypsum Stack
3. Additional visual observations
4. A list of maintenance performed
5. A list of any unusual occurrences at the dam
6. A copy of the engineering inspection reports

5.2 ENGINEERING INSPECTION

The engineering inspection is to be conducted by a qualified engineer approved by IPRG. The inspection will provide a thorough evaluation of the dam and appurtenant structures. The forms provided in Appendix C shall be utilized for these inspections.

Frequency: The Gypsum Stack Dam and Recycle Pond Dam are classified as CLASS III, LOW HAZARD POTENTIAL dams. Class III dams are to be inspected at least once every five years.

Inspection Items: The engineer will thoroughly inspect all of the items noted under Operation and Maintenance Inspection.

Records: The Dam Inspection Report form, Appendix C, will be completed by the inspecting engineer and will be signed and sealed by an Illinois Registered Professional Engineer. This report will document any deficiencies; recommend remedial actions; and establish time requirements for addressing the deficiencies. The original report will be retained in Ameren's file and a copy of the report will be submitted to the Illinois Department of Natural Resources, Office of Water Resources.

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SECTION 6.0
MAINTENANCE ACTIVITIES

Timely repairs are a must after problem areas have been identified. The dam Operator is to perform the work required to correct items noted in the operation and maintenance and engineering inspections. Such items include mowing, seeding, tree and brush removal, replacing rip rap, repairing fences and locks, clearing debris, etc. The maintenance activities specified in the following sections are minimum requirements. NOTE: NO alterations or repairs to structural elements should be made without the assistance of a qualified engineer and the concurrence of the Illinois Department of Natural Resources, Office of Water Resources.

6.1 ROUTINE MAINTENANCE

Debris: Remove all trash, logs and other debris which may obstruct flow into the principal spillway pipes and drop inlets, or block passage from their discharge channels.

Rip Rap: Replace rip rap as needed to provide adequate protection against erosion.

Vegetation Control:

1. Maintain a good grass cover on the embankment by seeding, fertilizing and mulching areas which are refilled, barren, or thinly vegetated. Seeding mixtures used for maintenance reseeding shall result in a cover compatible with adjacent cover. The seeding mixture specified at the time of the dam's construction was IDOT Standard Specifications Class 1A (Salt Tolerant Lawn Mixture) as follows:

   IDOT Class 1A Salt Tolerant Lawn Mixture
   Bluegrass .....60 lb/acre
   Perennial Ryegrass .....20 lb/acre
   Dawsons Red Fescue.....20 lb/acre
   Scaldis Hard Fescue .....20 lb/acre
   Fults Salt Grass .....60 lb/acre

2. Grassed areas such as the embankment and the areas beyond the embankment toes for a distance of at least 20 ft should be mowed at least twice annually or at any time the height of the grass exceeds 1 foot.

3. All erosion areas will be filled and compacted, reseeded, fertilized and mulched to establish a thick erosion resistant cover.

4. Remove all trees and brush growing on the dam embankment to prevent development of a root system which could provide seepage paths. Herbicides utilized for tree and brush control are discussed in Appendix D.

5. Keep the riprap basin clear of weeds, brush, and trees.

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6. Remove all trees and brush growing on the dam embankment to prevent development of a root system which could provide seepage paths. Herbicides utilized for tree and brush control are discussed in Appendix D.

7. Clear all brush and trees to a distance of approximately 20 ft beyond both toes of the dam.

Animal Damage: Fill rodent holes and other animal burrows with compacted clayey dirt and reseed. If rodents become a nuisance, an effective rodent control program as approved by the Illinois Department of Natural Resources District Wildlife Biologist should be implemented.

Signs: All warning sings shall be maintained (repaired, painted, or replaced) as needed.

6.2 EROSION AND DUST CONTROL

As stacking operations commence, the dewatered gypsum is expected to form a thin layer of "crust" which will resist erosion and prevent the migration of fugitive dust from the gypsum stack. (This expectation is based on a case study of flue-gas desulfurization by-product (gypsum) stacking by the Electric Power Research Institute entitled Evaluation of Chiyoda Thoroughbred 121 FGD Process and Gypsum Stacking, Volume 3 Addendum, dated March 1981.) Should a protective layer of crust fail to form or fail to provide adequate erosion and dust control, appropriate measures for addressing these concerns will be implemented.

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APPENDIX A
LOCATION MAP

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APPENDIX B
PERTINENT DATA ABOUT THE DAMS

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Gypsum Stack Dam

DAM		
Top of Dam Elevation	620	ft
Invert of Reservoir Elevation	585	ft
Reservoir Area at Invert	0.7	acres
Reservoir Area at Top of Dam	31.6	acres
Total Reservoir Volume	773.2	acre-ft
Total Watershed Area	31.6	acres

TRANSFER CHANNEL		
Bottom Width	16.00	ft
Top Width	16.00	ft
Depth	6.00	ft
Upstream Invert	614.00	ft
Downstream Invert	609.00	ft
Weir Elevation	616.00	ft
Weir Length	16.00	ft

PERIMETER DITCH		
Bottom Width	5.00	ft
Top Width	44.00	ft
Depth	6.00	ft
Outer Side Slope	3.5:1	H:V
Inner Side Slope	3:1	H:V
Upstream Invert	615.16	ft
Downstream Invert	614.00	ft
Ditch slope	0.00050	ft/ft
Bank Full Cross-sectional Area	147.00	sf
Length of Each Ditch (Centerline)	2322.00	ft
Bank Full Volume of Each Ditch	7.84	acre-ft
Total Ditch length (Centerline)	4644.00	ft
Total Ditch Bank Full Volume	15.67	acre-ft

0.5 PMF STORM EVENT		
Critical Storm Duration	24	hours
Peak Inflow	374.7	cfs
Peak Outflow	190	cfs
Total Inflow	54.88	acre-ft
Total Outflow	54.91	acre-ft
Peak Storage	9.46	acre-ft
Peak WSEL (HEC-HMS)	618.5	ft
Peak WSEL (HEC-RAS)	618.31	ft
Freeboard over Max WSEL	1.5	ft
Wave Runup/Wind Setup	1.48	ft

100-YR STORM EVENT		
Critical Storm Duration	0.5	hours
Peak Inflow	274.7	cfs
Peak Outflow	91.4	cfs
Total Inflow	21.08	acre-ft
Total Outflow	21.12	acre-ft
Peak Storage	6.31	acre-ft
Computed WSEL (HEC-HMS)	617.54	ft
Computed WSEL (HEC-RAS)	617.66	ft
Freeboard over Max WSEL	2.34	ft
Wave Runup/Wind Setup	1.48	ft

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Recycle Pond Dam

DAM		
Top of Dam Elevation	615	ft
Invert of Reservoir Elevation	592	ft
Reservoir Area at Invert	4.87	acres
Reservoir Area at Top of Dam	8.21	acres
Total Reservoir Volume	150.4	acre-ft
Total Watershed Area	39.81	acres

SPILLWAY		
Pipe Length	60	ft
Pipe Diameter (Inside)	42	inch
Number of Pipes	4	
Pipe Slope	0.03333	Ft/ft
Upstream Invert	610	ft
Downstream Invert	607	ft
Entrance Loss Coefficient	0.9	

0.5 PMF Storm Event - Starting WSEL @ 610		
Critical Storm Duration	24	hours
Peak Inflow	252.4	cfs
Peak Outflow	123.6	cfs
Total Inflow	65.96	acre-ft
Total Outflow	62.88	acre-ft
Peak Storage	135.79	acre-ft
Peak WSEL (HEC-HMS)	612.99	ft
Peak WSEL (HEC-RAS)	613.00	ft
Freeboard over Peak WSEL	2.01	ft
Wave Runup/Wind Setup	1.77	ft
Peak Spillway Outlet Velocity	12.73	fps

100-yr Storm Event - Starting WSEL @ 610		
Critical Storm Duration	2	hours
Peak Inflow	107.1	cfs
Peak Outflow	29.5	cfs
Total Inflow	27.22	acre-ft
Total Outflow	24.15	acre-ft
Peak Storage	125.25	acre-ft
Peak WSEL (HEC-HMS)	611.37	ft
Computed WSEL (HEC-RAS)	611.37	ft
Freeboard over Peak WSEL	3.63	ft
Wave Runup/Wind Setup	1.77	ft
Peak Spillway Outlet Velocity	9.92	fps

0.5 PMF Storm Event - Starting WSEL @ 599.5		
Critical Storm Duration	24	hours
Peak Inflow	252.1	cfs
Peak Outflow	0	cfs
Total Inflow	65.96	acre-ft
Total Outflow	0	acre-ft
Peak Storage	114.47	acre-ft
Peak WSEL (HEC-HMS)	609.70	ft
Freeboard over Peak WSEL	5.3	ft
Wave Runup/Wind Setup	1.77	ft

100-yr Storm Event - Starting WSEL @ 604		
Critical Storm Duration	24	hours
Peak Inflow	32.3	cfs
Peak Outflow	0	cfs
Total Inflow	36.46	acre-ft
Total Outflow	0	acre-ft
Peak Storage	114.07	acre-ft
Peak WSEL (HEC-HMS)	609.64	ft
Freeboard over Peak WSEL	5.36	ft
Wave Runup/Wind Setup	1.77	ft

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APPENDIX C
OPERATION AND MAINTENANCE INSPECTION CHECKLIST

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OPERATION AND MAINTENANCE INSPECTION CHECKLIST

Dam Name (circle one): Gypsum Stack Dam Recycle Pond Dam

Date: _____ Time: _____

Name of Inspector: _____

Reservoir Elevation: _____ ft

ITEM	NO	YES	IF YES
Record Piezometer Readings for Gypsum Stack. Are any readings above the critical level? (see section 4.8.2 of O&M)			Contact Engineering Manager and notify Hanson Professional Services
Note the condition of the Piezometers on the Gypsum Stack. Any damage?			Contact Engineering Manager
Deep Surface Cracks			Contact Engineering Manager
Slump or Slide on the upstream or downstream face			Contact Engineering Manager
Erosion from runoff, wave action or traffic			Repair and stabilize
Wet areas on the gypsum or earthen embankment indicating seepage			Contact Engineering Manager
Flows of cloudy water from seepage areas on the gypsum or earthen embankment			Contact Engineering Manager
Uneven settlement			Contact Engineering Manager
Trees, brush or burrow holes on the embankment or in the riprap basin			Remove trees and brush, fill holes
Transfer channel or Spillway pipes blocked			Clear immediately
Damage to stop logs			Repair or replace
Tear in Liner			Repair and schedule engineer inspection
Settlement or displacement of Gypsum Stack siphon decant pipes or outlets			Schedule engineer inspection
Settlement or displacement of Gypsum Stack fixed decant pipes or outlets			Schedule engineer inspection
Discharge from Gypsum Stack LD/LCRS Drains?			Record discharge rate for each outlet (time to fill bucket)
Discharge from Gypsum Stack Ring Drains?			Record discharge rate for each outlet (time to fill bucket)
Gypsum Stack Perimeter Ditch erosion			Schedule repair
Problems with Recycle Pond decant			Contact Engineering Manager
Height of grass (inches		inches	If more than 1 foot, schedule mowing

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APPENDIX D
ENGINEERING INSPECTION FORM

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Dam Inspection Report

Name of Dam IPRG Duck Creek Gypsum Stack & Recycle Pond Dams Dam ID No. IL50573 & IL50574

Permit Number DS2007125 Class of Dam III

Location NW 1/4 Section 18 Township 6N Range 5E 4th P.M.

Owner

Name Telephone Number (Day)

Street Telephone Number (Night)

City Zip Code County Fulton

Type of Dam Homogeneous earthen embankment (gypsum stack is homogeneous gypsum embankment)

Type of Spillway

Date(s) Inspected

Weather When Inspected

Temperature When Inspected

Pool Elevation When Inspected

Tailwater Elevation When Inspected

Inspection Personnel:

Name Title

Name Title

Name Title

Name Title

Professional Engineer's Seal

The Department of Natural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5 (1994 State Bar Edition). Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 702.160 of the "Rules for Construction and Maintenance of Dams". This form has been approved by the State Forms Management Center.

R000847

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CONDITION CODES

EC	**-**	**Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; such as, pool draw down, work stoppage, plant stoppage.**
NE	**-**	**No evidence of a problem**
GC	**-**	**Good condition**
MM	**-**	**Item needing minor maintenance and/or repairs within the year, the safety or integrity of the item is not yet imperiled**
IM	**-**	**Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should be completed within 1 month.**
EC	**-**	**Emergency condition which if not immediately repaired or other appropriate measures taken could lead to failure of the dam**
OB	**-**	**Condition requires regular observation to ensure that the condition does not become worse**
NA	**-**	**Not applicable to this dam**
NI	**-**	**Not inspected - list the reason for non-inspection under deficiencies**
EC	**-**	**Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; such as, pool draw down, work stoppage, plant stoppage.**

R000848

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GYPSUM STACK - EARTH EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of Outer Embankment Slopes			
Upstream Face Slope Protection (HDPE Liner)			
Seepage			
Animal Damage			

R000849

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GYPSUM STACK - EARTH EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Vegetative Cover			

R000850

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GYPSUM STACK - GYPSUM EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of **Outside** Embankment Slopes			
Sloughing or Erosion of **Inside** Embankment Slopes			
Seepage			
Animal Damage			

R000851

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GYPSUM STACK - GYPSUM EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Condition of Piezometers on Gypsum Stack			
Piezometer Readings on Gypsum Stack Above Critical Level?			

R000852

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GYPSUM STACK – PERIMETER DITCH

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Ditch Geometry (15 ft bottom width, 3:1 slopes, 8-9 ft depth)			
Concrete Apron at ring drain outlets			
Ring Drain Discharge Pipes			
Stilling Wells for Fixed Decants			

R000853

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TRANSFER CHANNEL - (between gypsum stack and recycle pond)

[ ] Drop Inlet Structure [X] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Debris			
Side Slope Stability			
HPDE Liner			
HDPE Liner Welds			
Stop Logs			
Differential Settlement			

R000854

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RECYCLE POND - EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of Outer Embankment Slopes			
Upstream Face Slope Protection (HDPE Liner)			
Seepage			
Animal Damage			

R000855

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RECYCLE POND - EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Vegetative Cover			

R000856

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RECYCLE POND - PRINCIPAL SPILLWAY (Left, Looking Downstream)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

R000857

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RECYCLE POND - PRINCIPAL SPILLWAY (Left, Looking Downstream)

(Continued)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

R000858

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RECYCLE POND - PRINCIPAL SPILLWAY (Center)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

R000859

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RECYCLE POND - PRINCIPAL SPILLWAY (Center)

(Continued)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

R000860

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RECYCLE POND - PRINCIPAL SPILLWAY (Right, Looking Downstream)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

R000861

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RECYCLE POND - PRINCIPAL SPILLWAY (Right, Looking Downstream)

(Continued)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

R000862

RECYCLE POND - ENERGY DISSIPATOR

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[X] Principal Spillway [ ] Outlet Works Type: Riprap Basin

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Riprap			
Outlet Channel			
Debris			

R000863

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RECYCLE POND - DECANT STRUCTURE

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment			
Connection to Bollard			
Debris in Inlets			
Condition of Pipe			
Condition of Liner Beneath Pipe			
Connection to Ballast			
Connection of Pipe Boot to Liner			

R000864

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RECYCLE POND - DECANT STRUCTURE

(continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Seepage Around or into Conduit			

R000865

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RECYCLE POND – WATER LEVEL GAGE STRUCTURE

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE

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APPENDIX E
HERBICIDES

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HERBICIDES

Site personnel should check with the Illinois Department of Natural Resources, Regional Fisheries Biologist and the Regional Wildlife Biologist before using any herbicide. Read the product label prior to use and follow the use directions and precautions accordingly.

On March 1, 1979 the U.S. Environmental Protection Agency (U.S.E.P.A.) halted the use of the herbicide 2, 4, 5-T in parks and recreation areas. The use of silvex (2, 4, 5-TP) around water has also been banned.

The Agronomy Department at the University of Illinois and the Aquatic Biology Section of the Department of Natural Resources, Office of Scientific Research and Analysis indicate that the herbicides containing the 2, 4-D or 2, 4-DP are legal for use in parks and recreation areas and effective for controlling brush and woody growth. Some examples of approved herbicides are:

1. Tordon RTU by DOW Chemical. (Can be obtained with blue dye.)
2. WEEDONE 170 by Union Carbide
3. WEEDONE, 2, 4-DP by Union Carbide
4. A 1% to 2% solution of ROUNDUP
5. Garlon by DOW Chemical
6. Banvel by Sandoz

Your distributor may carry brand name herbicides other than those listed above. Be certain that the product does not contain the ingredients 2, 4, 5-T or 2, 4, 5-TP. An example of an unacceptable product is ESTERON 2, 4, 5 by DOW Chemical.

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ATTACHMENT C

Electronic Filing: Received, Clerk's Office 06/20/2024

Duck Creek Power Plant – GMF Pond System's Chemical Constituents

In accordance with 35 I.A.C. 845.230(d)(2)(C), IPRG is submitting available/existing analyses of "the chemical constituents of all waste streams, chemical additives and sorbent materials entering or contained in" the CCR impoundments, GMF Pond System.

A list of the chemical constituents contained in the CCR surface impoundment and gypsum can be found in Appendix A. As determined through antidegradation studies, this list contains chemical constituents found in the surface free liquid. A list of chemical additives, sorbent materials and waste streams that were submitted in the facility's NPDES permit applications to IEPA within the past ten years at a minimum and/or listed in the current NPDES permit (IL0055620) can be found in Appendix B. For the chemical additives used, IPRG is also including in Appendix C the safety data sheet's Section 3 Composition/Information on Ingredients.

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Appendix A: Chemical Constituents Contained in the GMF Pond System

Pollutant	GMF Pond System			
	Surface Free Liquids Average Concentration	Units	Spray Dryer Absorber/Gypsum Concentration**	Units
Aluminum			236	mg/kg
Ammonia	430	mg/L		mg/kg
Antimony			< 0.79	mg/kg
Arsenic			< 0.79	mg/kg
Barium			7.9	mg/kg
Beryllium			< 0.32	mg/kg
Boron	71	mg/L	72.3	mg/kg
Cadmium			< 0.13	mg/kg
Calcium			243,000	mg/kg
Chloride	3,500	mg/L		mg/kg
Chromium			4.8	mg/kg
Chromium *			4.8	mg/kg
Cobalt			< 0.79	mg/kg
Copper			< 1.6	mg/kg
Fluoride			16	mg/kg
Iron			570	mg/kg
Lead			0.47	mg/kg
Lithium			< 0.79	mg/kg
Magnesium			2,170	mg/kg
Manganese			73.8	mg/kg
Mercury	0.0018	mg/L	0.073	mg/kg
Molybdenum			< 0.79	mg/kg
Nickel			1.2	mg/kg
pH			7.2	SU
Potassium			121	mg/kg
Selenium			8.8	mg/kg
Silver			< 0.79	mg/kg
Sodium			305	mg/kg
Sulfate	4,300	mg/L		mg/kg
Thallium			< 0.16	mg/kg
TDS	12,000	mg/L		mg/kg
TSS	30	mg/L		mg/kg
Vanadium			< 1.6	mg/kg
Zinc			< 7.9	mg/kg

*Chromium screened as both Total Chromium and Hexavalent Chromium to be conservative.

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Appendix B: List of Chemical Additives, Waste Streams and Sorbent Materials

Chemical Additives
Nalco – 71D5 Plus (Anti-Foam)
Activated Carbon (100%)

Waste Streams and Sorbent Materials*
Gypsum Slurry

*No sorbent materials

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Appendix C: SDS Section 3 Composition/Information on Ingredients

SAFETY DATA SHEET

NALCO® 71D5 PLUS

Section: 3. COMPOSITION/INFORMATION ON INGREDIENTS

Pure substance/mixture : Mixture

Chemical Name	CAS-No.	Concentration: (%)
Straight Run Middle Distillate	64741-44-2	30 - 60
Hydrotreated Light Distillate	64742-47-8	10 - 30
Polypropylene Glycol	25322-69-4	5 - 10
1-Octanol	111-87-5	1 - 5
Fatty Alkyl Polyglycol	Proprietary	1 - 5
Aliphatic alcohol	Proprietary	1 - 5
Paraffin Wax	8002-74-2	1 - 5

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DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	FGD Gypsum
Synonyms:	Gypsum, calcium sulfate dihydrate, calcium sulphate dihydrate, gesso, alabaster, plaster of Paris.
Formula:	UVCB Substance

1.2 Relevant Identified Uses of the Substance or Mixture and Uses Advices Against

Relevant Identified Uses:	Component of wallboard, concrete, roofing material, bricks, cement kiln feed, agricultural amendment.
Uses Advised Against:	None known.

1.3 Details of the Supplier of the SDS

Manufacturer/Supplier:	Dynegy, Inc.
Street Address:	601 Travis Street, Suite 1400
City, State and Zip Code:	Houston, TX 77002
Customer Service Telephone:	800-633-4704

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Section 2
Hazards Identification

2.1 Classification of the Substance

GHS Classification(s) according to OSHA Hazard Communication Standard (29 CFR 1910.1200):

- STOT-SE Category 3 (Respiratory Irritation)
- STOT-RE Category 1 (Lungs)
- Carcinogen Category 1A

2.2 Label Elements

Labelling according to 29 CFR 1910.1200 Appendices A, B and C*	
Hazard Pictogram(s):	
Signal word:	**DANGER**
Hazard Statement(s):	*May cause respiratory irritation.* *Causes damage to lungs after repeated/prolonged exposure via inhalation.* *May cause cancer of the lungs.*
Precautionary Statement(s):	*Obtain special instructions before use.* *Do not handle until all safety precautions have been read and understood.* *Do not breathe dust.* *Wash hands thoroughly after handling.* *Do not eat, drink or smoke when using this product.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Do not eat drink or smoke when using this product.* *Use outdoors or in a well-ventilated area.* *If inhaled: Remove to fresh air and keep comfortable for breathing.* *Get medical advice/attention if you feel unwell.* *Store in a secure area.* *Dispose of product in accordance with local/national regulations.*

The following elements may be present in trace amounts as oxides: aluminum, calcium, iron, magnesium, nickel, phosphorus, potassium, silicon, sulfur, titanium, and vanadium. The exact composition of the gypsum will be dependent on the fuel source and flue additives composed of many constituents.

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2.3 Other Hazards

Listed Carcinogens:

-Respirable Crystalline Silica

IARC: [Yes] **NTP:** [Yes] **OSHA:** [Yes] **Other:** **(ACGIH)** [Yes]

Section 3
Composition/Information on Ingredients

Substance	***CAS No.***	***Percentage (%)***	***GHS Classification***
Calcium sulfate, dihydrate	*10104-14-1*	*90 - 99%*	*STOT – Single Exposure Category 3 (Respiratory Irritation)*
Crystalline Silica	*14808-60-7*	*≥0.1 - 3%*	*STOT – Repeated Exposure Category 1 (Lung)* *Carcinogen, Category 1A*
Silica, crystalline respirable (RCS)	*14808-60-7*	***See Footnote 1***	*STOT – Repeated Exposure Category 1 (Lungs)* *Carcinogen Category 1A*
Fly Ash	*68131-74-8*	*<2%*	*STOT – Single Exposure Category 3 (Respiratory Irritation)*

Footnote 1: *The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen, Category 1A has been assigned.*

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Section 4
First Aid Measures

4.1 Description of First Aid Measures

Inhalation:	If product is inhaled and irritation of the nose or coughing occurs, remove person to fresh air. Get medical advice/attention if respiratory symptoms persist.
Skin Contact:	If skin exposure occurs, wash with soap and water.
Eye Contact:	If product gets into the eye, rinse copiously with water for several minutes. Remove contact lenses, if present and easy to do. Seek medical attention/advice if irritation occurs or persists.
Ingestion:	No specific first aid measures are required.

4.2 Most Important Health Effects, Both Acute and Delayed

Acute Effects: Short-term airborne exposure to FGD gypsum dust may cause respiratory irritation. Direct exposure can dry and irritate the skin and cause dermatitis or eye irritation through mechanical abrasion.

Chronic Effects: Chronic (long-term) exposure to FGD gypsum may cause lung damage from repeated exposure. Prolonged inhalation of dusts containing respirable crystalline silica above certain concentrations may cause lung disease (silicosis) and lung cancer.

4.3 Indication of Any Immediate Medical Attention and Special Treatment Needed

Seek first aid or call a doctor or Poison Control Center if contact with eyes occurs and irritation remains after rinsing. Get medical advice if inhalation occurs and respiratory symptoms persist.

Section 5
Firefighting Measures

5.1 Extinguishing Media

Suitable Extinguishing Media:	Product is not flammable. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Not applicable, the product is not flammable.

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5.2 Special Hazards Arising from the Substance or Mixture

Hazardous Combustion Products:	Above 1450°C (~2600°F), gypsum decomposes to calcium oxide and sulfur dioxide.

5.3 Advice for Firefighters

Special Protective Equipment and Precautions for Firefighters:	As with any fire, wear self-contained breathing apparatus (NIOSH approved or equivalent) and full protective gear.

Section 6
Accidental Release Measures

6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Personal precautions/Protective Equipment:	See Section 8.2.2 Individual Protective Measures. For concentrations exceeding Occupational Exposure Levels (OELs), use a self-contained breathing apparatus (SCBA).
Emergency procedures:	Use scooping, water spraying/flushing/misting or ventilated vacuum cleaning systems to clean up spills. Do not use pressurized air.

6.2 Environmental Precautions

Environmental precautions:	Prevent contamination of drains or waterways and dispose according to local and national regulations.

6.3 Methods and Material for Containment and Cleaning Up

Methods and materials for containment and cleaning up:	Do not use brooms or compressed air to clean surfaces. Use dust collection vacuum and extraction systems. Large spills of dry product should be removed by a vacuum system. Dampened material should be removed by mechanical means and recycled or disposed of according to local and national regulations.

See Sections 8 and 13 for additional information on exposure controls and disposal.

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Section 7
Handling and Storage

7.1 Precautions for Safe Handling

Practice good housekeeping. Use adequate exhaust ventilation, dust collection and/or water mist to maintain airborne dust concentrations below permissible exposure limits (note: respirable crystalline silica dust may be in the air without a visible dust cloud).

Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain and test ventilation and dust collection equipment. In cases of insufficient ventilation, wear a NIOSH approved respirator for silica dust when handling or disposing dust from this product. Avoid contact with skin and eyes. Wash or vacuum clothing that has become dusty. Avoid eating, smoking, or drinking while handling the material.

7.2 Conditions for Safe Storage, Including any Incompatibilities

Minimize dust produced during loading and unloading.

Section 8
Exposure Controls/Personal Protection

8.1 Control Parameters

OCCUPATIONAL EXPOSURE LIMITS					
SUBSTANCE		**OSHA PEL TWA (mg/m^3)**	**NIOSH REL TWA (mg/m^3)**	**ACGIH TLV TWA (mg/m^3)**	**CA - OSHA PEL (mg/m^3)**
Particulates Not Otherwise Regulated	Total	15	15	10	10
	Respirable	5	5	3	5
Respirable Crystalline Silica	Total Respirable	0.05-	0.05	0.025	0.05
Calcium Sulfate, anhydrous (CAS# 7778-18-9)	Total Dust	*	10	10	*
	Respirable	*	5	-	*
Note: In the absence of a CA-PEL, the value for Particulates Not Otherwise Regulated (PNOR) is applied.					

8.2 Exposure Controls

8.2.1 Engineering Controls

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Provide ventilation to maintain the ambient workplace atmosphere below the occupational exposure limit(s). Use general and local exhaust ventilation and dust collection systems as necessary to minimize exposure.

8.2.2 Personal Protective Equipment (PPE)

Respiratory protection:	Wear a NIOSH approved particulate respirator if exposure to airborne particulates is unavoidable and where occupational exposure limits may be exceeded. If airborne exposures are anticipated to exceed applicable PELs or TLVs, a self-contained breathing apparatus or airline respirator is recommended.
Eye and face protection:	If eye contact is possible, wear protective glasses with side shields. Avoid contact lenses.
Hand and skin protection:	Wear gloves and protective clothing. Wash hands with soap and water after contact with material.

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Section 9
Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Property: Value	Property: Value
Appearance (physical state, color, etc.): White or gray cake-like material	**Upper/lower flammability or explosive limits:** Not applicable
Odor: Odorless	**Vapor Pressure (Pa):** Not applicable
Odor threshold: Not applicable	**Vapor Density:** Not applicable
pH (25 °C) (in water): 6 - 8	**Specific gravity or relative density:** 2.0 – 2.9
Melting point/freezing point (°C): 128	**Water Solubility:** 0.1 – 0.3%
Initial boiling point and boiling range (°C): >163	**Partition coefficient: n-octane/water:** Not determined
Flash point (°C): Not determined	**Auto ignition temperature (°C):** Not applicable
Evaporation rate: Not applicable	**Decomposition temperature (°C):** 1450
Flammability (solid, gas): Nonflammable/non-combustible	**Viscosity:** Not applicable

Section 10
Stability and Reactivity

10.1 Reactivity:	Avoid contact with strong acids or oxidizers and diazomethane.
10.2 Chemical stability:	The material is stable under normal use conditions.
10.3 Possibility of hazardous reactions:	The material is a relatively stable, inert material; polymerization will not occur.
10.4 Conditions to avoid:	Product can become airborne in moderate winds. Dry material should be stored in silos. Materials stored out of doors should be covered or maintained in a damp condition.
10.5 Incompatible materials:	Acids, ammonium salts, diazomethane, phosphorus and aluminum metal.
10. 6 Hazardous decomposition products:	None known.

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Section 11
Toxicological Information

11.1 Information on Toxicological Effects

Endpoint	Data
Acute oral toxicity	Oral LD50 > 2000 mg/kg
Acute dermal toxicity	No data.
Acute inhalation toxicity	Inhalation LC50: > 3.26 mg/L
Skin corrosion/irritation	Not irritating or corrosive to skin based on 4-hour, semi-occlusive exposure to rabbits.
Eye damage/irritation	No positive responses in rabbits based upon 24-, 48-, and 72-hour mean scores for corneal opacity, iritis, conjunctival redness/edema.
Respiratory/skin sensitization	Not a respiratory or dermal sensitizer.
Germ cell mutagenicity	Several in vitro and in vivo mutagenicity assays determined that calcium sulfate, dihydrate was non-mutagenic, with and without metabolic activation.
Carcinogenicity	No data on calcium sulfate, dihydrate. Carcinogenic studies were not conducted based on the non-neoplastic effects noted in the oral and inhalation repeated dose studies as well as the negative mutagenicity assays. Respirable crystalline silica has been identified as a carcinogen by NTP, IARC, ACGIH and OSHA.
Reproductive toxicity	No significant developmental or reproductive toxicity were identified in rabbits after exposure to either calcium sulfate, dehydrate or calcium sulfate, dihydrate.
STOT-SE	Acute toxicity testing did not result in direct organ toxicity after a single exposure to calcium sulfate, dihydrate. However, as the form tested was not indicated, FGD gypsum dust may result in mechanical respiratory irritation.
STOT-RE	A repeat dose oral toxicity study (35-45 days) with calcium sulfate, dihydrate conducted using rats reported a NOAEL for males of 100 mg/kg/day on the basis of decreased total protein, albumin, blood urea nitrogen, and creatinine levels observed at the 300 and 1,000 mg/kg/day dose groups. No effects were observed in females. Repeated inhalation exposures to high levels of respirable crystalline silica may result in lung damage (silicosis) and lung cancer.
Aspiration Hazard	Not applicable based on product form.

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Section 12
Ecological Information

12.1 Toxicity

Calcium sulfate (CAS# 7778-18-9) [1]	
Toxicity to Fish	Fathead Minnow (*Pimephales promelas*): Acute, 7-day LC50 > 1,970 mg/L Acute, 96-hour NOEC = 1,470 mg/L
	Rainbow trout (*Oncorhynchus mykiss*): Chronic, 30-day NOEC (survival, growth, reproduction) = 732 mg/L
	Bluegill (*Lepomis macrochirus*): Acute, 96-hour LC50 = 2,890 mg/L
Toxicity to Aquatic Invertebrates	Water Flea (*Ceriodaphnia dubia*): Acute, 96-hour NOEC = 1447.4 mg/L
	Water Flea (*Daphnia magna*): Acute, 48-hour LC50 = 1,970 mg/L Chronic, 21-day NOEC (and 42-day post-hatch): 1,600 mg/L
Toxicity to Aquatic Algae and Plants	Algae (*Navicula seminulum; Nitzschia linearis*): Chronic, 96-hour LC50 and EC50 (growth) = 3,200 mg/L

[1]The aquatic toxicity of sulfate has been shown to be dependent on water hardness, generally decreasing as hardness increases.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

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Section 13
Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status
  - FGD gypsum as well as listed impurities are on the TSCA Inventory.
- California Proposition 65

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:
  - Respirable crystalline silica
- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Gypsum; calcium sulfate; calcium sulfate dihydrate	7778-18-9 or 10101-41-4	Yes	Yes	Yes	No
Calcium carbonate	1317-65-3	Yes	Yes	Yes	No
Silica-crystalline (SiO2), quartz	14808-60-7	Yes	Yes	Yes	No

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 27, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency
- FGD: Flue Gas Desulfurization
- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration estimated to result in the mortality of 50% of an animal population
- LD50: Dose estimated to result in the mortality of 50% of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey

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- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	1*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
*** Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

DISCLAIMER:

This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

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ATTACHMENT D

Electronic Filing: Received, Clerk's Office 06/20/2024

Memorandum

BURNS McDONNELL

Date: 25 October 2021

Subject: 35 Ill. Admin. Code Part 845 - Fault Area Location Demonstration for GMF Pond at Duck Creek Power Plant

Illinois Power resources Generating, LLC operates the coal-fired Duck Creek Power Plant located in Fulton County, Illinois. The Duck Creek GMF Pond is an existing surface impoundment storing coal combustion residuals (CCR). The requirements for the Duck Creek GMF Pond are found in 35 Ill. Admin. Code (I.A.C.) 845 (Part 845).

This memorandum addresses the requirements of Section 845.320 Fault Areas, which states:

Section 845.320 Fault Areas

a) *Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR surface impoundment.*

b) *The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).*

Pursuant to Section 845.210(d)(2), for existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas), provided that the previously completed assessments meet the applicable requirements of those Sections.

The previous fault area demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.62. The requirements described in 40 C.F.R. § 257.62 are nearly identical to the requirements contained in I.A.C. Section 845.320. Pursuant to Section 845.210(d)(2), a certification is not required for this demonstration. The previously completed fault area demonstration is included in Attachment D.

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HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

MEMORANDUM

16 October 2018
File No. 129788

SUBJECT: Location Restriction Demonstration - Fault Areas
Duck Creek Power Station
GMF Pond
Canton, Illinois

Illinois Power Resources Generating, LLC operates the coal-fired Duck Creek Power Station (Plant) located near Canton, Illinois. The GMF Pond (Unit) is an existing coal combustion residuals (CCR) surface impoundment. This demonstration addresses the requirements of 40 CFR §257.62 *(Fault Areas)* of the U.S. Environmental Protection Agency's (EPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21,302 (Apr. 17, 2015) (promulgating 40 CFR §257.62); 83 Fed. Reg. 36,435 (July 30, 2018) (amending 40 CFR §257.62).

§257.62(a): New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit.

A review of available data from the U.S. Geologic Survey, the Illinois State Geological Survey, and other available information was completed for this demonstration. The nearest known mapped fault is the Sicily Fault, which is located approximately 66 miles southeast and the timeframe of the most recent activity on this fault is not known. Based on the available published geologic data and information reviewed, there are no active faults or fault damage zones that have had displacement in Holocene time reported or indicated within 200 feet of the Unit.

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§257.62(b): The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

I, Steven F. Putrich, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the demonstration that the CCR Unit is not located within 60 meters (200 feet) of the outermost damage zone of a fault that has had a displacement in Holocene time as included in the CCR Rule Location Restrictions Evaluation memorandum dated 12 October 2018 meets the requirements of 40 CFR §257.62(a).

Signed: _____
Consulting Engineer

Print Name:	Steven F. Putrich
Illinois License No.:	62048779
Title:	Vice President
Company:	Haley & Aldrich, Inc.

Professional Engineer's Seal:



Duck Creek

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Memorandum

BURNS McDONNELL

Date: 25 October 2021

Subject: 35 Ill. Admin. Code Part 845 - Placement Above the Uppermost Aquifer Location Demonstration for GMF Pond at Duck Creek Power Plant

Illinois Power resources Generating, LLC operates the coal-fired Duck Creek Power Plant located in Fulton County, Illinois. The Duck Creek GMF Pond is an existing surface impoundment storing coal combustion residuals (CCR). The requirements for the Duck Creek GMF Pond are found in 35 Ill. Admin. Code (I.A.C.) 845 (Part 845).

This memorandum addresses the requirements of Section 845.300 Placement Above the Uppermost Aquifer, which states:

Section 845.300 Placement Above the Uppermost Aquifer

a) *Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments must, be constructed with a base that is located at least 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR surface impoundment and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table).*

b) *The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).*

Pursuant to Section 845.210(d)(2), for existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas), provided that the previously completed assessments meet the applicable requirements of those Sections.

The previous upper aquifer demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.60. The requirements described in 40 C.F.R. § 257.60 are nearly identical to the requirements contained in I.A.C. Section 845.300. Pursuant to Section 845.210(d)(2), a certification is not required for this demonstration. The previously completed upper aquifer demonstration is included in Attachment D.

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HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

MEMORANDUM

16 October 2018
File No. 129788

SUBJECT: Location Restriction Demonstration – Placement Above Uppermost Aquifer
Duck Creek Power Station
GMF Pond
Canton, Illinois

Illinois Power Resources Generating, LLC operates the coal-fired Duck Creek Power Station (Plant) located near Canton, Illinois. The GMF Pond (Unit) is an existing coal combustion residuals (CCR) surface impoundment. This demonstration addresses the requirements of 40 CFR §257.60 *(Placement above the uppermost aquifer)* of the U.S. Environmental Protection Agency's (EPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21,302 (Apr. 17, 2015) (promulgating 40 CFR §257.60); 83 Fed. Reg. 36,435 (July 30, 2018) (amending 40 CFR §257.60).

§257.60(a): New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table). The owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer.

Haley & Aldrich reviewed available information provided by Vistra including historic record drawings and design drawings and based on review and evaluation of the information provided, the results do not demonstrate compliance with the requirements of 40 CFR §257.60(a).

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§257.60(b): The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

I, Steven F. Putrich, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify that the above-referenced CCR Unit does not meet the requirements of 40 CFR §257.60(a).

Signed: _____
Consulting Engineer

Print Name:	Steven F. Putrich
Illinois License No.:	62048779
Title:	Vice President
Company:	Haley & Aldrich, Inc.

Professional Engineer's Seal:



Duck Creek

Electronic Filing: Received, Clerk's Office 06/20/2024

Memorandum

BURNS McDONNELL

Date: 25 October 2021

Subject: 35 Ill. Admin. Code Part 845 – Seismic Impact Zone Location Demonstration for GMF Pond at Duck Creek Power Plant

Illinois Power resources Generating, LLC operates the coal-fired Duck Creek Power Plant located in Fulton County, Illinois. The Duck Creek GMF Pond is an existing surface impoundment storing coal combustion residuals (CCR). The requirements for the Duck Creek GMF Pond are found in 35 Ill. Admin. Code (I.A.C.) 845 (Part 845).

This memorandum addresses the requirements of Section 845.330 Seismic Impact Zone, which states.

Section 845.330 Seismic Impact Zones

a) *Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments must not be located in seismic impact zones unless the owner or operator demonstrates that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.*

b) *The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).*

Pursuant to Section 845.210(d)(2), for existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas), provided that the previously completed assessments meet the applicable requirements of those Sections.

The previous seismic impact zone demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.63. The requirements described in 40 C.F.R. § 257.63 are nearly identical to the requirements contained in I.A.C. Section 845.330. Pursuant to Section 845.210(d)(2), a certification is not required for this demonstration. The previously completed seismic impact zone demonstration is included in Attachment D.

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HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

MEMORANDUM

16 October 2018
File No. 129788

SUBJECT: Location Restriction Demonstration – Seismic Impact Zone
Duck Creek Power Station
GMF Pond
Canton, Illinois

Illinois Power Resources Generating, LLC operates the coal-fired Duck Creek Power Station (Plant) located near Canton, Illinois. The GMF Pond (Unit) is an existing coal combustion residuals (CCR) surface impoundment. This demonstration addresses the requirements of 40 CFR §257.63 *(Seismic Impact Zones)* of the U.S. Environmental Protection Agency's (EPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21,302 (Apr. 17, 2015) (promulgating 40 CFR §257.63); 83 Fed. Reg. 36,435 (July 30, 2018) (amending 40 CFR §257.63).

§257.63(a): New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of a CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

A Seismic Impact Zone is defined in the CCR Rule (40 CFR §257.63) as "an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 50 years". The 2014 US Geological Survey Hazard Map raw data for the Duck Creek Power Station GMF Pond indicates that the maximum expected horizontal acceleration for 2 percent probability of exceedance in 50 years is 0.06g. Accordingly, the Unit is not located in a seismic impact zone and a demonstration that the structural components have been designed to resist the maximum horizontal acceleration in lithified earth material for the site is not required.

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§257.63(b): The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

I, Steven F. Putrich, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, that the CCR Unit is not located in a seismic impact zone as included in the CCR Rule Location Restrictions Evaluation memorandum dated 12 October 2018 and, therefore, satisfies all requirements of 40 CFR §257.63(a).

Signed: _____
Consulting Engineer

Print Name:	Steven F. Putrich
Illinois License No.:	62048779
Title:	Vice President
Company:	Haley & Aldrich, Inc.

Professional Engineer's Seal:



Duck Creek

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Memorandum

BURNS McDONNELL

Date: 25 October 2021

Subject: 35 Ill. Admin. Code Part 845 – Unstable Areas and Floodplains Location Standard Demonstration for the GMF Pond at Duck Creek Power Plant

Illinois Power Resources Generating, LLC is the owner of the coal-fired Duck Creek Power Plant (Plant) located in Fulton County, Illinois. The GMF Pond is an existing surface impoundment storing coal combustion residuals (CCR). The requirements for the GMF Pond are found in 35 Ill. Admin. Code (I.A.C.) 845 (Part 845).

This certification addresses the requirements of Part 845, Section 845.340 Unstable Areas and Floodplains, which states:

> *Section 845.340 (a): An existing or new CCR surface impoundment, or any lateral expansion of a CCR surface impoundment must not be located in an unstable area unless the owner or operator demonstrates that recognized and generally accepted engineering practices have been incorporated into the design of the CCR surface impoundment to ensure that the integrity of the structural components of the CCR surface impoundment will not be disrupted.*
>
> *Section 845.340 (b): The owner or operator must consider all the following factors, at a minimum, when determining whether an area is unstable: 1) On-site or local soil conditions, including but not limited to liquefaction, that may result in significant differential settling; 2) On-site or local geologic or geomorphologic features; and 3) On-site or local human-made features or events (both surface and subsurface).*

Pursuant to Section 845.210(d)(2), for existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas), provided that the previously completed assessments meet the applicable requirements of those Sections.

The previous unstable area demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.64. The requirements described in 40 C.F.R. § 257.64 are nearly identical to the requirements contained in I.A.C. Section 845.340 (a). Pursuant to Section 845.210(d)(2), a certification is not required for the unstable area demonstration. The previously completed unstable area demonstration meeting the requirements of Section 845.340 (a) is included in Attachment D.

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> *Section 845.340 (c): An existing or new CCR surface impoundment, or any lateral expansion of a CCR surface impoundment, must not be located in a floodplain unless the owner or operator demonstrates that recognized and generally accepted engineering practices have been incorporated into the design of the CCR surface impoundment to ensure that the CCR surface impoundment will not restrict the flow of the base flood , reduce the temporary water storage capacity of a floodplain , or result in washout of CCR, so as to pose a hazard to human life, wildlife, or land or water resources.*

The boundaries of the impoundment were determined by a survey conducted by a professional surveyor licensed in the State of Illinois. The surveyed boundaries were compared to the existing floodplain boundary from the effective FEMA Flood Insurance Rate Map (FIRM) Number 17057C0250E, dated February 4, 2011. The location of the Duck Creek GMF Pond is outside of the FEMA 100-year floodplain, therefore, it was determined that the Duck Creek GMF Pond is not located within the floodplain.

> *Section 845.330 (d): The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsections (a) and (c).*

Pursuant to Section 845.210(d)(2), for existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.340 (Unstable Areas) and demonstrated in Attachment D. Therefore, a new certification is not included for Section 845.340 (a). Certification for Section 845.340 (c) is included below.

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35 Illinois Administration Code Part 845:
Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments
Section 845.340 (c): Certification

I, *Sarah Espinosa*, being a Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that this floodplain demonstration meets the requirements of 35 Ill. Adm. Code 845.340(c).

Sarah Espinosa, P.E.

Printed Name



October 21, 2021

Date

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HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

MEMORANDUM

16 October 2018
File No. 129788

SUBJECT: Location Restriction Demonstration – Unstable Areas
Duck Creek Power Station
GMF Pond
Canton, Illinois

Illinois Power Resources Generating, LLC operates the coal-fired Duck Creek Power Station (Plant) located near Canton, Illinois. The GMF Pond (Unit) is an existing coal combustion residuals (CCR) surface impoundment. This demonstration addresses the requirements of 40 CFR §257.64 *(Unstable Areas)* of the U.S. Environmental Protection Agency's (EPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities.* 80 Fed. Reg. 21,302 (Apr. 17, 2015) (promulgating 40 CFR §257.64); 83 Fed. Reg. 36,435 (July 30, 2018) (amending 40 CFR §257.64).

§257.64(a): An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.

§257.64(b): The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;
(2) On-site or local geologic or geomorphologic features; and
(3) On-site or local human-made features or events (both surface and subsurface).

Determination of compliance with §257.64(b)(1) - Conditions associated with the potential for significant differential settlement due to liquefaction were not identified in the area where the Plant is located. A separate report completed by AECOM entitled "CCR Certification Report: Initial Structural Stability Assessment, Initial Safety Factor Assessment, and Initial Inflow Design Flood Control System Plan for the GMF Pond at Duck Creek Power Station" dated October 2016 concluded that the soils beneath the Unit are not susceptible to liquefaction.

Determination of compliance with §257.64(b)(2) - Based on available United States Geological Survey (USGS) and Illinois State Geological Survey (ISGS) information, karst topography or physiographic features such as sinkholes, vertical shafts, sinking streams, caves, large springs, or blind valleys do not exist at the Plant. To evaluate the susceptibility of landslides, we reviewed readily available USGS and ISGS data. The USGS data indicates that the Plant is in an area of low landslide incidence and ISGS data indicates that there has not been a documented landslide occurrence at the Unit. The ISGS documented

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landslide occurrences near the site are along U.S. Highway 24 and appear to be associated with roadside landslides. Accordingly, it is our opinion that the Unit is not located in an area that has high susceptibility to landslides.

Determination of compliance with §257.64(b)(3) - Finally, there are no documented surface or subsurface anthropogenic activities that would be indicative of creating unstable foundation conditions.

§257.64(c): The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

I, Steven F. Putrich, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the demonstration indicating the CCR Unit is not located in an unstable area as included in the CCR Rule Location Restrictions Evaluation memorandum dated 12 October 2018 meets the requirements of 40 CFR §257.64(a).

Signed: _____
Consulting Engineer

Print Name: Steven F. Putrich
Illinois License No.: 62048779
Title: Vice President
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:



Duck Creek

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Memorandum

BURNS McDONNELL

Date: 25 October 2021

Subject: 35 Ill. Admin. Code Part 845 - Wetland Location Demonstration for GMF Pond at Duck Creek Power Plant

Illinois Power resources Generating, LLC operates the coal-fired Duck Creek Power Plant located in Fulton County, Illinois. The Duck Creek GMF Pond is an existing surface impoundment storing coal combustion residuals (CCR). The requirements for the Duck Creek GMF Pond are found in 35 Ill. Admin. Code (I.A.C.) 845 (Part 845).

This memorandum addresses the requirements of Section 845.310 Wetlands, which states:

Section 845.310 Wetlands

a) *Existing and new CCR surface impoundments, and all lateral expansions of CCR surface impoundments must not be located in wetlands unless the owner or operator demonstrates* [that the requirements listed in 845.310(a)(1) through (5) are met.]

b) *The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of subsection (a).*

Pursuant to Section 845.210(d)(2), for existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas), provided that the previously completed assessments meet the applicable requirements of those Sections.

The previous wetlands demonstration was certified by a qualified professional engineer stating that the demonstration meets the requirements of 40 C.F.R. § 257.61. The requirements described in 40 C.F.R. § 257.61 are nearly identical to the requirements contained in I.A.C. Section 845.310. Pursuant to Section 845.210(d)(2), a certification is not required for this demonstration. The previously completed wetlands demonstration is included in Attachment D.

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HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

MEMORANDUM

16 October 2018
File No. 129788

SUBJECT: Location Restriction Demonstration - Wetland Areas
Duck Creek Power Station
GMF Pond
Canton, Illinois

Illinois Power Resources Generating, LLC operates the coal-fired Duck Creek Power Station (Plant) located near Canton, Illinois. The GMF Pond (Unit) is an existing coal combustion residuals (CCR) surface impoundment. This demonstration addresses the requirements of 40 CFR §257.61 *(Wetlands)* of the U.S. Environmental Protection Agency's (EPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21,302 (Apr. 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36,435 (July 30, 2018) (amending 40 CFR §257.61.

§257.61(a): New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in §232.2 of this chapter, unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section.

Based on a review of the U.S. Fish and Wildlife Service's National Wetland Inventory mapping, 0.5-meter resolution aerial imagery (2016) and the results of on-site field assessments, the Unit is not located in wetlands as defined by 40 CFR §232.2.

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§257.61(b): The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section.

I, Steven F. Putrich, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the CCR Unit is not located in wetlands as included in the CCR Rule Location Restrictions Evaluation memorandum dated 12 October 2018 and, therefore, meets the requirements of 40 CFR §257.61(a).

Signed: _____
Consulting Engineer

Print Name:	Steven F. Putrich
Illinois License No.:	62048779
Title:	Vice President
Company:	Haley & Aldrich, Inc.

Professional Engineer's Seal:



Duck Creek

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ATTACHMENT E

Electronic Filing: Received, Clerk's Office 06/20/2024



Electronic Filing: Received, Clerk's Office 06/20/2024

ATTACHMENT F

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Illinois Power Resources Generating, LLC

DUCK CREEK POWER PLANT

FULTON COUNTY, ILLINOIS

Emergency Action Plan (EAP)

40 C.F.R. § 257.73(a)(3), Ill. Adm. Code 845.520
Coal Combustion Residual (CCR) Impoundment
& Related Facilities

- Ash Pond No. 1 (NID # IL50715) (IEPA # W0578010001-01)
- Ash Pond No. 2 (NID # IL50014) (IEPA # W0578010001-02)
- Bottom Ash Pond (NID # IL50716) (IEPA # W0578010001-03)
- Gypsum Management Facility (GMF) Pond (NID # IL50573) (IEPA # W0578010001-04)

Revision Date: September 16, 2021

Electronic Filing: Received, Clerk's Office 06/20/2024

Qualified Professional Engineer Certification; Emergency Action Plan for the Duck Creek Power Plant Ash Pond 1, Ash Pond 2, Bottom Ash Pond, and GMF Pond

In accordance with 40 C.F.R. § 257.73(a)(3)(iv) and 35 Ill. Adm. Code 845.520(e), the owner or operator of a CCR unit that is required to prepare a written Emergency Action Plan under 40 C.F.R. § 257.73(a)(3) and 35 Ill. Adm. Code 845.520(a) must obtain a certification from a qualified professional engineer stating that the written Emergency Action Plan meets the requirements of 40 C.F.R. § 257.73(a)(3) and 35 Ill. Adm. Code 845.520.

I, Phil Morris, being a Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that:

1. the information contained in this Emergency Action Plan was prepared in accordance with the accepted practice of engineering; and

2. this Emergency Action Plan meets the requirements of 40 C.F.R. § 257.73(a)(3) and 35 Ill. Adm. Code 845.520.

Phil Morris
Senior Director, Corporate Environmental

9/27/21
Date



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DUCK CREEK POWER PLANT
EMERGENCY ACTION PLAN
CCR IMPOUNDMENTS & RELATED FACILITIES

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DUCK CREEK POWER PLANT
EMERGENCY ACTION PLAN
CCR IMPOUNDMENTS & RELATED FACILITIES

1 STATEMENT OF PURPOSE

The Duck Creek Power Plant (Power Plant) is a retired facility located near Canton in Fulton County, Illinois. The location is shown in Figure 1-1. The Power Plant is a coal-fired electricity producing power plant owned and operated by Illinois Power Resources Generating, LLC, a subsidiary of Dynegy Midwest Generation, LLC (DMG). This Emergency Action Plan (EAP) was prepared in accordance with 40 CFR § 257.73(a)(3) and Title 35, Section 845.520 of IEPA Administrative Code and covers the following Coal Combustion Residual (CCR) surface impoundments located at the site:

- Ash Pond No. 1 (Capped/Closed) (NID # IL50715) (IEPA # W0578010001-01)
- Ash Pond No. 2 (Capped/Closed) (NID # IL50014) (IEPA # W0578010001-02)
- Bottom Ash Pond (NID # IL50716) (IEPA # W0578010001-03)
- Gypsum Management Facility (GMF) Pond (NID # IL50573) (IEPA # W0578010001-04)

The locations of these impoundments are shown in Figure 1-2. Section 6 of this EAP includes a description of each impoundment.

The purpose of this Emergency Action Plan (EAP) is to:

1. Safeguard the lives, as well as to reduce property damage, of citizens living within potential downstream flood inundation areas of CCR impoundments and related facilities at the Duck Creek Power Plant.
2. Define the events or circumstances involving the CCR impoundments and related facilities at the Duck Creek Power Plant that represent atypical operating conditions that pose a safety hazard or emergency and how to identify those conditions.
3. Define responsible persons, their responsibilities, and notification procedures in the event of a safety emergency.
4. Provide contact information of emergency responders.
5. Identify emergency actions in the event of a potential or imminent failure of the impoundments.
6. Identify the downstream area that would be affected by failure of the impoundments.
7. Provide for effective facility surveillance, prompt notification to local Emergency Management Agencies, citizen warning and notification responses, and preparation should an emergency occur.

Information provided by Illinois Power Resources Generating, LLC was utilized and relied upon in preparation of this report.

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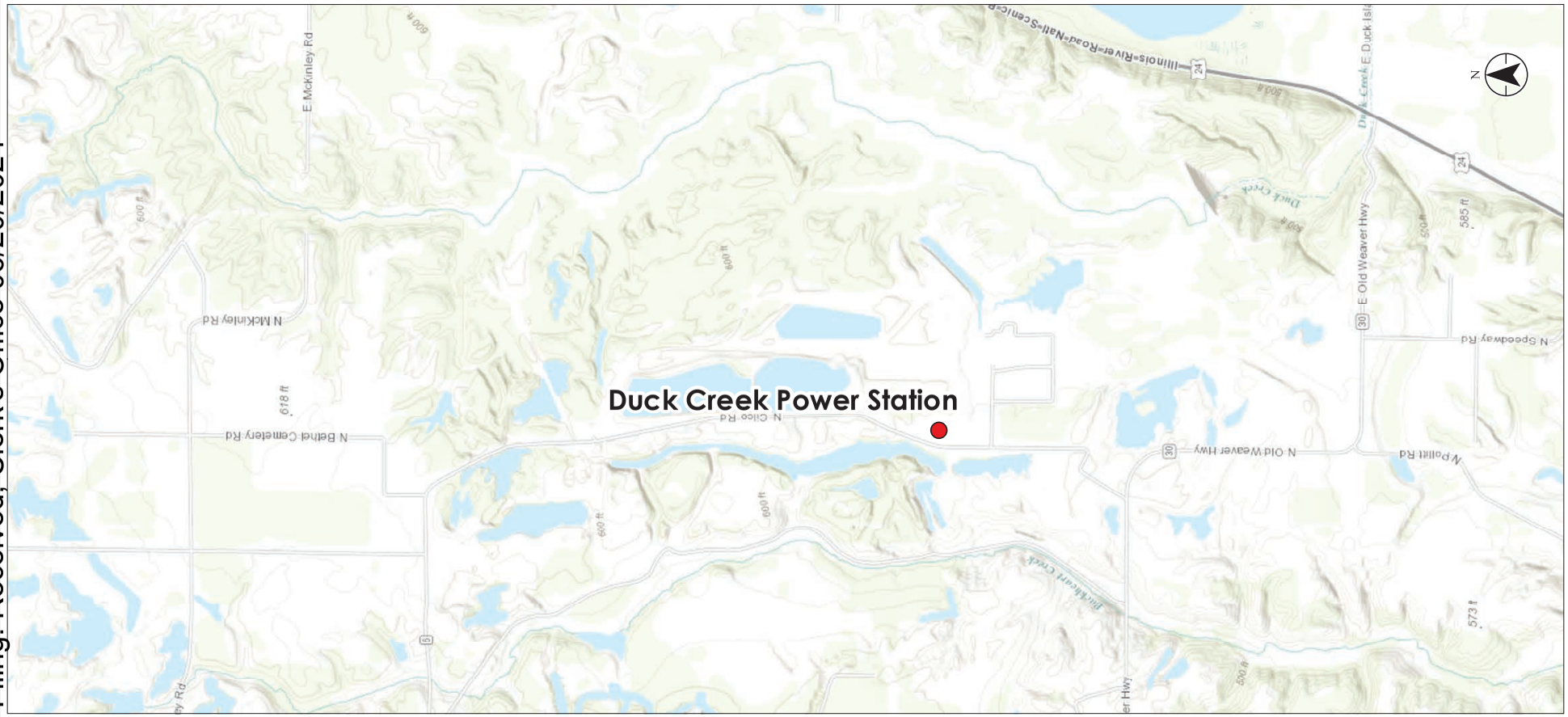



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1:36,000 (At original document size of 11x17)

Stantec DYNEGY

Project Location
Latitude: 40.466181
Longitude: -89.984236
Fulton County, Illinois

175605019
Prepared by CAJ on 2017-03-23
Technical Review by PV on 2017-03-23
Independent Review by NS on 2017-03-23

Client/Project
Duck Creek Power Station
Emergency Action Plan

Figure No.
1-1

Title
Location Map

Notes
1. Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
2. Aerial Source: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User

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Legend

CCR Surface Impoundment Boundary

0 3,000 Feet

1:18,000 (At original document size of 11x17)

Stantec DYNEGY

Project Location 175605019
Latitude: 40.466181
Longitude: -89.984236
Fulton County, Illinois

Prepared by CAJ on 2017-03-16
Technical Review by PV on 2017-03-16
Independent Review by NS on 2017-03-16

Client/Project
Duck Creek Power Station
Emergency Action Plan

Figure No.
1-2

Title
CCR Impoundments

Notes
1. Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
2. Aerial Source: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community2015 NAIP Imagery

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2 COMMUNICATION

To facilitate understanding among everyone involved in implementing this EAP, four response levels are used to identify the condition of an impoundment. These are:

Response Levels:

- **Level 0:** Normal conditions and routine operations, including surveillance and initial investigation of unusual conditions and effects of storm events.
- **Level 1:** Potentially hazardous condition exists, requiring investigation and possible corrective action.
- **Level 2:** Potential failure situation is developing; possible mode of failure is being assessed; corrective measures are underway.
- **Level 3:** Failure is occurring or is imminent, public protective actions are required.

The 4-Step Incident Response Process is outlined in Figure 2-1. This should be used in conjunction with the Notification Flowchart (Figure 2-2) and EAP Decision Tree (Figure 2-3). Section 4 provides guidance tables for determining Response Levels and a table providing emergency actions to be taken given various situations. Table 2-1 lists contact information for the emergency responders.

Figure 2-1. Summary/Sequence of Tasks 4-Step Incident Response Process

Step 1: Detection, Evaluation, and Response Level Determination

Sequence of Tasks:

- Notify EAP Coordinator, Power Plant Management (Director and Engineering), and DMG Dam Safety Manager of unusual condition detected and confer on next steps needed.
- Conduct technical evaluation of conditions as needed.
- Determine Response Level based on evaluation. **(Table 4-1)**
- Reset Response Level as revised evaluations warrant.

Step 2: Notification

Sequence of Tasks:

- Notify authorities, designated personnel, and external response partners of change in Response Level, using the Notification Flowchart. **(Figure 2-2)**
- *Re-notify authorities, designated personnel, and external response partners as Response Level is changed*.

Step 3: Emergency Actions

Sequence of Tasks:

- Perform emergency actions with goal of saving the impoundment and minimizing impacts to life, property, and environment. **(Table 4-3)**
- Take continuous actions to include situation assessment, information sharing, remediation, and public safety advisories or warnings, as warranted.
- *Revise action plan as changes in conditions warrant*.

Step 4: Follow-up

Sequence of Tasks:

- Document conditions and decisions in the Emergency Incident Log.
- Notify authorities, designated personnel, and external response partners that condition is stabilized; limit incident termination declarations to conditions at the site.
- Conduct and document after-action review of incident and response.

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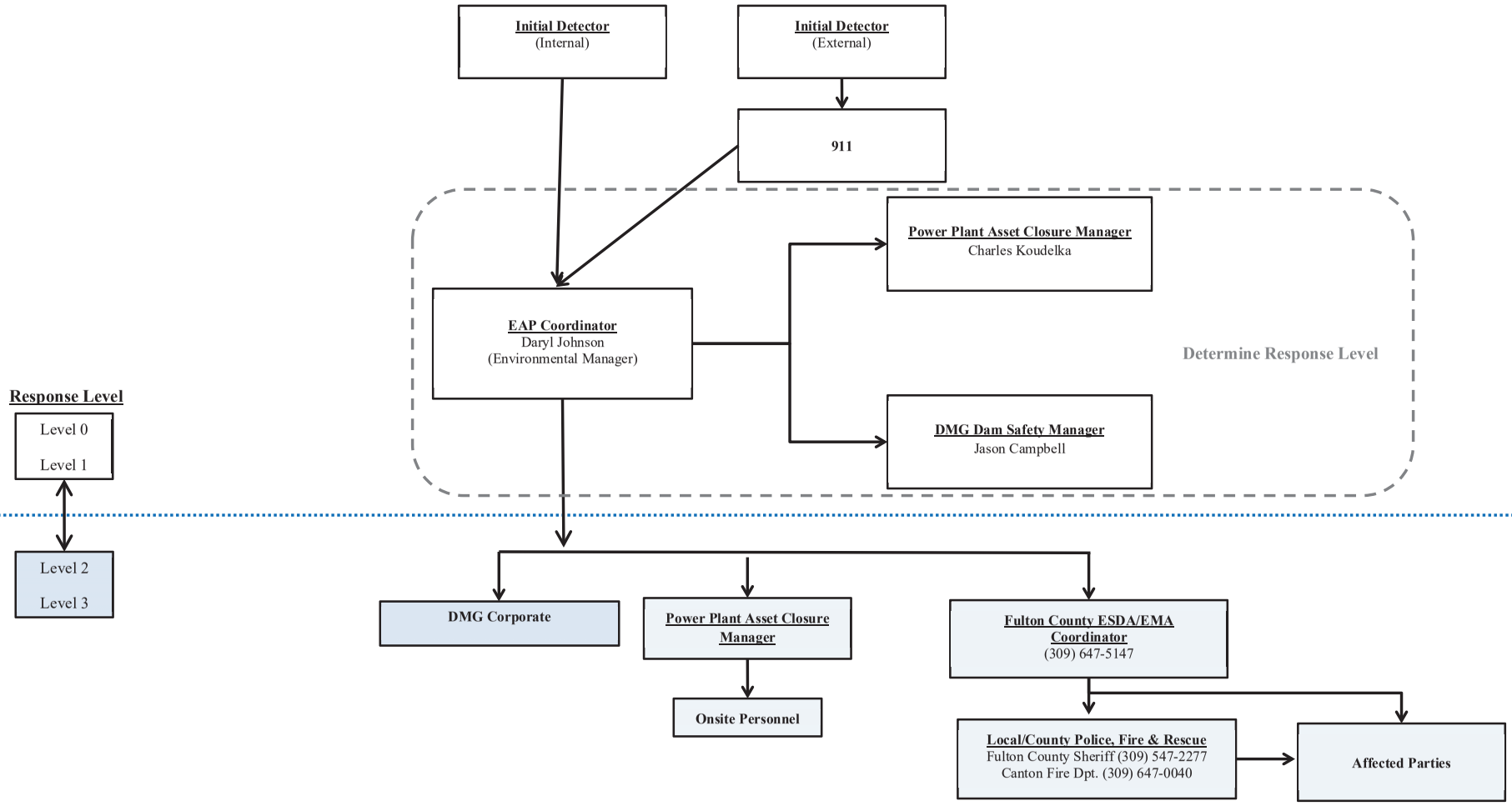
Figure 2-2. Notification Flowchart



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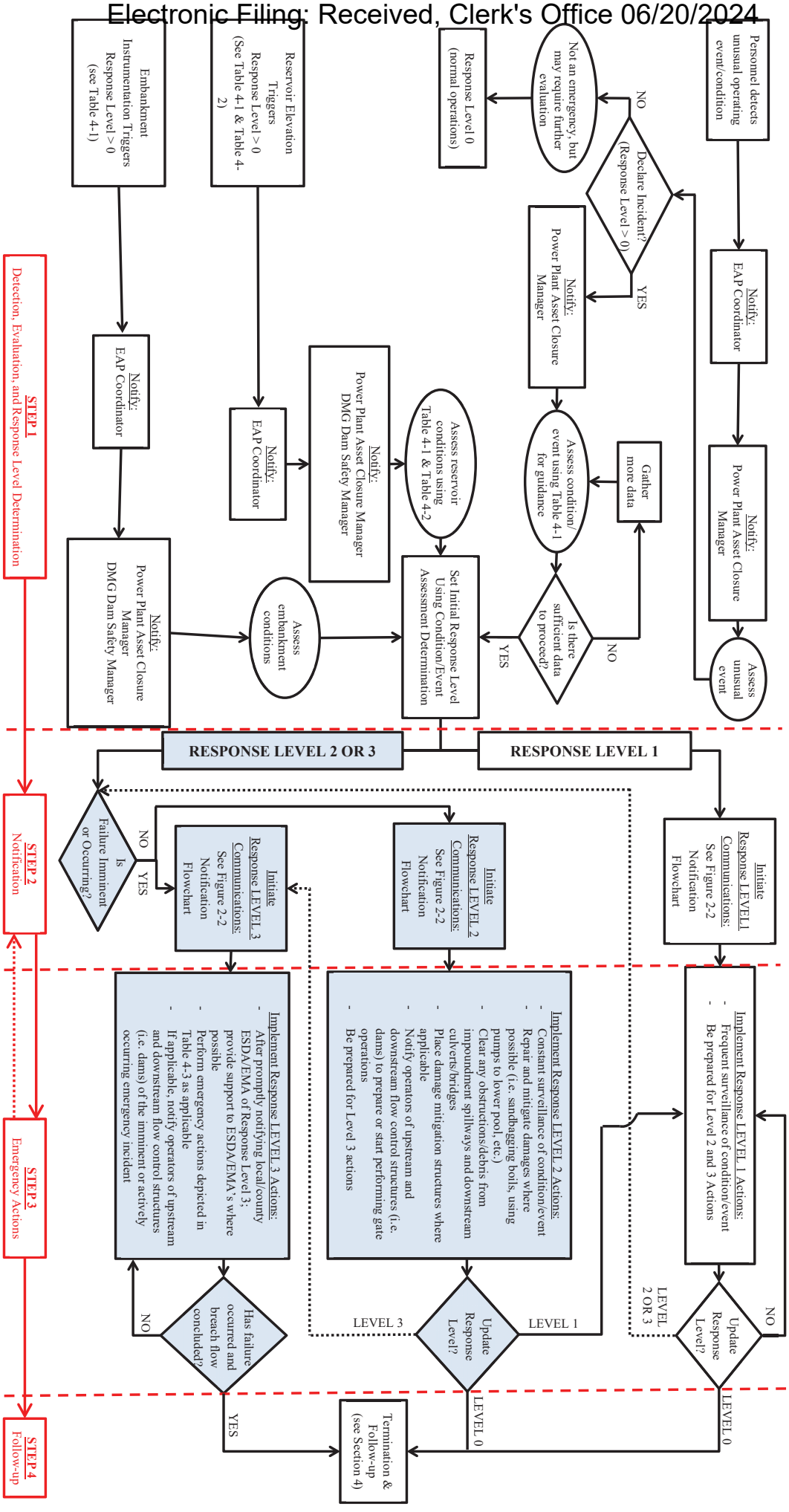

Figure 2-3. EAP Response Process Decision Tree

Note: At any given below, if failure is imminent or actively occurring **CALL 911 IMMEDIATELY** to notify emergency responders and then continue with process afterwards.

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Table 2-1. EAP Emergency Responders

Position / Entity	Contact Information	
Internal Contacts		
Duck Creek Power Plant	**Contact**	
Asset Closure Manager	(903) 577-5207	
EAP Coordinator (Environmental Manager)	(309) 668-3816	
DMG Corporate Operations		
Dam Safety Manager	(618) 792-8488	
External Contacts		
Local/County ESDA/EMA, Police, & Fire	**Phone #**	**Alternate Phone #**
Fulton County Sheriff	(309) 547-2277	911
Fulton County ESDA/EMA	(309) 224-7701	
City of Canton Police Department	(309) 647-5131	
City of Canton Fire Department	(309) 647-0040	
Fulton County Ambulance	(309) 647-5147	
State Emergency Management Agencies & Organizations	**Phone #**	**Alternate Phone #**
IDNR-OWR Dam Safety Section Manager	(217) 782-4427	
Rice Lake State Fish & Wildlife Area	(309) 647-9184	(309) 338-0496
Illinois Conservation Police	(309) 338-1017	
Illinois State Police	(309) 833-4046	

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3 EAP ROLES AND RESPONSIBILITIES

Table 3-1 provides a summary of the EAP roles during an emergency event.

Table 3-1. Summary of EAP Roles

Entity	Role Description
DMG Emergency Response Team (ERT)	**ERT:** DMG personnel responsible for EAP implementation, distribution, updates/maintenance, and training activities. The *ERT* is comprised of the following roles; 1. **DMG Corporate:** DMG corporate entity, committee, team, or position with relevant responsibility for a given generating power plant. 2. **Power Plant Management:** Personnel responsible for day-to-day operation and management of the Power Plant. 3. **Dam Safety Manager:** Personnel that is most knowledgeable about the design and technical operation of facilities at a given power plant. 4. **EAP Coordinator:** Personnel responsible for implementing the EAP and associated activities. **Emergency Event – EAP Responsibilities** 1. Respond to emergencies at the Power Plant. 2. Verify and assess emergency conditions. 3. Notify and coordinate as appropriate with participating emergency services disaster agencies or emergency management agencies (ESDA/EMA's), emergency responders, regulatory agencies, and all other entities involved or affected by this EAP. 4. Take corrective action at the Power Plant. 5. Declare termination of emergencies at the Power Plant.
Fulton County ESDA/EMA	1. Receive Response Level reports from *DMG Corporate* through *EAP Coordinator*. 2. Coordinate emergency response activities with local authorities: police, fire and rescue, etc. 3. Coordinate notification of public as necessary through established channels, which may include door-to-door contact. 4. Coordinate notification activities to affected parties within inundation areas. 5. Evaluate risk to areas beyond the inundation areas, communicate needs to the *DMG Corporate* and/or *EAP Coordinator*, and coordinate aid as appropriate. 6. Responsible for declaring termination of an emergency condition off-site upon receiving notification of an emergency status termination from the *DMG Corporate*. 7. If necessary, coordinate with *State ESDA/EMA*.
Canton Police, Fire, and Rescue	1. Receive alert status reports from the *ERT* or the Fulton County *ESDA/EMA*. 2. If necessary, notify affected parties and general public within inundation areas (see Section 7). 3. Render assistance to Fulton County *ESDA/EMA*, as necessary. 4. Render assistance to *DMG Corporate* and *Power Plant Management*, as necessary.
Fulton County Police, Fire and Rescue, and Emergency Services	1. Receive alert status reports from the *ERT* or the Fulton County *ESDA/EMA*. 2. If necessary, notify affected parties within the inundation area. 3. Provide mutual aid to other affected areas, if requested and able.

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4 EAP RESPONSE

The 4-Step Incident Response Process is shown in Figure 2-1. The Decision Tree shown in Figure 2-3 provides a flowchart for the various elements of the response process. Upon reaching Step 4 of the response process (termination and follow-up), the EAP Coordinator is responsible for notifying the ESDA/EMA's that the condition of the dam/impoundment has been stabilized. The purpose of this section is to provide specific information that can be used during a response. This information is provided in the following tables:

- Table 4-1 provides guidance for determining the response level.
- Table 4-2 provides impoundment pool level trigger elevations.
- Table 4-3 lists emergency actions to be taken depending on the situation.

Table 4-1. Guidance for Determining the Response Level

Event	Situation	Response Level
Spillway flow (See Table 4-2 for relevant elevations)	Primary spillway flow is not causing active erosion and impoundment water surface elevation is below auxiliary spillway crest elevation (if equipped).	Level 0
	Impoundment water surface elevation is at or above auxiliary spillway crest elevation (if equipped). No active erosion caused by spillway flow.	Level 1
	Spillway flow actively causing minor erosion that is not threatening the control section or dam/impoundment stability.	Level 2
	Spillway flow that could result in flooding of people downstream if the reservoir level continues to rise.	Level 2
	Abnormal operation of the spillway system due to blockage or damage that could lead to flooding.	Level 2
	Spillway flow actively eroding the soil around the spillway that is threatening the control section (e.g. undermining) or dam/impoundment stability.	Level 3
	Spillway flow that is flooding people downstream.	Level 3
Embankment Overtopping (See Table 4-2 for relevant elevations)	Impoundment water surface elevation at or below typical normal pool fluctuation elevation.	Level 0
	Impoundment water surface elevation above typical high pool fluctuation elevation.	Level 1
	Impoundment water surface elevation within 2 feet of the embankment crest elevation	Level 2
	Impoundment water surface elevation at or above embankment crest elevation.	Level 3
Seepage	New seepage areas in or near the dam/impoundment with clear flow.	Level 1
	New seepage areas with cloudy discharge or increasing flow rate.	Level 2
	Heavy seepage with active erosion, muddy flow, and/or sand boils.	Level 3
Sinkholes	Observation of new sinkhole in impoundment area or on embankment.	Level 2
	Rapidly enlarging sinkhole and/or whirlpool in the impoundment.	Level 3
Embankment cracking	New cracks in the embankment greater than ¼ inch wide without seepage.	Level 1
	Any crack in the embankment with seepage.	Level 2
	Enlarging cracks with muddy seepage.	Level 3

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Table 4-1. Guidance for Determining the Response Level

Event	Situation	Response Level
Embankment movement	Visual signs of movement/slippage of the embankment slope.	Level 1
	Detectable active movement/slippage of the embankment slope or other related effects (tension cracking, bulges/heaves, etc.) that could threaten the integrity of the embankment.	Level 2
	Sudden or rapidly proceeding slides of the embankment slopes.	Level 3
Embankment Monitoring Equipment (piezometers, inclinometers, surface displacement mounts, etc.)	Instrumentation readings beyond historic normal.	Level 1
	Instrumentation readings indicate the embankment is susceptible to failure.	Level 2
	Instrumentation readings indicate embankment is at threshold of failure or is currently failing.	Level 3
Earthquake or other event	Measurable earthquake felt or reported on or within 100 miles of the impoundment.	Level 1
	Earthquake or other event resulting in visible damage to the impoundment or appurtenances.	Level 2
	Earthquake or other event resulting in uncontrolled release of water or materials from the impoundment.	Level 3
Security threat	Verified bomb threat or other physical threat that, if carried out, could result in damage to the impoundment.	Level 2
	Detonated bomb or other physical damage that has resulted in damage to the impoundment or appurtenances.	Level 3
Sabotage/ vandalism	Damage to impoundment or appurtenance with no impact to the functioning of the impoundment.	Level 1
	Modification to the impoundment or appurtenances that could adversely impact the functioning of the impoundment. This would include unauthorized operation of spillway facilities.	Level 2
	Damage to impoundment or appurtenances that has resulted in seepage flow.	Level 2
	Damage to impoundment or appurtenances that has resulted in uncontrolled water release.	Level 3

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Table 4-2. Impoundment Trigger Elevations

Impoundment	Embankment Crest Elevation	Auxiliary Spillway Crest Elevation	Normal Pool Fluctuation	
			Typical	High
Ash Pond No. 1	625 ft.	N/A	N/A	N/A
Ash Pond No. 2	640 ft.	N/A	N/A	N/A
Bottom Ash Pond				
GMF Pond	620 ft.	Not Applicable	616 ft.	618 ft.

Notes:
*Elevation estimated from Digital Elevation Model (DEM) developed by the Illinois State Geological Survey.

Table 4-3. Step 3: Emergency Actions

Condition	Description of Condition	Action to be Taken
High Water Level/ Large Spillway Release	Not applicable to capped impoundments. See Table 4-1 and Table 4-2 for elevations and triggering water levels associated with the impoundments and spillways covered by this EAP.	1. Assess cause of increased reservoir stage, especially during fair weather conditions. 2. Determine Response Level. 3. Make proper notifications as outlined in the Figure 2-2 Notification Flowchart. 4. Perform additional tasks as determined through consultation with the ERT. 5. Make notifications if condition worsens such that downstream flooding is imminent. **Response Level 0**: require enhanced surveillance 3 times per day **Response Level 1**: contact internal chain of command and external response partners as necessary; inspect impoundment minimum 1 time per hour **Response Level 2**: contact internal chain of command; notify ESDA/EMA's and notify external response partners. ESDA/EMA's notify affected parties. **Response Level 3**: contact internal chain of command; notify ESDA/EMA's and notify external response partners. ESDA/EMA's notify affected parties of emergency incident.
Seepage	Localized new seepage or boil(s) observed along downstream face / toe of earthen embankment with muddy discharge and increasing but controllable discharge of water.	1. Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos. Document location on a site plan and in inspection notes. 2. Determine Response Level. 3. Make proper notifications as outlined in the Figure 2-2 Notification Flowchart. 4. ERT (with Dam Safety Manager as lead) to determine mitigation actions. The following actions may apply: a) Place a ring of sand bags with a weir at the top towards the natural drainage path to monitor flow rate. If boil becomes too large to sand bag, place a blanket filter over the area using non-woven filter fabric and pea gravel. Attempt to contain flow in such a manner (without performing any excavations) that flow rates can be measured. Stockpile gravel and sand fill for later use, if necessary.

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Table 4-3. Step 3: Emergency Actions

Condition	Description of Condition	Action to be Taken
		b) Inspect the embankment and collect piezometer, water level and seepage flow data daily unless otherwise instructed by the Dam Safety Manager. Record any changes of conditions. Carefully observe embankment for signs of depressions, seepage, sinkholes, cracking or movement. c) Maintain continuous monitoring of feature. Record measured flow rate and any changes of condition, including presence or absence of muddy discharge. 5. Make notifications as outlined in the lower portion of the Notification Flowchart (Figure 2-2) if condition worsens such that failure is imminent.
Sabotage and Miscellaneous Other Issues	Criminal action with significant damage to embankment or structures where significant repairs are required and the integrity of the facility is compromised—condition appears stable with time.	1. Contact law enforcement authorities and restrict all access (except emergency responders) to impoundment. Restrict traffic on embankment crest to essential emergency operations only. 2. Determine Response Level. 3. Make internal notifications as outlined in the upper portion of the Notification Flowchart (Figure 2-2). 4. In conjunction with the Dam Safety Manager, assess extent of damage and visually inspect entire embankment and ancillary structures for additional less obvious damage. Based on inspection results, confirm if extent of damage to various components of the impoundment warrants a revised Response Level and additional notifications. 5. Perform additional tasks as directed by the ERT. 6. Make notifications if conditions worsen.
Embankment Deformation	**Cracks:** New longitudinal (along the embankment) or transverse (across the embankment) cracks more than 6 inches deep or more than 3 inches wide or increasing with time. New concave cracks on or near the embankment crest associated with slope movement.	1. Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos. Document location on a site plan and in inspection notes. 2. Restrict traffic on embankment crest to essential emergency operations only. 3. Determine Response Level. 4. Make notifications as outlined in the Figure 2-2 Notification Flowchart. 5. ERT (with Dam Safety Manager as lead) to determine mitigation actions. The following actions may apply: a) Place buttress fill against base of slope immediately below surface feature. Stockpile additional fill. b) Place sandbags as necessary around crack area to divert any storm water runoff from flowing into crack(s). 6. As directed by the Dam Safety Manager, additional inspection and monitoring of the dam may be required. Items may include; inspect the dam on a schedule determined by the Dam Safety Manager; collect piezometer and water level data; and record any changes of condition. Carefully observe dam for signs of depressions, seepage, sinkholes, cracking or movement. 7. Make notifications as outlined in the Figure 2-2 Notification Flowchart if conditions worsen such that failure is imminent.
	Slides / Erosion: Deep slide / erosion (greater than 2 feet deep) on the embankment that may also extend beyond the	1. Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos. Document location on a site plan and in inspection report. 2. Restrict traffic on embankment crest to essential emergency operations only. 3. Determine the Response Level.

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Table 4-3. Step 3: Emergency Actions

Condition	Description of Condition	Action to be Taken
	embankment toe but does not encroach onto the embankment crest and appears stable with time.	4. Make notifications as outlined in the Figure 2-2 Notification Flowchart. 5. ERT (with Dam Safety Manager as lead) to determine mitigation actions. Additional actions may include the following items. a) Place sandbags as necessary around slide area to divert any storm water runoff from flowing into slide(s). b) Increase inspections of the dam; collect piezometer and water level data; and record any changes of condition. During inspections, carefully observe dam for signs of depressions, seepage, sinkholes, cracking or movement. 6. Make notifications as outlined in the Figure 2-2 Notification Flowchart if conditions worsen such that failure is imminent.
	Sinkholes: Small depression observed on the embankment or within 50 feet of the embankment toe that is less than 5 feet deep and 30 feet wide or which is increasing with time.	1. Slowly open drain gates to lower pool elevation. 2. Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos. Document location on a site plan and in inspection notes. 3. Restrict traffic on embankment crest to essential emergency operations only. 4. Determine Response Level. 5. Make notifications as outlined in the Figure 2-2 Notification Flowchart. 6. ERT (with Dam Safety Manager as lead) to determine mitigation actions. Additional actions may include the following items: a) Backfill the depression with relatively clean earth fill (free of organic materials) generally even with surrounding grade and slightly mounded (6 to 12 inches higher) in the center to shed storm water away from the depression. Stockpile additional fill. b) Increase inspections of the dam; collect piezometer and water level data daily unless otherwise instructed by Dam Safety Manager; and record any changes of condition. Carefully observe dam for signs of depressions, seepage, sinkholes, cracking or movement. 7. Make notifications as outlined in the Figure 2-2 Notification Flowchart if conditions worsen such that failure is imminent.
Gate Malfunction or Failure	Sluice gate damaged structurally (sabotage, debris, etc.) with uncontrolled release of water at a constant volume. Condition appears stable.	1. Close any other gates, if open. 2. Determine Response Level. 3. Make notifications as outlined in the Figure 2-2 Notification Flowchart. 4. Obtain instructions from the Dam Safety Manager to determine if there are other methods to stop or slow down the flow of water. 5. If conditions worsen such that failure is imminent, make notifications as outlined in the lower portion of the Figure 2-2 Notification Flowchart.

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5 PREPAREDNESS

The intent of this section is to provide information that will be utilized during a response. Established emergency supplies and locations, suppliers, and equipment are provided in Table 5-1. Supplier contact information is listed in Table 5-2.

A coordination meeting shall be conducted annually between representatives of the Illinois Power Resources Generating, LLC and local emergency responders. This meeting may be in the form of a face-to-face meeting, tabletop exercise, or additional training regarding the EAP.

Table 5-1. Emergency Supplies and Equipment

Item	On-site (Yes/No/Occasionally)	Remarks
Flashlights	Yes	Typically, at Duck Creek Power Plant Maintenance Facility: contact Asset Closure Manager for location(s).
Generator		
Extension Cords		
Fire extinguishers		
Floodlights		
Backhoe	Yes	John Deere 301 Backhoe/Loader and Caterpillar 426C Backhoe/Loader; contact Asset Closure Manager for location(s).
Dozer	Yes	Caterpillar D9R Dozer and Caterpillar D10R Dozer; contact Asset Closure Manager for location(s).
Large Equipment (Rental – including excavating equipment, pumps, lighting)	Yes	Two Caterpillar 834 Rubber Tired Bucket Loader, Fiatt Road Grader, two farm tractors with end loaders, and a Caterpillar Skid Steer with end loaders are also available; contact Asset Closure Manager for location(s). Contact Altorfer, Inc., Bolon's Repair, MH Equipment, or Sunbelt Rentals for additional large equipment (see Table 5-2).
Dump Truck	No	Contact Captain Hook Roll-Off Boxes or Done Rite Construction Co. Inc. for additional dump trucks (see Table 5-2).
Pump and Hoses	No	Contact Bolon's Repair or Pratt Lumber Do It Center for additional pumps and hoses (see Table 5-2).
Sandbags and Sand	No	Contact Duck Creek Sand and Gravel, Davis Sand and Gravel, or Pratt Lumber Do It Center for additional sandbags and sand (see Table 5-2).
Fill (Stone, aggregate, sand)	No	Contact Duck Creek Sand and Gravel, Davis Sand and Gravel, or Pratt Lumber Do It Center for additional fill (see Table 5-2).
Concrete/grout	No	Contact Canton Redi-Mix for additional batch plant concrete or Pratt Lumber Do It Center for additional bagged concrete (see Table 5-2).
Geotextile Filter Fabric	Yes	Two rolls of 10-ounce, non-woven filter fabric are available on site; contact Asset Closure Manager for location(s).
Plastic Sheeting	No	Contact Pratt Lumber Do It Center for additional plastic sheeting (see Table 5-2).
Rope	No	Contact Alexander Lumber, Bolon's Repair, and Pratt Lumber Do It Center for additional rope (see Table 5-2).
Personal Flotation Devices	Yes	Typically, at Duck Creek Power Plant Maintenance Facility, contact Asset Closure Manager for location(s).

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Table 5-2. Supplier Addresses

Supply/Rental Item(s)	Supplier Contact Information	Distance from Site (miles)	Address
Rope	**Alexander Lumber Co**. (309) 647-0396	8.4	406 South 5th Ave Canton, IL 61520
Large Equipment	**Altorfer, Inc.** (309) 697-1234	33.5	6315 West Fauber Road Bartonville, IL 61607
Large Equipment, Pump and Hoses, Rope	**Bolon's Repair** (309) 647-2203	10.5	999 West Locust Canton, IL 61520
Concrete/grout	**Canton Redi-Mix** (309) 668-2261	13.1	22381 IL-78 Canton, IL 61520
Dump Truck	**Captain Hook Roll-Off Boxes** (309) 565-7676	18.2	309 South Glasford Road Glasford, IL 61533
Sandbags and Sand	**Davis Sand and Gravel** (309) 647-0019	10.7	1130 West Locust Street Canton, IL 61520
Dump Truck	**Done Rite Construction Co Inc**. (309) 331-4983	55.6	10277 IL RT 101 Littleton, IL 61452
Fill (Stone, aggregate, sand)	**Duck Creek Sand and Gravel** (309) 668-2278	5.5	17505 North Duck Island Road Canton, IL 61520
Large Equipment	**MH Equipment** (309) 699-4024	38.4	111 Carver Lane East Peoria, IL 61611
Concrete/grout, Pump and Hoses, Sandbags and Sand, Fill (Stone, aggregate, sand), Plastic Sheeting, Rope	**Pratt Lumber Do It Center** (309) 547-3587	13.4	311 East Avenue E Lewistown, IL 61542
Large Equipment	**Sunbelt Rentals** (309) 694-6201	39.7	1601 North Main Street East Peoria, IL 61611

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6 FACILITY/IMPOUNDMENT DESCRIPTION

The impoundments included in this EAP are described as follows and illustrated in Figure 1-2. Table 6-1 contains additional geometric details for each impoundment.

The Duck Creek Power Plant is a retired plant located in Canton, Illinois, roughly 50 miles west of Bloomington, Illinois east of IL-78 and west of US-24.

Ash Pond No. 1 is a diked impoundment that was commissioned in 1976. The main inflow into Ash Pond No. 1 was precipitation, which accumulated and transported through channels around the inside perimeter of the pond, reaching two small internal impoundments. It has a maximum embankment height of 28 feet, a crest elevation of 625 feet above Mean Sea Level (MSL), and a crest width of 20 feet. The total length of the embankment is approximately 6,500 feet. The storage capacity of the pond is approximately 1,300 acre-feet at normal pool elevation. Approximately three-fourths of Ash Pond No. 1 is stacked ash, located on the southern side. Free water volume accounts for approximately one-fourth of the pond and is located on the northern end.

Ash Pond No. 2 is a diked impoundment that was commissioned in 1986. The main inflows into Ash Pond No. 2 are precipitation and stormwater pumped from Ash Pond No. 1. The diked fly ash is constructed in a serpentine channel to direct process water and allow for additional time to filter suspended solids before entering the main pond. The outlet structure is in the northeast corner of the pond and transports water into the Recycle Pond, along with a seepage blanket and pump. It has a maximum embankment height of 30 feet, a crest elevation of 640 feet above MSL, and a crest width of 20 feet. The total length of the embankment is approximately 9,000 feet. The storage capacity of the pond is approximately 1,000 acre-feet at normal pool elevation.

The Bottom Ash Pond…….

The GMF Pond is located directly north of the GMF Recycle Pond, east of North Bethel Cemetery Road. The pond encompasses approximately 30 acres and is graded to the south, where water discharges into a channel to flow into the GMF Recycle Pond. From the GMF Recycle Pond, water exits through piping into the Duck Creek Cooling Pond.

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Table 6-1. Power Plant Impoundment Characteristics

Feature/Parameter	Ash Pond No. 1	Ash Pond No. 2	Bottom Ash Pond	GMF Pond
Maximum Embankment Height	28 feet*	30 feet*		11 feet
Length of Dam	6,500 feet*	9,000 feet*		4,560 feet
Crest Width	N/A	N/A		30 feet
Crest Elevation	±625 feet	±640 feet*		±620 feet
Reservoir Area at Top of Dam	N/A	N/A		31.6 acres
Storage Capacity at Top of Dam	N/A	N/A		Unknown
Primary Spillway Type	Stormwater let-down structures are now the spillways	Stormwater let-down structures are now the spillways		Lined open channel
Primary Spillway Crest Elevation	None	None		615 feet
Storage Capacity at Primary Spillway Elevation	None	None		None
Reservoir Area at Normal Water Surface Elevation	N/A	N/A		31 acres
Auxiliary Spillway Type	None	None		None
Auxiliary Spillway Crest Elevation	None	None		None

Notes:
*Source: "COAL ASH IMPOUNDMENT SITE ASSESSMENT FINAL REPORT", May 10, 2011. Elevations are in reference to original construction drawings by Commonwealth Associates, Inc.
All remaining values are GIS estimated.

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7 BREACH INUNDATION MAPS AND POTENTIAL IMPACTS

Inundation maps for Ash Pond No. 1, Ash Pond No. 2, Bottom Ash Pond, and the GMF Pond potential breach scenarios are provided in this section. It is the Fulton County ESDA/EMA's responsibility to keep a current list of affected parties/properties to contact in the case of emergencies that result in Response Level 2 or 3. This list should encompass all properties within and adjacent to the probable inundation extents shown in the provided maps.

The methodology used to identify probable inundation extents for potential breach scenarios varied as a function of the impoundment size, location, surrounding topography, and surrounding structures/facilities/waterbodies.

Ash Pond No. 1, Ash Pond No. 2, Bottom Ash Pond, and the GMF Pond inundation maps were developed from visual assessments. Topographic data and basemap imagery were used to identify the mapped inundation areas.

Three failure scenarios were identified at Ash Pond No. 1 and Ash Pond No. 2. At both impoundments, the breach would be contained in either the Duck Creek Cooling Pond or the unnamed body of water west of N. Cilco Road. The Bottom Ash Pond is incised and no failure scenarios were identified. Four failure scenarios were identified at the GMF Pond. Only Duck Creek Power Plant owned structures were identified in the potential breach paths, with a breach contained in the Duck Creek Cooling Pond. The land between the impoundments and the Duck Creek Cooling Pond and unnamed body of water west of N. Cilco Road would also be inundated during a breach.

Approximate inundation areas are illustrated on Figure 7-1, Figure 7-2, Figure 7-3, and Figure 7-4.

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Legend

- Disposal Area Approximate Limits
- Approximate Anticipated Inundation Extents

0 1,500 3,000 Feet

1:18,000 (At original document size of 11x17)

Stantec DYNEGY

Project Location
Latitude: 40.466181
Longitude: -89.984236
Fulton County, Illinois

175605019
Prepared by CAJ on 2017-03-06
Technical Review by MAT on 2017-03-10

Client/Project
Duck Creek Power Station
Emergency Action Plan

Figure No.
7-1

Title
Inundation Map
Ash Pond No. 1

Notes
1. Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
2. Aerial Source: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, 3. USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User

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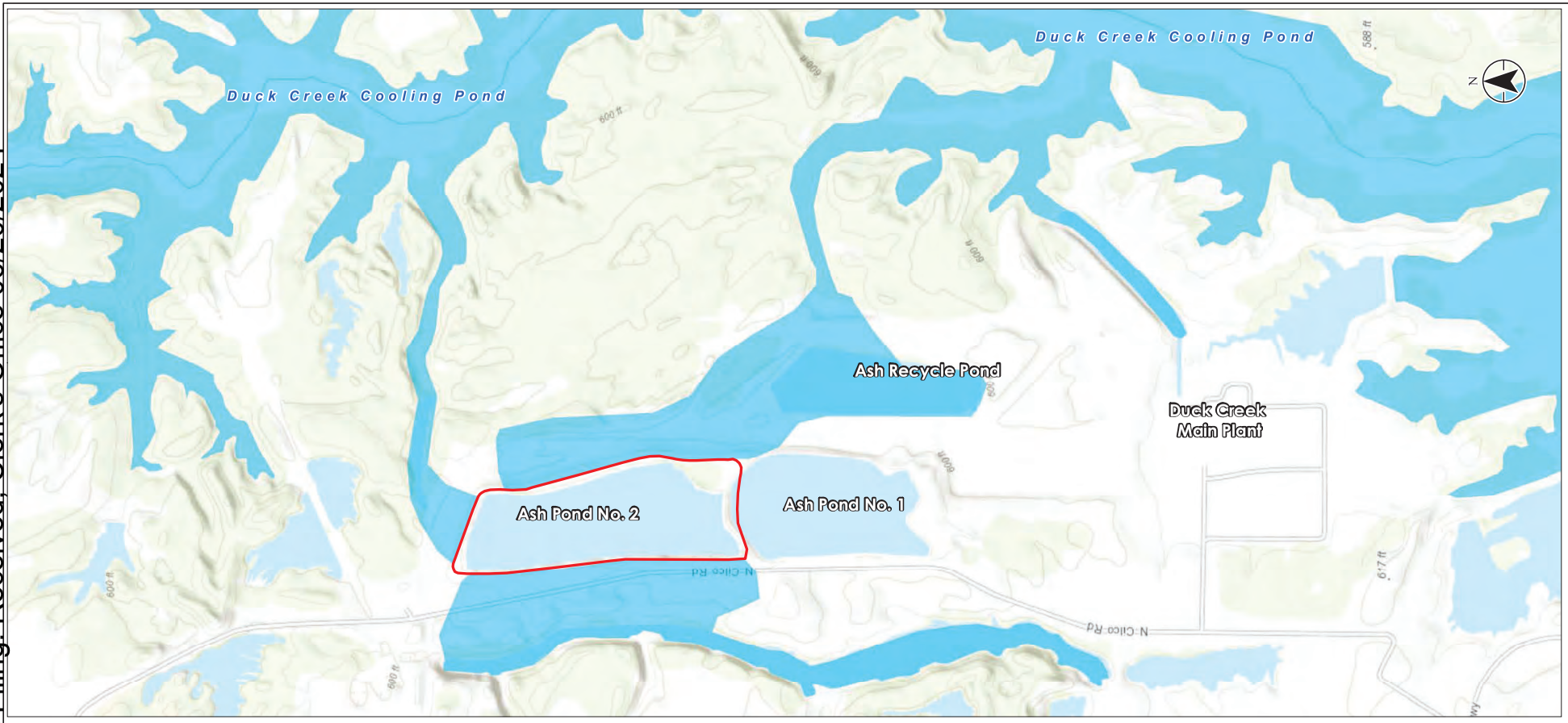



Legend

- Disposal Area Approximate Limits
- Approximate Anticipated Inundation Extents

0 1,500 3,000 Feet

1:18,000 (At original document size of 11x17)

Stantec DYNEGY

Project Location
Latitude: 40.466181
Longitude: -89.984236
Fulton County, Illinois

175605019
Prepared by CAJ on 2017-03-06
Technical Review by MAT on 2017-03-10

Client/Project
Duck Creek Power Station
Emergency Action Plan

Figure No.
7-2

Title
Inundation Map
Ash Pond No. 2

Notes
1. Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
2. Aerial Source: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, 3. USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User

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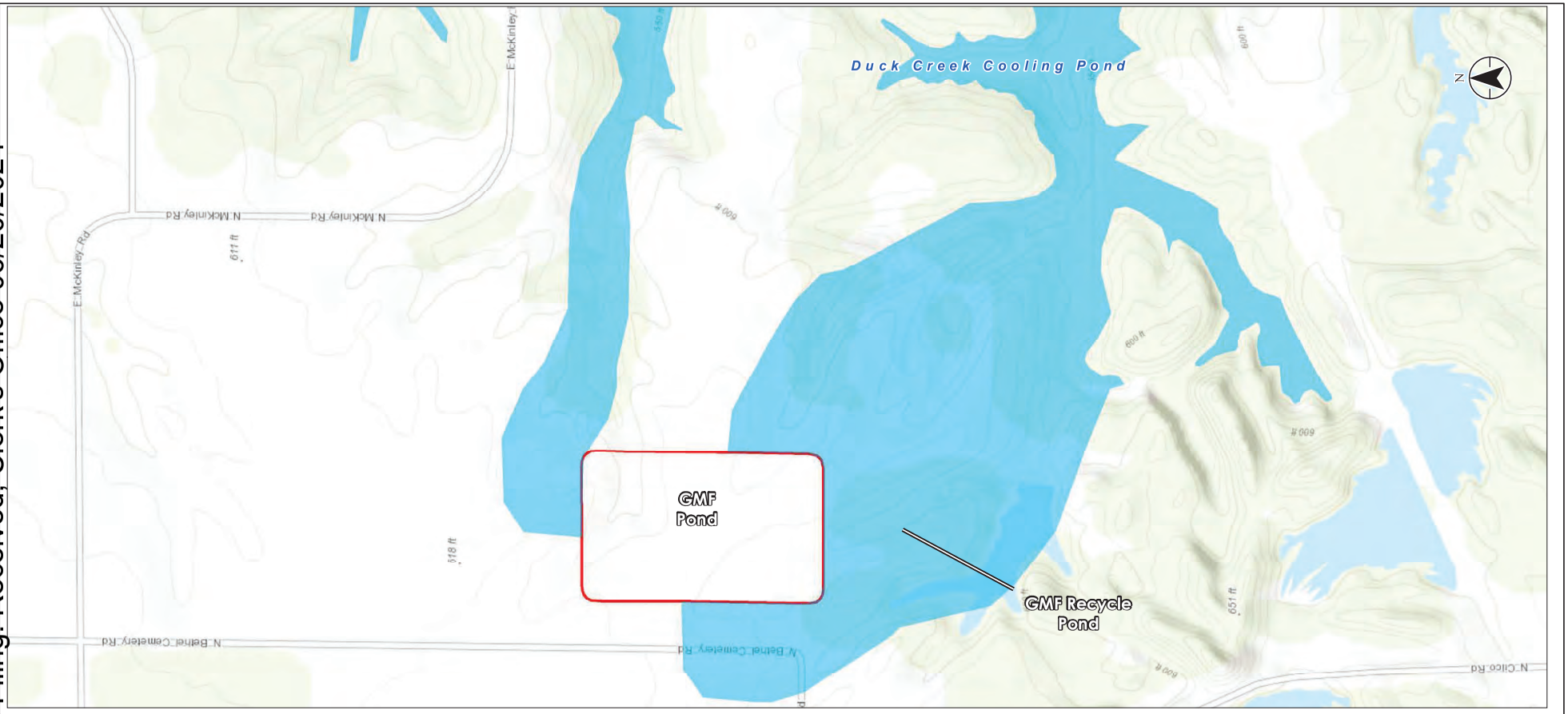



Legend

- Disposal Area Approximate Limits
- Approximate Anticipated Inundation Extents

0 800 1,600 Feet

1:9,600 (At original document size of 11x17)

Stantec DYNEGY

Project Location
Latitude: 40.466181
Longitude: -89.984236
Fulton County, Illinois

175605019
Prepared by CAJ on 2017-03-06
Technical Review by MAT on 2017-03-10
Independent Review by MC on 2017-03-14

Client/Project
Duck Creek Power Station
Emergency Action Plan

Figure No.
7-3

Title
Inundation Map
GMF Pond

Notes

1. Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
2. Aerial Source: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User

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ATTACHMENT G

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CCR Fugitive Dust Control Plan

for

Duck Creek Power Plant

Prepared for:

Illinois Power Resources Generating, LLC

Duck Creek Power Plant
17751 North Cilco Road
Canton, IL 61520

Prepared by:

Burns & McDonnell
Kansas City, Missouri

Amendment 1

October 2021

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1 Introduction

This Coal Combustion Residuals (CCR) fugitive dust control plan has been prepared for the Duck Creek Power Plant, located in Fulton County, Illinois. This plan addresses the air criteria in 40 C.F.R. § 257.80 of the United States Environmental Protection Agency's CCR rule, which requires the owner or operator of a CCR unit to "adopt measures that will effectively minimize CCR from becoming airborne at the facility" and to "prepare and operate in accordance with a CCR fugitive dust control plan." The plan also addresses the air criteria in 35 I.A.C. 845.500 of the Illinois Environmental Protection Agency's CCR rule, which contains similar requirements to the federal CCR rule.

1.1 Facility Information

- Facility Name: Duck Creek Power Plant (Retired)
- Facility Address: 17751 North Cilco Road, Canton, IL 61520
- Owner/Operator: Illinois Power Resources Generating, LLC

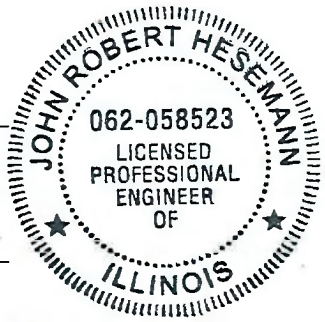
1.2 Certification

The owner or operator must obtain a certification from a qualified professional engineer that the initial CCR fugitive dust control plan, or any subsequent amendment of it, meets the requirements of 40 C.F.R. § 257.80 and 35 I.A.C. 845.500. See 40 C.F.R. §257.80(b)(7); 35 I.A.C. 845.500(b)(7).

I certify under penalty of law that, to the best of my knowledge, this plan meets the requirements of 40 C.F.R. § 257.80 and 35 I.A.C. 845.500. This certification is based on my review of the document and conditions at the site and on my inquiry of the person or persons who managed the preparation of this document.

John R. Hesemann
Printed Name of Qualified Professional Engineer

John R. Hesemann 9/09/2021
Signature of Qualified Professional Engineer and Date



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2 CCR Fugitive Dust Control Measures and Appropriateness

CCR fugitive dust has the potential to become airborne at the facility during periods of CCR management in the CCR units, CCR handling and CCR transport. Areas at the facility that have the potential for airborne CCR fugitive dust are CCR surface impoundments, a CCR landfill, CCR handling equipment and CCR transport in trucks. This section identifies and describes the control measures selected and adopted by the facility to minimize CCR from becoming airborne at the facility and explains how the selected measures are applicable and appropriate for site conditions. The control measures may be adjusted or modified based on observed effectiveness of minimizing CCR from becoming airborne and weather conditions.

2.1 Management of CCR in the CCR Units

The facility manages CCR in surface impoundments and a landfill located at the facility. Table 2-1 below identifies CCR fugitive dust control measures that have been selected for use by the facility during CCR management in the CCR units, including placement of CCR into the CCR units, and explains how the selected measures are applicable and appropriate for site conditions. The facility will use the identified measures during CCR management in the CCR units to minimize CCR from becoming airborne at the facility.

CCR Activity	CCR Fugitive Dust Control Measure	Applicability and Appropriateness of Control Measure
Management of CCR in the facility's CCR units	Condition CCR to be emplaced in the landfill before emplacement.	Conditioning CCR to be placed in the landfill allows CCR to bind together and thus minimizes the potential for CCR fugitive dust generation when CCR is managed in the landfill. The added moisture content will prevent wind dispersal of the CCR but will not result in free liquids.
	Cover exposed dry CCR in the landfill.	Applying approved cover material, such as conditioned fly ash, minimizes wind entrainment of CCR.
	Wet management of CCR bottom ash and flue gas desulfurization materials in CCR surface impoundments.	Wet management of CCR minimizes the potential for CCR fugitive dust generation.
	Water areas of exposed CCR in CCR units, as necessary.	Water will be applied to areas of exposed CCR to maintain moisture content to minimize the potential for CCR fugitive dust generation in excessively dry or windy conditions. Wetting activities will not generate "free liquids" within the landfill.
	Naturally occurring grass vegetation in areas of exposed CCR in CCR surface impoundments.	Vegetation provides a wind screen and/or cover and reduces wind entrainment of CCR.
	Apply chemical dust suppressant on areas of exposed CCR in CCR units, as necessary.	Mixing an appropriate chemical dust suppressant with water and applying to areas of exposed CCR will minimize the potential for CCR fugitive dust generation in excessively dry or windy conditions.
	Reduce or halt operations during high wind events, as necessary.	Reducing or halting operations during high wind events minimizes the potential for CCR fugitive dust generation.

Table 2-1. Control Measures for CCR Management in CCR Units

2.2 Handling of CCR

Bottom ash may be periodically removed from the CCR surface impoundments and remains sufficiently wet during and after handling activities, including dewatering, associated with transfer of the CCR. Table 2-2 below identifies CCR fugitive dust control measures that have been selected for use by the facility during handling of CCR and explains how the selected measures are applicable and appropriate for site conditions. The facility will use the identified measures when handling CCR to minimize CCR from becoming airborne at the facility.

CCR Activity	CCR Fugitive Dust Control Measure	Applicability and Appropriateness of Control Measure
Handling of CCR at the facility	CCR bottom ash removed from CCR surface impoundments and loaded into trucks for transport remains conditioned during handling.	Conditioned CCR allows CCR to bind together and thus minimizes the potential for CCR fugitive dust generation when CCR is handled.
	CCR to be emplaced in the landfill is conditioned before emplacement.	Conditioning allows CCR to bind together and thus minimizes the potential for CCR fugitive dust generation.
	Condition CCR materials to be transported offsite before they are loaded into trucks, as necessary.	Conditioning allows CCR to bind together and thus minimizes the potential for CCR fugitive dust generation while loading CCR into trucks and during transport.
	Reduce or halt operations during high wind events, as necessary.	Reducing or halting operations during high wind events minimizes the potential for CCR fugitive dust generation.

Table 2-2. Control Measures for Handling CCR

2.2.1 Conditioning of CCR Prior to Emplacement in CCR Landfill

Conditioned CCR is CCR that has been wetted with water or an appropriate chemical dust suppressant. Water or a chemical dust suppressant is added to raise the moisture content of the CCR to prevent wind dispersal but will not result in free liquids. Conditioning allows for the CCR to bind together, which minimizes the potential for CCR fugitive dust.

All CCR generated on site that is placed into the facility's landfill, as well as CCR generated offsite that is authorized for placement in the facility's landfill, is conditioned before emplacement. All CCR that is added to the facility's landfill is emplaced in the landfill as conditioned CCR.

2.3 Transportation of CCR

CCR is transported via truck at the facility using a combination of paved and unpaved facility roads. Table 2-3 below identifies CCR fugitive dust control measures that have been selected for use by the facility during transport of CCR. The facility will use the identified measures when transporting CCR to minimize CCR from becoming airborne at the facility.

CCR Activity	CCR Fugitive Dust Control Measure	Applicability and Appropriateness of Control Measure
Transportation of CCR at the facility	Condition CCR to be emplaced in the landfill before emplacement.	Conditioning CCR increases moisture content of the CCR and minimizes the potential for CCR fugitive dust generation during CCR transport (and emplacement in the landfill).
	Condition CCR materials to be transported offsite before they are loaded into trucks, as necessary.	Conditioning allows CCR to bind together and thus minimizes the potential for CCR fugitive dust generation while loading CCR into trucks and during transport.
	Cover or enclose trucks used to transport CCR fly ash.	Covering or enclosing trucks transporting CCR on facility roads minimizes the potential for CCR fugitive dust generation from the CCR transport trucks.
	Limit the speed of vehicles to no more than 15 mph on facility roads.	Limiting the speed of vehicles traveling on facility roads minimizes the potential for CCR fugitive dust generation from the CCR transport trucks.
	Cover or enclose trucks used to transport CCR other than fly ash, as necessary.	Covering or enclosing trucks transporting CCR on facility roads minimizes the potential for CCR fugitive dust generation from the CCR transport trucks.
	Sweep or rinse CCR off of the outside of the trucks transporting CCR, as necessary.	Removing CCR present on the outside of the truck minimizes the potential for movement of the truck or wind to cause CCR fugitive dust to become airborne.
	Remove CCR, as necessary, deposited on facility road surfaces during transport.	Removing CCR deposited on facility road surfaces as a result of transport minimizes the potential for CCR fugitive dust generation from vehicle traffic.
	Condition CCR haul roads with water or dust suppressant, as necessary.	Watering CCR haul roads minimizes the potential for dust generation to occur as a result of CCR hauling traffic and heavy equipment use.
	Reduce or halt operations during high wind events, as necessary.	Reducing or halting operations during high wind events minimizes the potential for CCR fugitive dust generation.

Table 2-3. Control Measures for Transportation of CCR

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3 Procedures for Periodic Assessment of Effectiveness of the Plan

The facility conducts inspections associated with CCR fugitive dust control. The facility also uses the procedures identified in section 5 of this plan to log every citizen complaint involving CCR fugitive dust events at the facility. These inspections and the investigations of citizen complaints will be used to periodically assess the effectiveness of the CCR fugitive dust control plan per 40 C.F.R. § 257.80(b)(4) and 35 I.A.C. 845.500(b)(3).

The facility routinely performs inspections to verify the effectiveness of the CCR fugitive dust control measures used at the facility. Inspections are conducted during daylight working hours and include observing for the presence of CCR fugitive dust emissions from vehicles transporting CCR on facility roads, CCR handling and CCR management activities, including CCR placement in CCR units. Inspection records include information such as the name of the person conducting the inspection, the date and time of the inspection, the results of the inspection, and any corrective action taken.

When a CCR fugitive dust event is observed or a citizen complaint involving a CCR fugitive dust event at the facility is received, current CCR management practices will be reviewed to see that the selected control measures are being properly implemented. If the control measures are not being properly implemented, relevant operating personnel will be notified and, as warranted, re-trained in the proper implementation of CCR fugitive dust control measures. If appropriate, use of revised and/or additional control measures will be evaluated. As warranted, revised and/or additional control measures found to be applicable and appropriate to control CCR fugitive dust emissions will be incorporated into an amended CCR fugitive dust control plan.

The plan also will be reassessed in the event of material changes in site conditions potentially resulting in CCR fugitive dust becoming airborne at the facility.

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4 Recordkeeping, Notification, Internet Site

The written CCR fugitive dust control plan, any amendment of the written plan, and the annual CCR fugitive dust control report required by 40 C.F.R. § 257.80(c) and 35 I.A.C. 845.500(c) will be placed in the facility's written operating record and posted to the company's CCR website in accordance with 40 C.F.R. § 257.105(g), § 257.107(g), and 845.800(d)(7), (14), and 845.810(e). Notification of the availability of the CCR fugitive dust control plan, any amendment of the plan, and the annual CCR fugitive dust control report will be provided to IEPA in accordance with 40 C.F.R. § 257.106(g). Any amendment of the fugitive dust control plan will be submitted to IEPA in accordance with 845.500(b)(5).

Additionally, pursuant to 845.500(b)(6), this fugitive dust control plan is being placed in facility's operating record and posted to the company's CCR website prior to the submission of any permits for the Duck Creek Power Plant.

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5 Procedures to Log Citizen Complaints

In the event the owner or operator of the facility receives a citizen complaint involving a CCR fugitive dust event at the facility, relevant information about the complaint will be logged. Information that will be recorded includes, as applicable:

- Date/Time the complaint is received
- Date/Time and duration of the CCR fugitive dust event
- Description of the nature of the CCR fugitive dust event
- Name of the citizen entering the complaint
- Address & phone number of citizen entering the complaint
- Name of the personnel who took the complaint
- All actions taken to assess and resolve the complaint

All citizen complaints involving CCR fugitive dust events at the facility will be investigated promptly. As deemed appropriate or necessary, corrective measures will be taken and a follow-up response will be provided to the complainant.

Pursuant to 35 I.A.C. 845.500(b)(2), quarterly reports will be submitted to IEPA no later than 14 days from the end of the quarter for all complaints received in that quarter. At a minimum, the quarterly report will include the date of the complaint, the date of the incident, the name and contact information of the complainant (if given), and all actions taken to assess and resolve the complaint.

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6 Amendments

The written CCR fugitive dust control plan may be amended at any time provided the revised plan is placed in the facility's operating record as required by 40 C.F.R. § 257.105(g)(1) and 845.500(b)(6). Any amendment of the fugitive dust control plan will be submitted to IEPA in accordance with 845.500(b)(5). The written CCR fugitive dust control plan must be amended whenever there is a change in conditions that would substantially affect the written plan in effect.

Amendment Number and Date	Pages or Section	Description of Amendment	Professional Engineer Certifying Plan
Version 0 October 2015	--	Initial Plan	Wendy M. Pennington
Amendment 1 October 2021	Various	Administrative changes and adjustments to site condition controls as appropriate.	John R. Hesemann

Table 6-1. CCR Fugitive Dust Control Plan Amendments

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ATTACHMENT H

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Intended for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

GYPSUM MANAGEMENT FACILITY POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

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HYDROGEOLOGIC SITE CHARACTERIZATION REPORT DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND

Project Name	**Duck Creek Power Plant Gypsum Management Facility Pond**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Hydrogeologic Site Characterization Report**
Revision	**FINAL**
Date	**October 25, 2021**

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APPENDICES

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Appendix F	FEMA Flood Hazard Map

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
CSM	conceptual site model
CQA	Construction Quality Assurance
DCPP	Duck Creek Power Plant
DWW	Illinois Drinking Water Watch
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
ft/day	feet per day
ft/ft	feet per feet
GMF	Gypsum Management Facility
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standard
Hanson	Hanson Professional Services, Inc.
HCR	Hydrogeologic Site Characterization Report
HDPE	high density polyethylene
HMP	Hydrogeologic Monitoring Plan
HUC	Hydrologic Unit Code
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ILWATER	Illinois Water and Related Wells
IPRG	Illinois Power Resources Generating, LLC
ISAS	Illinois State Archaeological Survey
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
mg/L	milligrams per liter
mil	millimeter
msl	above mean sea level
NAVD88	North American Vertical Datum of 1988
NGWMN	National Groundwater Monitoring Network
NID	National Inventory of Dams
No.	Number
NRCS	Natural Resources Conservation Service
NRT	Natural Resource Technology, Inc.
NRT/OBG	Natural Resource Technology, Inc., an OBG Company
oz/yd^2	ounce per square yard

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Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
pCi/L	picocuries per liter
pcf	Pound per cubic foot
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RCRA	Resource Conservation and Recovery Act
RQD	rock quality designation
SDWIS	Safe Drinking Water Information System
SI	Surface Impoundment
SSURGO	Soil Survey Geographic
SU	standard unit
TDS	total dissolved solids
USCS	Unified Soil Classification System
USFWS	United States Fish and Wildfire Service
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

This Hydrogeologic Site Characterization Report (HCR) for the Gypsum Management Facility (GMF) Pond at Duck Creek Power Plant (DCPP) expands upon the hydrogeology, groundwater quality data, and conceptual site model (CSM) presented in previous hydrogeologic investigation reports prepared for the GMF Pond. This report has been assembled to satisfy the information and analysis requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845.620 as summarized in **Table ES-1**. The CSM includes hydrogeologic and groundwater quality data specific to the GMF Pond, which has been collected from 2015 to 2021. The GMF Pond (Vistra identification [ID] number [No.] 203, Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04, and National Inventory of Dams [NID] No. IL50573) is located at the DCPP southwest of Canton, Illinois (**Figure 1-1**).

The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP. Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development.

The GMF Pond is a 1500-foot by 900-foot earthen berm double-lined coal combustion residuals (CCR) Surface Impoundment (SI) located north of the former power plant. The GMF Pond decant water discharges to the lined GMF Recycle Pond. Several other CCR units are located on the DCPP property, including the Landfill located due north of the GMF Pond; the closed units, Ash Pond No. 1 and Ash Pond No. 2, located south of the GMF Pond; and the Bottom Ash Basin located between the former power plant and the closed Ash Pond Nos. 1 and 2.

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) coal unit at some portions of the DCPP property. Previous investigations completed outside of the GMF Pond indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to and downgradient of several former large surface mining areas.

In addition to the CCR within the lined GMF Pond, there are five layers of unlithified material present above the Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). These materials have been categorized into three hydrostratigraphic units presented below in descending order:

- **Uppermost Aquifer:** At the GMF Pond this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sands. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (Natural Resource Technology, an OBG Company [NRT/OBG], 2017a). The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally located at an elevation of 570 to 590 feet above mean sea level (msl). The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the

northeast corner and southwest corner of the pond), putting the base of liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.

- **Lower Radnor Till/Lower Confining Unit:** Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick.
- **Bedrock Confining Unit:** The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet.

The Peoria/Roxanna Loess within the uppermost aquifer has also been identified as a potential migration pathway (PMP) for contaminant migration. While the primary migration pathway is the shallow sand of the uppermost aquifer, the groundwater within the overlying Peoria/Roxanna Loess has the potential to be impacted and is considered a PMP.

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow in the sands is generally in a northwest to southeast direction. Seasonal variation of groundwater levels at the GMF Pond are present and may fluctuate approximately 1 to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond associated with the elevation changes. Groundwater flows toward the Duck Creek Cooling Pond located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Cooling Pond is estimated from 562.5 to 565 feet North American Vertical Datum of 1988 (NAVD88). Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond.

Part 845 parameters were monitored in uppermost aquifer and PMP monitoring wells as part of groundwater quality evaluations performed from 2015 to 2021. These data were supplemented with installation and sampling of additional locations in 2021. The results indicate that the following parameters were detected at concentrations greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs) and are considered potential exceedances:

- Antimony, arsenic, cobalt, lead, pH, sulfate, and thallium were detected at least once at concentrations greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). Lead, mercury, pH, and thallium were detected at concentrations greater than the GWPS in upgradient uppermost aquifer wells. Radium 226 and 228 combined was detected once at concentrations greater than the GWPS in the bedrock confining unit well.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPS to determine potential exceedances. Potential exceedances include results reported during the background groundwater monitoring or prior period that are greater than the GWPS. The results are considered potential exceedances because the results were compared directly to the standard and did not include an evaluation of background groundwater quality or the statistical methodologies proposed in the groundwater monitoring plan (GMP) provided in the Operating Permit application. Exceedances will be determined following IEPA approval of the GMP.

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TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)	**The hydrogeologic site characterization shall include but not be limited to the following:**	--
845.620(b)(1)	Geologic well logs/boring logs;	Table 3-1 Figure 3-1 Appendix B
845.620(b)(2)	Climatic aspects of the site, including seasonal and temporal fluctuations in groundwater flow;	Sections 3.2.4 & 3.3.1 Figures 3-2 to 3-5
845.620(b)(3)	Identification of nearby surface water bodies and drinking water intakes;	Sections 3.3.2 & 5.2 Appendix A
845.620(b)(4)	Identification of nearby pumping wells and associated uses of the groundwater;	Section 5.1 Appendix A
845.620(b)(5)	Identification of nearby dedicated nature preserves;	Section 5.3 Appendix A
845.620(b)(6)	Geologic setting;	Section 2 Figures 2-1 to 2-4
845.620(b)(7)	Structural characteristics;	Section 2.4.3 Figure 2-5
845.620(b)(8)	Geologic cross-sections;	Figures 2-7 and 2-8
845.620(b)(9)	Soil characteristics;	Section 2.3 Figure 2-2 Tables 2-1 & 2-4

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TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(10)	Identification of confining layers;	Section 3.2.1
845.620(b)(11)	Identification of potential migration pathways;	Section 3.2.1 & 3.2.3
845.620(b)(12)	Groundwater quality data;	Section 4.2 Table 4-1 & 4-2
845.620(b)(13)	Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy;	Section 2.5 Figures 2-7 through 2-9 Appendix B
845.620(b)(14)	A map displaying any known underground mines beneath a CCR surface impoundment;	Section 2.4.5 Appendix A
845.620(b)(15)	Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface;	Section 2.5 Tables 2-1, 2-2, & 2-4 Appendices B & C
845.620(b)(16)	Hydraulic characteristics of the geologic layers identified as migration pathways and geologic layers that limit migration, including:	Sections 3.2.4.1, 3.2.5, & 3.2.6 Tables 3-2 to 3-4 Appendices C & E
845.620(b)(16)(A)	water table depth;	Section 3.2.4 Figures 3-3 to 3-5
845.620(b)(16)(B)	hydraulic conductivities;	Section 3.2.5 Tables 2-1 & 3-3 Appendix E
845.620(b)(16)(C)	effective and total porosities;	Sections 2.5.1 Table 2-1

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TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(16)(D)	direction and velocity of groundwater flow; and	Sections 3.2.4 & 3.2.6 Tables 3-2, 3-4, & 4-2 Figures 3-3 to 3-5 Appendix D
845.620(b)(16)(E)	map of the potentiometric surface;	Figures 3-2 through 3-5
845.620(b)(17)	Groundwater classification pursuant to 35 I.A.C. § 620	Section 3.2.7

[O: EDP 08/24/21, C: LDC 09/16/21]

Notes:
35 I.A.C. § 620 = Title 35 of the Illinois Administrative Code, Part 620
HCR = Hydrogeologic Characterization Report
-- = reference to main regulation

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: 35 I.A.C. § 845 (Part 845) (IEPA, April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this HCR on behalf of DCPP (**Figure 1-1**), operated by Illinois Power Resources Generating, LLC (IPRG). This report will apply specifically to the CCR Unit referred to as the GMF Pond. However, information gathered to evaluate other CCR units in the vicinity regarding geology, hydrogeology, and groundwater quality is included, where appropriate. The GMF Pond consists of a 1,500-foot by 900-foot earthen berm with 3.5:1 side slopes, a maximum elevation of 620 feet, a double geomembrane liner consisting of a 60-millimeter (mil) high-density polyethylene (HDPE) geomembrane liner, 12-inch clay cushion, 4 ounce per square yard (oz/yd^2) non-woven geotextile filter fabric, 12-inch highly permeable granular drainage (sand), 10 oz/yd^2 non-woven geotextile filter fabric, 60-mil HDPE geomembrane liner, reinforced bentonite mat, 36-inch compacted clay, all installed over in-situ foundation soil, and all pipes, pumps, and appurtenances necessary for the storage of approximately 3.6 million tons of gypsum at a maximum elevation of 715 feet with discharge to the GMF Recycle Pond. This HCR includes Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the GMF Pond at the DCPP.

1.2 Part 845 Description

CCR is commonly referred to as coal ash, and CCR SIs are commonly referred to as coal ash ponds. Part 845 contains comprehensive rules for the design, construction, operation, corrective action, closure, and post closure care of these SIs. This rule includes GWPSs applicable at the waste boundary at each CCR SI and requires each owner or operator to monitor groundwater. IEPA's rule includes a permitting program as well as all federal standards for CCR SIs promulgated by the United States Environmental Protection Agency (USEPA). In addition, the rules include procedures for public participation, closure alternatives analyses, and closure prioritization, and provides access to records via public website. The rules also include financial assurance requirements for CCR SIs.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.620 is included in **Table ES-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.620.

1.3 Previous Investigations and Reports

Numerous hydrogeologic investigations have been performed concerning the CCR Units at the DCPP. The information presented in this HCR includes data collected in support of the monitoring well network established for development of the GMP and supplements comprehensive data collection and evaluations from prior hydrogeologic investigation reports (recent to oldest), including, but not limited to, the following:

- ***Hanson Professional Services, Inc. (Hanson), March 25, 2021. First Quarter 2021 Groundwater Report, Duck Creek Power Station, Gypsum Stack and Recycle Pond, WPC Permit No. 2017-EO-62640, Fulton County.***
  Quarterly comparison of groundwater monitoring results to the relevant groundwater standard and submittal of the quarterly sample results.

- ***Natural Resource Technology, an OBG Company (NRT/OBG), October 17, 2017. Hydrogeologic Monitoring Plan, Duck Creek GMF Pond – CCR Unit ID 203, Duck Creek Landfill – CCR Unit ID 204, Duck Creek Power Station, Canton, Illinois.***
  Hydrogeologic Monitoring Plan (HMP) prepared to provide background information necessary to support the groundwater monitoring system established to comply with Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257.91 to regulate the disposal of CCR as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA) [40 C.F.R. § 257 Subpart D; published in 80 FR 21302-21501, April 17, 2015] for the DCPP located in Canton, Illinois.
- ***AECOM, October 2016. History of Construction, USEPA Final CCR Rule, 40 C.F.R. § 257.739(c), Duck Creek Power Station, Canton, Illinois.***
  History of construction for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the DCPP in accordance with 40 C.F.R. § 257.73(c).
- ***Hanson, March 2016. Clay Liner Evaluation Report, Illinois Power Resources Generating LLC, Duck Creek Power Station, Fulton County, Illinois.***
  Evaluation prepared to show that the existing liner in the GMF Pond meets the minimum requirements of the 40 C.F.R. § 257 regulations. Conclusion indicated that the as built liner exceeds the performance standard set by 40 C.F.R. § 257.70(b). Construction Quality Assurance (CQA) documents are presented to verify the integrity of the liner components.
- ***Natural Resource Technology, Inc. (NRT), March 31, 2016. Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan, Duck Creek Ash Ponds 1 and 2, Duck Creek Energy Center, Canton, Illinois.***
  This Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan was prepared to develop hydrogeologic information in support of a Closure Plan for the Duck Creek Energy Center Ash Ponds 1 and 2.
- ***Hanson, February 29, 2016. Ash Pond 1 and Ash Pond 2, Aquifer Evaluation in the Surface (Strip) Mining Area, Duck Creek Power Station, Illinois Power Resources Generating, LLC, Fulton County, IL.***
  Characterization of strip mining areas adjacent to Ash Ponds 1 and 2 at the DCPP.
- ***Hanson, March 2010. Hydrogeologic Report, Ameren Duck Creek Power Generating Station Solid Waste Disposal System (Ash Pond 1, Ash Pond 2, and Recycle Pond).***
  Hydrogeologic site characterization report for multiple ponds at the DCPP.
- ***Hanson, 2009. Section 3 – Hydrogeologic Report, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Springfield, Fulton County, Illinois.***
  An overview prepared to illustrate regional climate, geology, and hydrogeology and site-specific information related to geotechnical, hydrogeological, and geochemical characteristics found at the site.

A GMP is being prepared for the GMF Pond in conjunction with this report and is included in the Operating Permit to which this Report is attached.

1.4 Site Location and Background

The DCPP is located in Fulton County, Illinois and approximately 6 miles southeast of the town of Canton. The GMF Pond is located north of the power plant in Section 18 of Township 6 North,

Range 5 East (**Figure 1-1**). The GMF Recycle Pond is located just south of the GMF Pond (**Figure 1-2**). The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. The Landfill is located due north of the GMF Pond and the closed units, Ash Pond No. 1 and Ash Pond No 2, are located south of the GMF Recycle Pond. Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP (**Figure 1-1**). Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development.

1.5 Site History and Unit Description

Surface preparation for the GMF Pond began in 2007 and construction took place from 2008 to 2009. The GMF Recycle Pond was constructed at the same time.

The GMF Pond, also referred to as the gypsum stack/management system, operates under an IEPA permit (#2017-E0-62640) issued in December 2017. It consists of a 1,500-foot by 900-foot earthen berm with 3.5:1 side slopes, a maximum elevation of 620 feet, a double geomembrane liner consisting of a 60-mil HDPE geomembrane liner, 12-inch clay cushion, 4 oz/yd^2 non-woven geotextile filter fabric, 12-inch highly permeable granular drainage (sand), 10 oz/yd^2 non-woven geotextile filter fabric, 60-mil HDPE geomembrane liner, reinforced bentonite mat, 36-inch compacted clay, all installed over in-situ foundation soil, and all pipes, pumps, and appurtenances necessary for the storage of approximately 3.6 million tons of gypsum at a maximum elevation of 715 feet with discharge to the GMF Recycle Pond.

The GMF Pond decant water discharges to the GMF Recycle Pond, which has a capacity of 32.6 million gallons. The GMF Recycle Pond is lined with a 60-mil HDPE geomembrane liner, reinforced bentonite mat and 36 inches of compacted clay.

2. REGIONAL AND LOCAL GEOLOGY

2.1 Topography

Topography within the DCPP property (**Figure 1-1**) is significantly influenced by the history of mining in the area. Strip mining has occurred in this area since the 1930s prior to mine reclamation laws; and, where present, has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit. The strip mining activity has produced rough topography from soil piles and depressions, often ponded with water (Hanson, 2009). As discussed later in this document, soils in the immediate vicinity of the GMF Pond and GMF Recycle Pond do not appear to have been disturbed by surface mining activities; however, areas surrounding these ponds have been disturbed. Topography adjacent to the GMF Pond is provided in **Figure 2-1**.

2.2 Regional Geomorphology

The DCPP lies near the east edge of Fulton County in north central Illinois. The study area lies along the southeast edge of the Galesburg Plain Division of the Central Lowland Physiographic Province. The area consists of flat to gently rolling uplands that are dissected by many, deeply incised streams that are tributaries to major river systems. The erosional landforms have developed primarily within deposits of glacial drift that blanket Pennsylvanian-aged bedrock. The Pennsylvanian bedrock generally controls the landforms, particularly drainage ways and rivers in the area (Hanson, 2009).

The Illinois River delineates the southeast border of the Galesburg Plain and is the main drainage for the region. The physiography of many areas in the Galesburg Plain has been affected by strip mining of coal. Strip mines have altered the natural landforms and drainage systems. Unreclaimed strip mine areas are usually very hummocky with mine spoils and are pocked with ponds and depressions (Hanson, 2009).

2.3 Soils

Surficial soils at the Site and vicinity are shown on **Figure 2-2**, based on the soil survey performed in Fulton County in 1994 available in the Soil Survey Geographic database (SSURGO) by the United States Department of Agriculture Natural Resources Conservation Service (NRCS) provided by the Environmental Systems Research Institute (ESRI) web-hosted layer (NRCS, 1997).

Former soils underlying the Site are identified as Fayette Silt Loam (#280E2 and #280gD2), Keomah Silt Loam (#17A), and Rozetta Silt Loam (#279B and #279C2). The Fayette series consists of well drained loess on sideslopes along upland drainageways. This soil is well suited for and used as habitat for openland and woodland wildlife. These soils are moderately suitable for cultivated crops due to crusting and water erosion and unsuitable for dwellings due to flooding. The Keomah series consists of somewhat poorly drained loess in interfluvial areas. This soil is well suited for and used as habitat for openland wildlife. These soils are moderately suitable for cultivated crops due to crusting and flooding and only moderately suitable to unsuitable for dwellings due to slope. The Rozetta series consists of well drained loess in interfluvial areas, head slopes, and sideslopes along upland drainageways. This soil is well suited for and used as habitat for openland and woodland wildlife. These soils are moderately suitable for cultivated crops due to crusting and water erosion and only moderately suitable for dwellings due to flooding.

Areas surrounding the GMF Pond are classified as Hickory Silt Loam (#8cF), Elco Silt Loam (#119E2), and Clarksdale Silt Loam (#257A). The Hickory series consists of well-drained till. These soils formed on sideslopes along upland drainageways. Most areas of this association are moderately unsuitable for cultivated crops due to frost heave, low pH, and water erosion. The Elco series consists of moderately well drained loess and underlying paleosol. These soils formed in loess and till on sideslopes along upland drainageways. Most areas of this association are moderately suitable for cultivated crops due to frost heave, low pH, and water erosion. The Clarksdale series consists of somewhat poorly drained loess. These soils formed in interfluvial areas. Most areas of this association are moderately suitable for cultivated crops due to frost heave, low pH, and wetness.

2.4 Regional Geology

Regionally, the DCPP is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province.

2.4.1 Regional Unlithified Geology

Upper unlithified materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems. The erosional landforms have developed primarily within deposits of glacial drift that blanket Pennsylvanian-aged bedrock (NRT/OBG, 2017a).

Areas near the GMF Pond are part of several large surface coal mines (**Figure 2-3**) where unlithified materials are present in the excavated strip mine spoils, but have been mixed due to the surface mining activities. Mining operations in the area have ceased (NRT/OBG, 2017a).

The Radnor Till is the only surficial Quaternary geologic deposit regionally mapped in the vicinity of the GMF Pond and is shown on **Figure 2-4**.

2.4.2 Regional Bedrock Geology

The uppermost bedrock stratum in the area is the Carbondale Formation of the Kewanee Group of the Pennsylvanian System. The Carbondale Formation consists of interbedded sequences of shale, sandstone, limestone, and coal with associated underclay. These sediments were deposited in shallow marine, deltaic, and swamp environments. Some of the shales are fossiliferous (containing either plant or marine fossils), and some contain sideritic nodules and bands. The sandstones are mostly subgraywackes and occur in elongated channel facies. The limestones are generally gray to dark gray, argillaceous, and normally fossiliferous. Thin black fissile shales are commonly associated with the limestones. The Carbondale Formation includes the principle Illinois economic coals: the Herrin (No. 6), the Springfield (No. 5), the Colchester (No. 2), and the Danville (No. 7). Underclays occur at the base of the coal seams. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) coal seam (Hanson, 2009).

2.4.3 Structure

The bedrock surface in the site area has been mapped at about elevation 560 feet NAVD88. The bedrock mapping indicates the beds dip to the east-southeast at about 60 feet per mile. The St. Davis anticline occurs within the Pennsylvanian sequence and passes through the landfill area which explains the lack of strip mining activity in this portion of the DCPP (Hanson, 2005).

2.4.4 Seismic Setting

The major geologic structural features within Illinois are depicted on **Figure 2-5**. Fulton County is not located in a seismic impact zone. The nearest areas of present-day fault-related, seismic activity are the Northern Illinois Seismic Source Zone and the Wabash Valley Fault Zone near southwestern Indiana and the New Madrid Fault Zone along the Ohio and Mississippi River Valleys in southeastern Illinois. Records dating from 1811 indicate that earthquakes greater than a Richter Scale Magnitude 6.0 occurred in or near the New Madrid Fault line. Away from the fault, all earthquakes have been a 5.9 magnitude or less. The earthquake epicenters appear to be the result of modern regional stress fields and are not related to the nearby inactive faults (Hanson, 2009).

2.4.5 Mining Activities

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. As indicated above, strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit at some portions of the Site. Previous investigations completed outside of the GMF Pond at the Site also indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet (as observed at monitoring well OM24D and OM15 near the ash ponds). The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to several former large surface mining areas (**Figure 2-3** and **Appendix A**).

2.5 Site Geology

A field investigation was performed in 2021 to collect additional data for the discussion of vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet below ground surface (bgs) as specified in 35 I.A.C. § 845.620(b). Field investigation locations from 2021 are shown on **Figure 2-6**. The major geomorphic features occurring within and nearby the GMF Pond include Peoria/Roxanna Loess overlying Glasford Formation clayey diamictons (till).

2.5.1 Site-Specific Unlithified Geology

The unlithified stratigraphy within and immediately surrounding the GMF Pond consists of the following in descending order: fill material and CCR; silt and clayey silt loess (Peoria/Roxanna Loess); weathered till (upper Radnor Till); shallow, medium-grained sand to silt zone within the Radnor Till; and till (lower Radnor Till). The unlithified units overlay Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). Boring logs and monitoring well and piezometer construction forms obtained from investigations at the GMF Pond are provided in **Appendix B**. Cross-sections showing the subsurface materials encountered at the GMF Pond are included in **Figures 2-7 and 2-8**. Samples for geotechnical analysis were collected from interpreted geologic units and composited to obtain a representative sample of the entire geologic unit prior to submittal (**Table 2-1**).

2.5.1.1 Fill and CCR

Gypsum is present within the GMF Pond at a maximum thickness of approximately 22 feet, as estimated from topography and the elevation of the base of the liner from available construction details (**Figure 2-9**). The range of gypsum thickness is estimated from less than 1 to 22 feet.

The thickest areas of gypsum are to the north and west within the GMF Pond and thin toward the south end of the GMF Pond. The base of the liner rests on top of the lower Radnor Till.

Geotechnical analysis results from two grab samples (sample IDs Gypsum and LSN-3781/Gypsum) collected from the GMF Pond near XTPW01 are summarized in **Table 2-1**. Sample locations are shown on **Figure 2-6**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results from grab samples near XTPW01 indicated the following:

- Average moisture content of 30.7 percent, with a range of 28.8 to 32.5 percent.
- Total porosity (calculated) of 56.1 percent.
- Dry density of 73.9 pounds per cubic foot (pcf).
- Average specific gravity of 2.51, with a range of 2.310 to 2.700.
- Grain size composition of 0 percent gravel, 4 percent sand, and 96 percent fines (silt and clay).
- Vertical hydraulic conductivity of 6.7 x 10^{-4} centimeters per second (cm/s).

Solid samples were collected from grab samples near XTPW01 in 2021 for chemical analysis. The results of solid samples collected from within the gypsum are summarized in **Table 2-2**.

To sample porewater, a piezometer (pre-pack well, XTPW02) was installed by Golder Associates, Inc. 5.5 feet into the gypsum on June 23, 2021. XTPW02 is located approximately 132 feet east of the western edge of the GMF Pond and is shown on **Figure 2-6**. The piezometer was installed using hand tools (no drilling log). A porewater sample was collected from XTPW02 on June 23, 2021. The results of porewater sample are summarized in **Table 2-3.**

2.5.1.2 Peoria/Roxanna Loess

The Wisconsinan Stage Peoria/Roxanna Loess extends from beneath the topsoil developed in the loess to depths ranging from 11 to 21 feet. The loess consists predominantly of silt and clayey silt with minor amounts of sand. The loess exhibits iron staining, concretions, and some fracturing. The Loess Unit is saturated below depths varying from approximately 3.5 to 11 feet.

Geotechnical analysis results from samples collected from Peoria/Roxanna Loess yielded Unified Soil Classification System (USCS) soil classifications of lean clay. Sample locations are shown on **Figure 2-6,** the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 22.0 percent, with a range of 18.6 to 25.9 percent.
- Average total porosity (calculated) of 37 percent, with a range of 32.4 to 41.8 percent.
- Average dry density of 103.8 pcf, with a range of 97.3 to 113.1 pcf.
- Average specific gravity of 2.67, with a range of 2.650 to 2.680.
- Average grain size composition of 0.1 percent gravel, 8.6 percent sand, and 91.4 percent fines (silt and clay). The fines content ranged from 88.2 to 97.4 percent, with a median value of 88.5 percent.

- Geometric mean vertical hydraulic conductivity of 2.1 x 10^{-7} cm/s and ranged from 7.1 x 10^{-8} to 6.3 x 10^{-7} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the loess are summarized in **Table 2-4**.

2.5.1.3 Upper Radnor Till

The loess is generally underlain by a relatively thin till sequence consisting of the Berry Clay (where present) and the Illinoian Stage upper Radnor Till. The till sequence ranges in thickness from 9 to 21 feet in the area of the GMF Pond. This shallow till is generally weathered and exhibits signs of oxidation and fracturing. The till is primarily clayey silt with minor amounts of sand and gravel.

Geotechnical analysis results from samples collected from the upper Radnor Till yielded USCS soil classifications of lean clay. Sample locations are shown on **Figure 2-6,** the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 22.4 percent, with a range of 21.1 to 24.6 percent.
- Average total porosity (calculated) of 36.8 percent, with a range of 30.7 to 41.4 percent.
- Average dry density of 106.1 pcf, with a range of 98.0 to 116.7 pcf.
- Average specific gravity of 2.69, with a range of 2.680 to 2.700.
- Average grain size composition of 1.5 percent gravel, 22.6 percent sand, and 75.9 percent fines (silt and clay). The fines content ranged from 77 to 80.6 percent, with a median value of 75.4 percent.
- Geometric mean vertical hydraulic conductivity of 7.7 x 10^{-7} cm/s and ranged from 2.6 x 10^{-7} to 2.3 x 10^{-6} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the upper Radnor Till are summarized in **Table 2-4**.

2.5.1.4 Shallow Sand Zone

The Shallow Sand Zone is laterally extensive within the Radnor Till across the site and varies in thickness from less than 1 to 18 feet near the GMF Pond. The top of the Shallow Sand Zone is generally located at an elevation of 570 to 590 feet msl. The Shallow Sand Zone exhibits lateral facies changes across the site and varies from a medium-grained sand to a silt and often contains intercalated till seams, as shown in the hydrogeologic cross sections (**Figures 2-7 and 2-8**). The Shallow Sand Zone is saturated. The Shallow Sand Zone is the most laterally extensive at the GMF Pond, with other zones having either an unsaturated component, intermittent presence, or entirely absent.

During construction, shallow sand was encountered and completely removed from underneath the northeast corner and southwest corner of the GMF Pond, putting the liner in contact with clay of the lower Radnor Till (**Figures 2-7 and 2-8**). Sand outside the GMF Pond footprint remains.

Geotechnical analysis results from samples collected from the Shallow Sand Zone yielded USCS soil classifications of silty lean clay and lean clay. These USCS classifications contain more fines

than expected, and are likely a result of difficulty targeting a thin sand zone within largely fine-grained materials. Sample locations are shown on **Figure 2-6**, the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 17.5 percent, with a range of 14.5 to 21.9 percent.
- Average total porosity (calculated) of 29.5 percent, with a range of 27.4 to 31.4 percent.
- Average dry density of 115.0 pcf, with a range of 105.1 to 122.3 pcf.
- Average specific gravity of 2.663, with a range of 2.640 to 2.700.
- Average grain size composition of 5.7 percent gravel, 27.1 percent sand, and 67.2 percent fines (silt and clay). The fines content ranged from 63.6 to 73.7 percent, with a median value of 64.4 percent.
- Geometric mean vertical hydraulic conductivity of 9.0×10^{-7} cm/s and ranged from 7.5×10^{-7} to 1.1×10^{-6} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the Shallow Sand Zone are summarized in **Table 2-4**.

2.5.1.5 Lower Radnor Till

Till sequences underlying the Shallow Sand Zone consist of clay, silt, and sand of the Illinoian Stage lower Radnor Till. The till ranges in thickness from 42 to 58 feet. In some areas of the site, including the area near the GMF Pond, the till sequences typically extend from the base of the shallow sand to the bedrock surface. In other areas of the site, the till sequences extend to intermediate or deep sands. The till sequences are typically high in silt content with varying amounts of clay, sand, and gravel, and are often calcareous.

Geotechnical analysis results from samples collected from the lower Radnor Till at soil borings yielded USCS soil classifications of silty clayey sand, silty lean clay, and lean clay. Sample locations are shown on **Figure 2-6**, the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 10.5 percent, with a range of 7.7 to 12.6 percent.
- Average total porosity (calculated) of 22.3 percent, with a range of 20.6 to 23.5 percent.
- Average dry density of 127.5 pcf, with a range of 123.2 to 133.8 pcf.
- Average specific gravity of 2.670, with a range of 2.640 to 2.700.
- Average grain size composition of 7.7 percent gravel, 38.2 percent sand, and 54 percent fines (silt and clay). The fines content ranged from 49.3 to 56.5 percent, with a median value of 64.4 percent.
- Geometric mean vertical hydraulic conductivity of 4.7×10^{-7} cm/s and ranged from 4.1×10^{-8} to 5.4×10^{-6} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the lower Radnor Till are summarized in **Table 2-4**.

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2.5.2 Site Specific Bedrock Geology

Pennsylvanian bedrock was encountered at greatly varying depths across the site. Bedrock depths ranged from a minimum of 52 feet to a maximum of 108 feet. Bedrock was encountered at boring locations B-54, B-60, and G54C at 84 feet bgs, 88 feet bgs, and 90 feet bgs, respectively, in the vicinity of the GMF Pond (**Appendix D** for boring locations). The bedrock shows little compositional variation across the site and consists primarily of shaley siltstone and silty shale. The shale bedrock unit is typically weathered near the surface, has low hydraulic conductivity, and underlies the glacial till sequences. These units often contain thin dolomite ledges and nodules and some fractures.

3. REGIONAL AND LOCAL HYDROGEOLOGY

3.1 Regional Hydrogeology

As discussed in **Section 2**, unlithified materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits overlying Pennsylvanian-aged bedrock. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems in areas that have not been disturbed by strip mining activity.

Available records of wells within one mile of the site indicate potable water may be obtained from unconsolidated materials or from deep bedrock. Estimated specific capacity (used to approximate the transmissivity of a formation) indicated shallow sands near the GMF Pond provide a very modest specific capacity and groundwater yield (Hanson, 2009).

3.2 Site Hydrogeology

Wells used for groundwater monitoring at the GMF Pond have been constructed in phases since 2008. Prior to 2021, there were more than 30 wells used to monitor the GMF Pond. In 2021, one additional well (G54C) was installed in bedrock to provide information to meet the requirements of Part 845. Construction details for monitoring wells and piezometers associated with the GMF Pond are provided in **Table 3-1** and depicted in **Figure 3-1**. Boring logs, monitoring well and piezometer construction forms are provided in **Appendix B**.

3.2.1 Hydrostratigraphic Units

Three distinct water-bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics which are summarized and discussed in subsequent sections:

- **The Uppermost Aquifer**: At the GMF Pond this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sands described in detail in **Section 2.5.1**. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (NRT/OBG, 2017a). The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally located at an elevation of 570 to 590 feet msl. The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the northeast corner and southwest corner of the pond), putting the base of liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.
- **Lower Radnor Till/Lower Confining Unit**: Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick. Previous hydrogeologic studies indicate discontinuous sand lenses observed within the till are not hydraulically connected to the shallow sand unit (NRT/OBG, 2017a).
- **Bedrock Confining Unit**: The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet. The boring for monitoring well G54C extends 11.5 feet into the bedrock. Additional bedrock detail is provided in **Section 2.5.2**.

3.2.2 Uppermost Aquifer

As stated above, this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sand zone. The shallow sand zone is the primary migration pathway within these hydraulically connected formations. In places where the shallow sand unit is absent (such as beneath the GMF Pond Liner) the uppermost aquifer may be functionally absent, as the liner is in contact with clay till. Groundwater monitoring is focused in the shallow sand unit because it is the most permeable and laterally continuous unit at the Site. The top of the uppermost aquifer is presented in **Figure 3-2.** The base of the uppermost aquifer is the lower confining unit (the lower Radnor Till).

3.2.3 Potential Migration Pathway

The Peoria/Roxanna Loess within the uppermost aquifer has also been identified as a PMP. While the primary migration pathway is the shallow sand of the uppermost aquifer, impacts have the potential to migrate within groundwater in the overlying Peoria/Roxanna Loess. The PMP is saturated at depths of 3.5 to 11 feet bgs. While the PMP and uppermost aquifer are hydraulically connected, groundwater flow in the PMP is expected to be primarily vertical, with the majority of the horizontal migration expected to occur within the uppermost aquifer. Monitoring wells with the suffix “L” are screened within the loess and provide representative data on the hydraulic properties and groundwater quality of the PMP.

3.2.4 Water Table Elevation and Groundwater Flow Direction

Groundwater flow across the GMF Pond within the uppermost aquifer is consistently in a southeast direction toward the Duck Creek Cooling Pond (**Figures 3-3 and 3-4**). Groundwater elevations of the uppermost aquifer vary seasonally although flow directions are generally consistent (additional contour maps are included in **Appendix D**).

Groundwater elevations in the PMP wells are generally higher than those in the uppermost aquifer and reflect the groundwater flow in the underlying uppermost aquifer wells. Surface water elevations within the GMF Pond are higher than the groundwater.

3.2.4.1 Vertical Hydraulic Gradients

Vertical hydraulic gradients were calculated using available groundwater elevation data from April to August 2021 at wells screened in the PMP, uppermost aquifer, and bedrock (**Table 3-2**). The results of the vertical hydraulic gradient calculations between these hydrostratigraphic units are summarized below:

- Uppermost aquifer to PMP:
  - Vertical hydraulic gradients between wells G51L (PMP) and G51S (uppermost aquifer) ranged from -0.01 to -0.03 feet per feet (ft/ft), upward, averaging 0.02 ft/ft upward
  - G54L (PMP) and G54S (uppermost aquifer) ranged from 0.01 to 0.09 ft/ft downward, averaging 0.04 ft/ft downward
  - G57L (PMP) and G57S (uppermost aquifer) ranged from -0.04 ft/ft upward to 0.12 ft/ft downward, averaging 0.02 ft/ft downward
  - G60L (PMP) and G60S (uppermost aquifer) ranged from 1.2 to 1.6 ft/ft downward, averaging 1.3 ft/ft downward

- Bedrock confining unit to uppermost aquifer:
  - Vertical hydraulic gradients between wells G54C (bedrock confining unit) and G54S (uppermost aquifer) ranged from 0.17 to 0.27 ft/ft, downward, averaging a downward vertical gradient of 0.20 ft/ft

The downward gradients observed between downgradient wells G54L and G54S, and G60L and G60S, are consistent with vertical gradients reported by Hanson in 2009. The slightly upward gradient between upgradient wells G51L and G51S, and the variable gradients between downgradient wells G57L and G57S did not have a comparable measurement from previous studies.

3.2.4.2 Impact of Existing Ponds and Ash Saturation

The GMF Pond is lined, as described in **Section 1.5,** and the shallow sands of the uppermost aquifer were removed from within the footprint of the pond. The phreatic surface measured from a transducer at location X301 within the GMF Pond ranges from approximately 613 to 617 feet NAVD88 with an average around 614 feet (**Appendix D**), whereas groundwater elevations measured in monitoring wells located around the GMF Pond and screened within the uppermost aquifer range from approximately 590 to 578 feet NAVD88. Groundwater elevation contours indicate groundwater generally flow to the southeast, with no indication of radial flow. The elevation difference between the phreatic surface and groundwater elevations, in addition to no observations of radial flow, provide evidence that the GMF Pond does not impact groundwater flow directions via recharge to groundwater. Given the low permeability of the liner system, it is more likely that the GMF Pond is a barrier to groundwater flow within the uppermost aquifer, deflecting flow from upgradient areas around the perimeter of the pond toward the downgradient areas.

With the relatively stable phreatic surface elevation within the pond around 614 feet, the thickness of saturated CCR (gypsum) in the pond will correspond with the thickness of gypsum in the pond. Thicker accumulations of gypsum are present in the north end of the pond and thin to the south.

3.2.4.3 Impact of Surface Water Bodies

The nearest surface water body to the GMF Pond is the Duck Creek Cooling Pond, which is located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Cooling Pond is estimated to be from 562.5 to 565 feet NAVD88. Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond, indicating that groundwater in the vicinity of the GMF Pond is flowing toward the Cooling Pond. The shoreline of the Cooling Pond is very irregular (**Figure 1-1**) as it occupies the former surface water drainage features associated with Duck Creek (which was impounded to create the Cooling Pond).

3.2.5 Hydraulic Conductivities

3.2.5.1 Field Hydraulic Conductivities

Field hydraulic conductivity tests were performed in the uppermost aquifer by Hanson in 2021. Hydraulic conductivity test analyses and results are summarized in **Table 3-3** and provided in **Appendix E**. Field hydraulic conductivity tests from monitoring wells G50L, G51L, G53L, G54L, G60L, G50S, G51S, G53S, G54S, G57S, G60S, and G63S indicated hydraulic conductivities from 3.0×10^{-5} to 3.9×10^{-3} cm/s with a geometric mean of 3.6×10^{-4} cm/s.

Results of field hydraulic conductivity tests conducted in 2021 in the bedrock confining unit by Hanson at monitoring well G54C ranged from 1.4 x 10^{-4} to 1.6 x10^{-4} cm/s, with a geometric mean of 1.5 x 10^{-4} cm/s. This is higher in comparison to the horizontal hydraulic conductivity range of 1.3 x 10^{-6} cm/s to 1.3 x 10^{-9} cm/s, established by Hanson in 2015, which used pressure testing on borehole OM32. The higher values observed at G54C are attributed to the highly weathered nature of the bedrock in the screen interval which is supported by the low rock quality designation (RQD) N values ranging from 14-22 (lower numbers indicating lower percentage of intact rock core recovered).

3.2.5.2 Laboratory Hydraulic Conductivities

Falling head permeability tests (ASTM D5084 Method F) were performed in the laboratory on samples collected during the 2021 investigations. Sample locations are shown on **Figure 2-6**. The geotechnical laboratory report from the most recent investigation and previous investigations (AECOM, 2016) are provided in **Appendix C**. The results are summarized in **Table 2-1** and discussed below.

- One CCR sample (LSN-3781) was collected from gypsum boring XTPW01. Laboratory falling head permeability test results in the CCR indicated a vertical hydraulic conductivity of 6.7 x 10^{-4} cm/s.
- Two samples were collected from the lower Radnor Till from soil boring G54C. Laboratory falling head permeability test results in the lower Radnor Till indicated a vertical hydraulic conductivity ranging from 4.1 x 10^{-8} to 5.4 x 10^{-6} cm/s.
- Seven samples were collected from the uppermost aquifer from soil borings G54C, SB50, and SB62. Laboratory falling head permeability test results in the uppermost aquifer indicated vertical hydraulic conductivities ranging from 7.1 x 10^{-8} to 1.1 x 10^{-6} cm/s, and a geometric mean vertical hydraulic conductivity of 4.6 x 10^{-7} cm/s.

3.2.6 Horizontal Groundwater Gradients and Flow Velocities

Groundwater flow around the GMF is generally in a southeast direction (**Figures 3-3 through 3-4**). Seasonal variation of groundwater levels at the GMF Pond are indicated in the series of 2015 to 2020 groundwater elevation contour maps and groundwater elevation table (**Appendix D**). Observed groundwater elevations may fluctuate seasonally by 1 to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond.

Horizontal hydraulic gradients and groundwater velocities for the uppermost aquifer were calculated based upon groundwater elevation measurements from April through August 2021 between G50S and G60S, G51S and G54S, and G50S and G64S (**Table 3-4**). Horizontal hydraulic gradients are slight across the GMF Pond and ranged from 0.0111 ft/ft between G50S and G64S in August 2021 to 0.0225 ft/ft between G51S and G54S in May 2021. The hydraulic gradients are consistent with previous calculations of horizontal gradients at upgradient locations (NRT/OBG, 2017a).

Horizontal hydraulic gradients calculated to the north of the GMF Pond, between G50S and G64S, were on average 0.0121 ft/ft with an average groundwater velocity of 0.045 feet per day (ft/day). Horizontal hydraulic gradients calculated through the center of the GMF Pond, between G50S and G60S, were on average 0.0172 ft/ft with an average groundwater velocity of 0.625 ft/day. Horizontal hydraulic gradients calculated to the south of the GMF Pond, between G51S

and G54S, were on average 0.0199 ft/ft, with an average groundwater velocity of 0.041 ft/day. From April to June 2021, average groundwater flow velocities at the GMF Pond were 0.024 ft/day and from July to August 2021, groundwater flow velocities at the GMF Pond were on average 0.023 ft/day. Horizontal hydraulic gradients and groundwater flow velocities are presented in **Table 3-4**.

3.2.7 Groundwater Classification

Per 35 I.A.C. § 620.210, groundwater within the uppermost aquifer at the GMF Pond meets the definition of a Class I – Potable Resource Groundwater based on the following criteria:

- Groundwater in the uppermost aquifer extends 10 feet or more below the land surface.
- Hydraulic conductivity exceeds the 1 x 10^{-4} cm/s criterion (**Table 3-3**).

Field hydraulic conductivity tests performed on the unlithified geologic materials that include loess, shallow sand, and intermediate sand at the GMF Pond had geometric mean hydraulic conductivities exceeding 1 x 10^{-4} cm/s. Based on this information groundwater is classified as Class I – Potable Resource Groundwater.

However, background (upgradient) groundwater originates from areas north and west of the GMF Pond that have been surface mined and present a significant alternative source for groundwater impacts.

3.3 Surface Water Hydrology

Surface water drainage over much of the site flows east or southeast into the Duck Creek Cooling Pond. The Duck Creek Cooling Pond was formed by damming a portion of Duck Creek, a minor tributary of the Illinois River, and was used for thermal treatment of cooling water discharged from the DCPP.

3.3.1 Climate

The climate in Canton is humid and annual precipitation generally exceeds evapotranspiration. Illinois State Water Survey (ISWS) records from 1989 through 2020 at Peoria, Illinois, which is located approximately 35 miles northeast of the DCPP, indicates precipitation averages 35.3 inches per year. Monthly precipitation averages higher than 3 inches from April through August, and 1 to 3 inches in September through March. On average 16 inches of precipitation occur as snowfall.

As shown in **Table A** below, ISWS temperature records show average maximum daily temperatures for 1989 to 2020 ranging from above 70 degrees Fahrenheit (°F) in May through September and minimum average daily temperatures that are below freezing December through March.

Table A. Average Monthly Temperature Extremes and Precipitation for Peoria, Illinois

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum Temperature (ºF)	33.3	37.6	49.9	62.5	72.6	81.3	84.4	82.5	76.9	64.5	50.1	37.2	61.2
Minimum Temperature (ºF)	18.3	21.5	31.6	41.8	52.2	61.7	65.4	63.2	55.4	44.1	33.3	22.7	42.7
Precipitation (inches)	1.71	1.60	2.08	3.42	3.93	3.18	3.02	3.10	2.97	2.64	2.35	1.84	35.3
https://www.isws.illinois.edu/warm/stationmeta.asp?site=ICC&from=wx													

3.3.2 Surface Waters

Duck Creek formerly bordered the east perimeter of the DCPP. In this area, Duck Creek has been dammed for use for thermal treatment of cooling water discharge from the DCPP and is now the predominant surface water body in the vicinity of the GMF Pond. Surface water elevations of the Cooling Pond are from 562.5 to 565 feet NAVD88. Other surface waters in the vicinity include Buckheart Creek to the west, and Rice Lake, Miserable Lake, Big Lake, and Goose Lake to the east, all of which are backwater lakes located between Duck Creek and the Illinois River. The distance between the GMF Pond and the Illinois River is sufficient to eliminate influence on local flow conditions at the site; therefore, site-specific flow conditions are not subject to surface water conditions of the Illinois River. Other surface waters in the vicinity of the GMF Pond include freshwater emergent wetland to the east, and various freshwater ponds to the northeast, south, southeast, and southwest.

4. GROUNDWATER QUALITY

4.1 Summary of Groundwater Monitoring Activities

Groundwater monitoring programs are currently being conducted at the GMF Pond as required by USEPA and IEPA. Additional monitoring was completed in 2021 for development of the Part 845 monitoring program. These programs are summarized below.

4.1.1 40 C.F.R. § 257 Program Monitoring and Well Network

The 40 C.F.R. § 257 Well Network consists of seven monitoring wells screened in the uppermost aquifer nearby and adjacent to the GMF Pond including: three background monitoring wells (G02S, G50S, and G51S) and four compliance monitoring wells (G54S, G57S, G60S, and G64S). The boring logs, well construction forms, and other related monitoring well forms for the GMF Pond 40 C.F.R. § 257 Well Network are included in **Appendix B** of this HCR. The well locations are shown on **Figure 3-1**.

Groundwater is being monitored at the GMF Pond in accordance with the Detection Monitoring Program requirements specified in 40 C.F.R. § 257.94. Details of the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the Sampling and Analysis Plan for the GMF Pond (NRT/OBG, 2017b). Results are discussed in **Section 4.2**.

The 40 C.F.R. § 257 groundwater samples are collected semi-annually and analyzed for the field and laboratory parameters from Appendix III of 40 C.F.R. § 257, summarized in **Table B** below.

Table B. 40 C.F.R. § 257 Groundwater Monitoring Program Parameters

Field Parameters[1]		
pH	Groundwater Elevation	
Appendix III Parameters (Total, except total dissolved solids [TDS])		
Boron	Chloride	Sulfate
Calcium	Fluoride	TDS

[1]Dissolved oxygen, temperature, specific conductance, oxidation/reduction potential, and turbidity were recorded during sample collection.

4.1.2 IEPA Groundwater Monitoring

Routine quarterly groundwater monitoring is completed at GMF Pond wells G50L/S, G51L/S, G52L/S, G53L/S, G54L/S, G55L/S, G56L/S, G57L/S, G58L/S, G59L/S, G60L/S, R61L/G61S, G62L, G63L/S, and G64L/S at the GMF Pond, in accordance with Water Pollution Control Permit No. 2017-E0-62640. This permit also requires sampling G65L/S, G66L/S, G67L/S, G70L, G71L/S, and G72L/S at the GMF Recycle Pond. The boring logs, well construction forms, and other related monitoring well forms for the GMF Pond well network are included in **Appendix B** of this HCR. The GMF Pond well locations are shown on **Figure 3-1**. Quarterly and annual samples are analyzed for the following field and laboratory parameters listed in **Table C** below.

Table C. IEPA Groundwater Monitoring Program Parameters

Field Parameters			
pH	Temperature	Specific Conductance	
Groundwater Elevation	Depth to Water (bmp)	Bottom of Well Elevation	
Quarterly Parameters (Dissolved)			
Arsenic	Cadmium	Lead	Sulfate
Boron	Chloride	Manganese	TDS
Annual Parameters (Dissolved)			
Alkalinity, bicarbonate	Chromium	Mercury	Selenium
Alkalinity, carbonate	Cobalt	Nickel	Sodium
Ammonia as Nitrogen	Iron	Nitrate nitrogen	Zinc
Calcium	Magnesium	Potassium	

4.1.3 Part 845 Well Installation and Groundwater Monitoring

In 2021, one additional monitoring well (G54C) was installed between the GMF Pond and the Gypsum Recycling Pond to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b). Additionally, a porewater sample was collected from temporary leachate monitoring location (XTPW02) installed within the GMF Pond to characterize the CCR materials.

Prospective Part 845 monitoring wells were sampled for eight rounds from February to August 2021 and the results were assessed for selection of the GMF Pond Part 845 monitoring well network presented in the groundwater monitoring plan. Samples were collected from the new monitoring points and analyzed for 35 I.A.C. § 845.600 parameters summarized in **Table D** below. Part 845 groundwater monitoring results are included below in **Section 4.2**.

Table D. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
pH	Turbidity	Groundwater Elevation	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1]Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

4.2 Groundwater Monitoring Results and Analysis

Groundwater data collected from the GMF Pond 40 C.F.R. § 257 network monitoring wells from 2015 to 2021 were supplemented with sampling of additional locations in 2021 and evaluated with respect to standards included in 35 I.A.C. § 845.600(a)(1). This data set was selected because it includes parameters (total metals) consistent with the parameter list in 35 I.A.C. § 845.600(a)(1). The groundwater analytical results are summarized in **Table 4-1** and discussed in the subsections below. Field parameters are included in **Table 4-2**. Results indicate that the parameters discussed in the following sections were detected at concentrations greater than the applicable 35 I.A.C. § 845.600(a)(1) standards and are considered potential exceedances[1].

4.2.1 Total Antimony

Total antimony was detected greater than the GWPS (0.006 milligrams per liter [mg/L]) in one of eight samples collected from downgradient well G57S. The other seven samples were non-detect. No other exceedances for total antimony were observed.

4.2.2 Total Arsenic

Total arsenic was detected greater than the GWPS (0.01 mg/L) in eleven downgradient wells G52S, G35S, G54L, G56S, G57L, G58L, G59L, G59S, G60S, G64S and P60. Total arsenic concentrations ranged from 0.001 to 0.051 mg/L. G52S is commonly in a side-gradient or upgradient position.

4.2.3 Total Cobalt

Total cobalt was detected greater than the GWPS (0.006 mg/L) in one of eight samples collected from downgradient well 60L. The other seven samples ranged from non-detect to 0.0052 mg/L. No other exceedances of total cobalt were observed.

4.2.4 Total Lead

Total lead was detected greater than the GWPS (0.0075 mg/L) in nine downgradient wells (G52S, G55S, G56S, G58L, G58S, G59L, G59S, G60S, G63L, and P60); and one background well G51S. Total lead concentrations in downgradient wells ranged from non-detect to 0.041 mg/L. Total lead concentrations in the upgradient well ranged from non-detect to 0.015 mg/L. G52S is commonly in a side-gradient or upgradient position.

4.2.5 Total Mercury

Total mercury was detected greater than the GWPS (0.002 mg/L) in one of 16 samples collected from upgradient well G02S. The other 15 samples were non-detect. No other exceedances for total mercury were observed.

[1] Potential exceedances include results reported during the eight rounds of baseline groundwater monitoring that are greater than the applicable 35 I.A.C. § 845.600(a)(1) standards. The results are considered potential exceedances because they were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the Groundwater Monitoring Plan (GMP). For simplicity, “GWPS” will be used hereafter in discussing potential exceedances. Exceedances will be determined following IEPA approval of the GMP.

4.2.6 pH (Lower Limit)

The GWPS lower standard for pH (6.5 standard units [SU]) was exceeded at four downgradient wells (G52L, G54L, G60L, and P60); and one background well G02S. Measurements of pH ranged from 6 to 7.1 SU in downgradient wells. Measurements ranged from 6.4 to 7.1 SU in the background well. G52L is commonly in a side-gradient or upgradient position.

4.2.7 Radium 226 and 228 Combined

Radium 226 and 228 combined was detected greater than the GWPS (5 picocuries per liter [pCi/L]) in one of five samples collected from bedrock well G54C. Observations ranged from non-detect to 5.38 pCi/L. No other exceedances for radium 226 and 228 combined were observed.

4.2.8 Total Sulfate

Sulfate can be a primary indicator parameter of CCR leachate impacts on groundwater quality. Total sulfate has been detected greater than the GWPS (400 mg/L) at downgradient well G58S in two of four samples. Total sulfate concentrations ranged from 250 to 540 mg/L. No other exceedances of total sulfate were observed.

4.2.9 Total Thallium

Total thallium was detected greater than the GWPS (0.002 mg/L) in one downgradient well (G57S); and one background well G51S. One of eight samples collected for total thallium from downgradient well G57S exceeded the GWPS; the other seven samples were non-detect. One of 16 samples collected for total thallium from background well G51S exceeded the GWPS; the other 15 samples were non-detect. No other exceedances for total thallium were observed.

5. EVALUATION OF POTENTIAL RECEPTORS

5.1 Water Well Survey

A water well survey was conducted for a 1,000 meter radius of the GMF Pond (Hanson, 2021; Ramboll, 2021). Additionally, a potable water well inventory was completed in 2021 utilizing federal and state databases to assess nearby pumping wells, drinking water receptors, and other uses of water in the vicinity of the GMF Pond. The following sources of information were queried to identify well locations, drinking water receptors, and other uses of water within 1,000 meters of the GMF Pond boundary:

- United States Geological Survey (USGS) National Groundwater Monitoring Network (NGWMN)[1]
- Illinois State Geological Survey (ISGS) Illinois Water and Related Wells (ILWATER) Map[2]
- USEPA Safe Drinking Water Information System (SDWIS)[3]
- IEPA Illinois Drinking Water Watch (DWW)[4]

According to the ISGS ILWATER Map, USEPA SDWIS, and IEPA DWW available records, there is one private well located southwest of the GMF Pond and within 1,000-meters of the GMF Pond. There is no data for Fulton County available from USGS NGWMN.

5.2 Surface Water

A search was performed utilizing the United States Fish and Wildlife Service (USFWS) Wetlands Mapper[5] and the USGS National Map[6] for surface water bodies within 1,000 meters of the GMF Pond.

As indicated on the USFWS Wetlands Mapper and USGS National Map, various surface water features were identified within a 1,000-meter radius of the GMF Pond. Surface waters in the vicinity of the GMF Pond include freshwater emergent wetland to the east, and various freshwater ponds to the northeast, south, southeast, and southwest (**Appendix A**).

The predominant surface water body in the region is the Illinois River and associated lowland backwater lakes. Duck Creek, a minor tributary of the Illinois River, formerly bordered the east perimeter of the DCPP. In this area, Duck Creek has been dammed for use for thermal treatment of cooling water discharge from the DCPP and is now the predominant surface water body in the vicinity of the GMF Pond. The distance between the GMF Pond and the Illinois River is sufficient to eliminate influence on local flow conditions at the site; therefore, site-specific flow conditions are not subject to surface water conditions of the Illinois River. Other surface waters in the vicinity of the GMF Pond include freshwater emergent wetland to the east, and various freshwater ponds to the northeast, south, southeast, and southwest. The USGS National Map places the DCPP within the lower Illinois-Lake Chautauqua watershed subbasin (Hydrologic Unit Code [HUC] 07130003) (**Appendix A**).

[1] USGS NGWMN: https://cida.usgs.gov/ngwmn/index.jsp
[2] ISGS ILWATER Map: https://prairieresearch.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87
[3] USEPA SDWIS: https://www.epa.gov/enviro/sdwis-search
[4] IEPA Illinois DWW: http://water.epa.state.il.us/dww/index.jsp
[5] USFWS Wetlands Mapper: https://www.fws.gov/wetlands/data/mapper.html
[6] USGS National Map: https://apps.nationalmap.gov/viewer/

A Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map for Fulton County Unincorporated Areas, Illinois (Map No. 17057C0375E, effective on 02/04/2011) is attached in **Appendix F**. The flood hazard areas to the east of the DCPP are defined as those areas subject to inundation by the 1 percent annual chance flood (*i.e.,* 100-year flood), also known as the base flood, that has a 1 percent chance of being equaled or exceeded in any given year.

5.3 Nature Preserves, Historic Sites, Endangered/Threatened Species

A search of the Illinois Department of Natural Resources (IDNR) Natural Heritage Database[7] for natural areas and protected areas within 1,000 meters of the GMF Pond was performed. According to the IDNR Natural Heritage Database, there are 15 Natural Areas in Fulton County, including two Category III - Nature Preserves (Harper-Rector Woods Nature Preserve [34.67 acres] and Kedzior Woodlands Land and Water Reserve [163.64 acres]). No natural areas were identified within 1,000 meters of the GMF Pond.

The IDNR Natural Heritage Database Threatened and Endangered Species by County[8] lists 11 state threatened and 12 state endangered species in Fulton County. The USFWS Environmental Conservation Online System[9] lists three federally threatened and one federally endangered species in Fulton County (**Appendix A**).

Additionally, a search of the IDNR Historic Preservation Division[10] database for historic sites in the vicinity of the Site yielded no results within 1,000 meters of the GMF Pond. The Illinois State Archaeological Survey (ISAS)[11] databases that do not require credentials to access were also searched and yielded no results within 1,000 meters of the GMF Pond.

[7] IDNR Natural Heritage Database: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Pages/NaturalHeritageDatabase.aspx
[8] Illinois Threatened and Endangered Species by County: https://www2.illinois.gov/dnr/ESPB/Documents/ET_by_County.pdf
[9] Illinois Threatened and Endangered Species by County: https://www2.illinois.gov/dnr/ESPB/Documents/ET_by_County.pdf
[10] IDNR Historic Preservation Division: https://www2.illinois.gov/dnrhistoric/Pages/default.aspx
[11] ISAS: https://www.isas.illinois.edu/

6. CONCLUSIONS

Hydrogeologic characterization of the GMF Pond was originally developed as part of the *Hydrogeologic Report, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Fulton County, Illinois* (Hanson, 2009) and most recently updated for this HCR. Results of these hydrogeologic studies were reintroduced in this HCR and updated to include geologic, hydrogeologic, and groundwater quality data collected with a focus on the GMF Pond (Part 845 regulated) CCR Unit.

The data were summarized and evaluated for changes in groundwater conditions since the previous investigations; available groundwater quality data for the GMF Pond was compared to the Part 845 Standards.

The results of the hydrogeologic and groundwater quality evaluation are:

- The unlithified stratigraphy within and immediately surrounding the GMF Pond consists of the following in descending order: fill material and CCR (gypsum); silt and clayey silt loess (Peoria/Roxanna Loess); weathered till (upper Radnor Till); shallow, medium-grained sand to silt zone; and till (lower Radnor Till).
- The unlithified units overlay Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). Bedrock was encountered approximately 90 feet bgs at the GMF Pond.
- Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit at some portions of the DCPP property. Previous investigations completed outside of the GMF Pond indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to and downgradient of several former large surface mining areas.
- Three distinct water-bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics:
  - **Uppermost Aquifer:** At the GMF Pond this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the Shallow Sand Zone. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (NRT/OBG, 2017a). The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally located at an elevation of 570 to 590 feet msl. The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the northeast corner and southwest corner of the pond), putting the base of the liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.
  - **Lower Radnor Till/Lower Confining Unit:** Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick.

  - **Bedrock Confining Unit:** The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet.

- Groundwater flow around the GMF Pond is generally in a southeast direction. Seasonal variation of groundwater levels at the GMF Pond are present and may fluctuate approximately 1 to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond associated with the elevation changes.
- Surface water drainage over much of the site flows east or southeast into the Duck Creek Cooling Pond. The Duck Creek Cooling Pond was formed by damming a portion of Duck Creek, a minor tributary of the Illinois River.
- The nearest surface water body to the GMF Pond is the Duck Creek Cooling Pond, which is located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Cooling Pond is estimated from 562.5 to 565 feet NAVD88. Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond, indicating that groundwater in the vicinity of the GMF Pond is flowing toward the Cooling Pond.
- Groundwater flow velocities in the uppermost aquifer are estimated from 3.1×10^{-2} to 6.5×10^{-1} ft/day.
- The GMF Pond is lined and the shallow sands of the uppermost aquifer were removed from within the footprint of the pond during construction. The GMF Pond does not appear to impact groundwater flow directions via recharge to groundwater. Given the low permeability of the liner system and the removal of sand below the unit, it is more likely that the GMF Pond is a barrier to groundwater flow within the uppermost aquifer deflecting flow from upgradient areas around the perimeter of the pond toward the downgradient areas south and east of the pond toward the Cooling Pond.
- Based on the detailed geologic information provided, and the hydrogeologic and groundwater quality data, groundwater within the uppermost aquifer at the GMF Pond is classified as Class I – Potable Resource Groundwater. However, background (upgradient) groundwater originates from areas north and west of the GMF Pond that have been extensively surface mined and present a significant alternative source for groundwater impacts.
- Antimony, arsenic, cobalt, lead, pH, sulfate, and thallium were detected at least once at concentrations greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). Lead, mercury, pH, and thallium were detected at concentrations greater than the GWPS in upgradient uppermost aquifer wells. Radium 226 and 228 combined was detected once at concentrations greater than the GWPS in the bedrock confining unit well.

Groundwater results are considered potential exceedances because they were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the GMP.

This HCR satisfies Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the GMF Pond at the DCPP.

7. REFERENCES

Federal Emergency Management Agency (FEMA), 2021. Flood Insurance Rate Map for Fulton County Unincorporated Areas, Illinois (Map No. 17057C0375E, effective on 02/04/2011). Accessed on August 27, 2021 from URL: https://msc.fema.gov/portal/search?AddressQuery=17751%20North%20Cilco%20Rd%2C%20Canton%2C%20IL#searchresultsanchor

Hanson Professional Services, Inc. (Hanson), 2005. *Geology and Hydrogeology Report* in Illinois EPA Bureau of Land Permit Application – Log No. 2005-121-LF. Hanson Professional Services Inc., Springfield, IL, 115 pp + App.

Hanson Professional Services, Inc. (Hanson), 2009. Section 3 – *Hydrogeologic Report*, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Springfield, Fulton County, Illinois.

Hanson Professional Services, Inc. (Hanson), 2015. *Aquifer Evaluation in the Surface Strip Mining Area (Ash Ponds 1 and 2).* December 22, 2015.

Hanson Professional Services, Inc. (Hanson), 2021. *First Quarter 2021 Groundwater Report, Duck Creek Power Station, Gypsum Stack and Recycle Pond*, WPC Permit No. 2017-EO-62640, Fulton County. March 25, 2021.

Illinois Department of Natural Resources (IDNR), 2021. Natural Heritage Database. Accessed from URL: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Pages/NaturalHeritageDatabase.aspx

Illinois Environmental Protection Agency (IEPA), 2021. Illinois Drinking Water Watch (DWW). Accessed from URL: http://water.epa.state.il.us/dww/index.jsp

Illinois Environmental Protection Agency (IEPA), 2021. *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New Title 35 Illinois Administration Code 845, Addendum*. April 15, 2021.

Illinois State Geological Survey (ISGS), 2021. Fulton County Coal Data, including Mine Map and Mine Directory. Accessed on August 27, 2021 from URL: https://isgs.illinois.edu/research/coal/maps/county/fulton

Illinois State Geological Survey (ISGS), 2021. Fulton County Coal Data, including Mine Map and Mine Directory. Accessed on August 27, 2021 from URL: https://isgs.illinois.edu/research/coal/maps/county/fulton

Illinois State Geological Survey (ISGS), 2021. *Illinois Water & Related Wells Map (ILWATER) for 17751 North Cilco Rd Canton, IL 61520*. Accessed from URL: https://prairie-research.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87

Illinois State Geological Survey (ISGS), 2021. ILMINES Interactive Map. Accessed from URL: https://isgs.illinois.edu/illinois-coal-mines-ilmines

Illinois State Water Survey (ISWS), 2021. *Official Climate Network: Station Data: Peoria. 1989-2020.* Accessed from URL: https://www.isws.illinois.edu/warm/stationmeta.asp?site=ICC&from=wx

NRCS, 1997. *Soil Survey of Fulton County, Illinois, Part 1*. Natural Resources Conversation Service. 1997.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017a. *Hydrogeologic Monitoring Plan, Duck Creek GMF Pond – CCR Unit ID 203 and Duck Creek Landfill – CCR Unit ID 204.* October 17, 2017.

Natural Resource Technology, an OBG Company. (NRT/OBG), 2017b. *Sampling and Analysis Plan, Final, Duck Creek GMF Pond, Duck Creek Power Station, Canton, Illinois, Project No. 2285, Revision 0.* October 17, 2017.

United States Environmental Protection Agency (USEPA), 2021. Safe Drinking Water Information System (SDWIS). Accessed from URL: https://www.epa.gov/enviro/sdwis-search

United States Fish and Wildlife Service (USFWS), 2021. Environmental Conservation Online System. Listed species believed to or known to occur in Fulton County, Illinois. Accessed from URL: https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=17057

United States Fish and Wildlife Service (USFWS), 2021. Wetlands Mapper, National Wetlands Inventory, surface waters and wetlands. Accessed from URL: https://www.fws.gov/wetlands/data/mapper.html

United States Geological Survey (USGS), 2021. Daily Gauge Height January 1, 2018 to May 31, 2021 for USGS Gaging Station 05568615 at the Illinois River at Copperas Creek, Illinois. Accessed from URL: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=05568615

United States Geological Survey (USGS), 2021. National Groundwater Monitoring Network (NGWMN). Accessed from URL: https://cida.usgs.gov/ngwmn/index.jsp

United States Geological Survey (USGS), 2021. National Map Viewer. Accessed from URL: https://apps.nationalmap.gov/viewer/

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TABLES

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TABLE 2-1. GEOTECHNICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample ID	Field Location ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Moisture Content (%)	Dry Density (pcf)	Specific Gravity	Total Porosity[1] (%)	Vertical Hydraulic Conductivity (cm/s)	LL	PL	PI	Laboratory USCS	Gravel (%)	Sand (%)	Fines (%)
Peoria/Roxana Loess															
G54C-Comp 1	G54C	7	19	18.6	113.1	2.680	32.4	--	35	22	13	CL	0.2	11.6	88.2
G54C-ST14-16	G54C	14	16	22.2	104.0	--	--	7.10E-08	--	--	--	--	--	--	--
SB50/ST10-12	SB50	10	12	25.9	98.0	--	--	6.30E-07	--	--	--	--	--	--	--
SB50-Comp 1	SB50	5	19	24.9	97.3	2.680	41.8	--	32	23	9	CL	0.0	2.6	97.4
SB62/ST12-14	SB62	12	14	21.1	105.5	--	--	1.90E-07	--	--	--	--	--	--	--
SB62-Comp 1	SB62	7	19	19.3	104.7	2.650	36.7	--	35	22	13	CL	0.0	11.5	88.5
Upper Radnor Till															
G54C-Comp 2	G54C	25	33	24.6	98.0	2.680	41.4	--	40	18	22	CL	1.0	18.4	80.6
SB50/ST22-24	SB50	22	24	21.8	106.3	--	--	2.60E-07	--	--	--	--	--	--	--
SB50-Comp 2	SB50	21	31	21.1	116.7	2.700	30.7	--	28	18	10	CL	3.4	26.5	70.1
SB62/ST26-28	SB62	26	28	23.2	105.3	--	--	2.30E-06	--	--	--	--	--	--	--
SB62-Comp 2	SB62	23	33	21.5	104.1	2.700	38.2	--	29	17	12	CL	0.0	23	77
Shallow Sand Zone															
G54C-Comp 3	G54C	35	41	18.2	113.0	2.640	31.4	--	24	19	5	CL-ML	10.6	25.8	63.6
G54C-ST32-34	G54C	32	34	21.9	105.1	--	--	7.50E-07	--	--	--	--	--	--	--
SB50-Comp 3	SB50	31	39	17.1	122.3	2.700	27.4	--	27	18	9	CL	3.6	32	64.4
SB62/ST38-40	SB62	38	40	15.6	118.4	--	--	1.10E-06	--	--	--	--	--	--	--
SB62-Comp 3	SB62	33	39	14.5	116.1	2.650	29.8	--	26	19	7	CL-ML	2.9	23.4	73.7
Lower Radnor Till															
G54C-Comp 4	G54C	47	73	9.8	128.4	2.670	22.9	--	21	13	8	CL	7.4	36.3	56.3
G54C-ST44-46	G54C	44	46	12.2	126.1	--	--	5.40E-06	--	--	--	--	--	--	--
G54C-ST76-78	G54C	76	78	12.6	123.2	--	--	4.10E-08	--	--	--	--	--	--	--
SB50-Comp 4	SB50	41	51	7.7	133.8	2.700	20.6	--	21	15	6	SC-SM	12.9	37.8	49.3
SB62-Comp 4	SB62	41	51	10.0	126.1	2.640	23.5	--	21	15	6	CL-ML	2.8	40.7	56.5
CCR															
Gypsum	XTPW01[2]	grab	grab	32.5	--	2.310	--	--	--	--	--	Gypsum	0.0	4	96
LSN-3781/Gypsum	XTPW01[2]	grab	grab	28.8	73.9	2.700	56.1	6.70E-04	--	--	--	--	--	--	--

[O:FPO 7/13/21, U: EDP 8/25/21, C:LDC 09/07/21, C:SSW 09/16/21]

Notes:
[1] Porosity calculated as relationship of bulk density (p_b) to particle density (p_d) (n = 100[1- (p_b/p_d)])
[2] Gypsum grab samples were collected near location XTPW01
-- = Not Analyzed
% = Percent
bgs = below ground surface
CCR = coal combustion residuals
cm/s = centimeters per second
ft = foot/feet
GMF = Gypsum Management Facilty
LL = Liquid limit
pcf = pounds per cubic foot
PI = Plasticity Index
PL = Plastic Limit

USCS = Unified Soil Classification System
CL = lean clay
CL-ML = silty lean clay
SC-SM = Silty Clayey Sand

HSU = Hydrostratigraphic Unit
LCU = lower confining unit
UA = uppermost aquifer

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TABLE 2-2. CCR ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Plant	Sample Location	Sample Depth (ft)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chloride (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Fluoride (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Sulfate (mg/kg)	Thallium (mg/kg)
DC	GMF Gypsum	0-0	03/08/2021	<3	<1	6	<1	16	<1	100000	64	<4	<2	20	<1	<5	2.9	2.3	14000	<1

Notes:
-- = data not available
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
ft = feet
mg/kg = milligrams per kilogram

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TABLE 2-3. POREWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)
XTPW02	06/23/2021	<0.003	0.0026	0.059	<0.001	63	0.0066	750	3900	<0.004	0.0064	22.6	<0.001	0.26	0.00054	1.4	6.6	2.65	2.1	4300	0.0015

Notes:
Field readings are reported with as many significant figures as provided by analytical laboratory.
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units

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TABLE 2-4. SOIL ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Geologic Unit	Sample Depth (ft BGS)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Chloride (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Fluoride (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Sulfate (mg/kg)	Thallium (mg/kg)
SB-50	Peoria/Roxana Loess	4-18	02/02/2021	<2.8	<0.95	75	<0.95	<9.5	<0.95	<1	18	4	<0.25	6.7	6.7	<0.19	<0.95	<0.95	3	<0.95
SB-50	Upper Radnor Till	20-30	02/02/2021	<2.7	1.6	36	<0.91	<9.1	<0.91	<1	12	6.3	<0.25	10	12	<0.18	<0.91	<0.91	<1	<0.91
SB-50	Shallow Sand Zone	30-38	02/02/2021	<3	8.1	29	<1	<10	<1	<1	8.8	5.4	<0.25	7	11	<0.2	1.8	<1	<1	<1
SB-50	Lower Radnor Till	40-50	02/02/2021	<3	3.1	17	<1	<10	<1	<10	6.1	3.5	<2.5	4.3	14	<0.2	<1	<1	270	<1
SB-62	Peoria/Roxana Loess	6-18	02/03/2021	<3	4.6	87	<1	<10	<1	<10	16	3.5	<2.5	7.2	6.4	<0.2	<1	<1	27	<1
SB-62	Upper Radnor Till	22-32	02/03/2021	<3	3.2	30	<1	<10	<1	<10	8.3	4.3	<2.5	6.6	9.5	<0.2	<1	<1	12	<1
SB-62	Shallow Sand Zone	32-38	02/03/2021	<3	3.2	26	<1	<10	<1	<10	8.1	5.4	<2.5	7.2	9.3	<0.2	<1	<1	11	<1
SB-62	Lower Radnor Till	40-50	02/03/2021	<3.3	2.3	20	<1.1	12	<1.1	<11	6	2.7	<2.7	5	20	<0.22	<1.1	<1.1	130	<1.1
G54C	Peoria/Roxana Loess	6-18	02/03/2021	<2.8	2.5	100	<0.93	<9.3	<0.93	10	17	4.1	3	6.6	9.4	<0.19	<0.93	<1.9	37	<0.93
G54C	Upper Radnor Till	24-32	02/03/2021	<3	1.7	21	<1	<10	<1	<10	9.1	5.6	3.7	9.5	8.5	<0.2	<1	<1	11	<1
G54C	Shallow Sand Zone	34-40	02/04/2021	<2.4	3	33	<0.79	<7.9	<0.79	<10	9	5	<2.5	6	11	<0.16	1.7	<0.79	13	<0.79
G54C	Lower Radnor Till	46-80	02/04/2021	<2.1	9.4	86	0.87	<7.2	<0.72	<10	13	7	5.7	11	7	<0.14	<0.72	<0.72	<10	<0.72

Notes:
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
BGS = below ground surface
ft = foot or feet
mg/kg = milligrams per kilogram

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TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G02L	--	12/10/2003	--	621.94	Top of Disk	619.50	10.00	15.00	609.50	604.50	15.00	603.50	5	2	40.512901	-89.991114
G02S	UA	09/29/2003	--	621.66	Top of Disk	619.18	23.00	28.00	596.18	591.18	28.00	589.20	5	2	40.512879	-89.991105
G50L	UA/PMP	03/13/2007	623.52	623.52	Top of Riser	620.85	11.61	16.32	609.24	604.53	16.70	604.10	4.7	2	40.508688	-89.990606
G50S	UA	03/13/2007	623.65	623.65	Top of Riser	620.83	29.17	33.98	591.66	586.85	34.30	586.50	4.8	2	40.508672	-89.990607
G51L	UA/PMP	01/28/2008	619.74	619.74	Top of Riser	616.84	12.04	16.83	604.80	600.01	17.21	599.10	4.8	2	40.506573	-89.990864
G51S	UA	01/28/2008	619.66	619.66	Top of Riser	616.83	24.01	28.79	592.82	588.04	29.16	587.70	4.8	2	40.50656	-89.990864
G52L	UA/PMP	01/22/2008	619.55	619.55	Top of Riser	616.70	29.21	33.80	587.49	582.90	34.17	582.50	4.6	2	40.504515	-89.990871
G52S	UA	01/22/2008	619.62	619.62	Top of Riser	616.56	39.15	43.93	577.41	572.63	44.20	570.60	4.8	2	40.504502	-89.990869
G53L	UA/PMP	02/05/2009	623.24	623.24	Top of Riser	620.34	16.97	26.32	603.37	594.02	26.79	593.60	9.4	2	40.508739	-89.988768
G53S	UA	02/05/2009	623.05	623.05	Top of Riser	620.36	30.64	35.13	589.72	585.23	35.56	584.30	4.5	2	40.508739	-89.988753
G54C	BR	02/05/2021	622.72	622.72	Top of PVC	619.59	91.59	101.50	528.00	518.09	102.00	517.59	9.07	2	40.504533	-89.988975
G54L	UA/PMP	02/12/2009	622.95	622.95	Top of Riser	620.18	27.32	36.75	592.86	583.43	37.22	583.00	9.4	2	40.504524	-89.988927
G54S	UA	02/12/2009	622.98	622.98	Top of Riser	620.25	43.50	47.97	576.75	572.28	48.41	571.80	4.5	2	40.504525	-89.98894
G55L	UA/PMP	02/19/2009	623.20	623.20	Top of Riser	620.45	36.12	36.60	584.33	583.85	36.60	583.90	0.5	2	40.504532	-89.988061
G55S	UA	02/19/2009	622.89	622.89	Top of Riser	620.11	41.04	45.49	579.07	574.62	45.96	574.20	4.5	2	40.504522	-89.988062
G56L	UA/PMP	02/16/2009	622.42	622.42	Top of Riser	619.96	13.77	22.11	606.19	597.85	22.89	597.10	8.3	2	40.504643	-89.987075
G56S	UA	02/16/2009	622.71	622.71	Top of Riser	619.84	33.17	37.66	586.67	582.18	38.29	579.80	4.5	2	40.504633	-89.987076
G57L	UA/PMP	01/30/2009	622.90	622.90	Top of Riser	620.22	16.17	25.62	604.05	594.60	26.00	594.20	9.5	2	40.50562	-89.987044
G57S	UA	01/30/2009	622.76	622.76	Top of Riser	620.20	29.65	34.18	590.55	586.02	34.62	582.20	4.5	2	40.505608	-89.987043
G58L	UA/PMP	01/26/2009	622.95	622.95	Top of Riser	620.17	20.69	30.10	599.48	590.07	30.56	589.60	9.4	2	40.506004	-89.987036
G58S	UA	01/26/2009	622.93	622.93	Top of Riser	620.06	31.32	35.80	588.74	584.26	36.43	583.60	4.5	2	40.505993	-89.987033
G59L	UA/PMP	01/23/2009	622.35	622.35	Top of Riser	620.11	22.91	32.33	597.20	587.78	33.03	587.10	9.4	2	40.506386	-89.987023
G59S	UA	01/23/2009	622.79	622.79	Top of Riser	620.11	37.38	41.88	582.73	578.23	42.49	577.60	4.5	2	40.506375	-89.987023

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TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G60L	UA/PMP	01/17/2008	615.39	615.39	Top of Riser	612.69	20.12	24.91	592.57	587.78	25.28	587.40	4.8	2	40.506745	-89.986816
G60S	UA	01/16/2008	615.03	615.03	Top of Riser	612.33	31.12	35.91	581.21	576.42	36.29	574.30	4.8	2	40.506732	-89.986815
G61S	UA	01/21/2009	622.58	622.58	Top of Riser	620.11	30.19	34.63	589.92	585.48	35.26	582.10	4.4	2	40.507213	-89.987013
G62L	UA/PMP	01/22/2009	623.48	623.48	Top of Riser	620.37	20.31	29.66	600.06	590.71	30.12	582.40	9.4	2	40.507597	-89.987012
G63L	UA/PMP	02/02/2009	623.03	623.03	Top of Riser	620.27	18.47	27.89	601.80	592.38	28.36	591.90	9.4	2	40.507992	-89.987
G63S	UA	02/02/2009	623.00	623.00	Top of Riser	619.98	34.52	39.01	585.46	580.97	39.47	580.00	4.5	2	40.50798	-89.986998
G64L	UA/PMP	01/22/2009	622.46	622.46	Top of Riser	620.24	18.12	27.48	602.12	592.76	27.95	592.30	9.4	2	40.508378	-89.987007
G64S	UA	01/22/2009	623.06	623.06	Top of Riser	620.25	34.50	38.99	585.75	581.26	39.48	580.30	4.5	2	40.508365	-89.987011
G65L	UA/PMP	01/15/2008	612.76	612.76	Top of Riser	610.29	17.28	22.08	593.01	588.21	22.45	587.80	4.8	2	40.50266	-89.987293
G65S	UA	01/15/2008	612.94	612.94	Top of Riser	610.09	26.92	31.70	583.17	578.39	32.08	577.40	4.8	2	40.502657	-89.987313
G66L	UA/PMP	02/04/2009	617.93	617.93	Top of Riser	614.98	9.84	19.27	605.14	595.71	19.74	595.20	9.4	2	40.503359	-89.987127
G66S	UA	02/04/2009	617.83	617.83	Top of Riser	615.04	35.10	39.59	579.94	575.45	40.59	574.50	4.5	2	40.503346	-89.987129
G67L	--	02/03/2009	617.26	617.26	Top of Riser	614.77	7.36	16.72	607.41	598.05	17.18	597.60	9.4	2	40.504146	-89.987257
G67S	--	02/03/2009	617.77	617.77	Top of Riser	614.81	31.09	35.58	583.72	579.23	36.21	576.80	4.5	2	40.504154	-89.98727
G68L	--	02/09/2009	616.31	616.31	Top of Riser	614.28	15.48	24.85	598.80	589.43	25.31	589.00	9.4	2	40.504213	-89.988407
G68S	--	02/09/2009	616.93	616.93	Top of Riser	614.24	34.75	39.22	579.49	575.02	39.88	568.20	4.5	2	40.50421	-89.988421
G69L	--	02/10/2009	616.95	616.95	Top of Riser	614.56	15.31	24.68	599.25	589.88	25.15	589.40	9.4	2	40.504194	-89.989567
G69S	--	02/10/2009	617.65	617.65	Top of Riser	614.68	36.08	40.58	578.60	574.10	41.01	573.70	4.5	2	40.504194	-89.989552
G70L	--	11/18/2008	617.76	617.76	Top of Riser	615.08	20.19	29.54	594.89	585.54	30.00	585.10	9.4	2	40.503721	-89.990033
G71L	--	11/20/2008	617.52	617.52	Top of Riser	615.13	19.80	29.29	595.33	585.84	30.20	584.90	9.5	2	40.502994	-89.989596
G71S	--	11/20/2008	617.81	617.81	Top of Riser	615.24	33.96	37.96	581.28	577.28	38.40	575.20	4	2	40.503005	-89.989603
G72L	--	11/19/2008	617.71	617.71	Top of Riser	614.86	14.65	24.01	600.21	590.85	24.79	590.10	9.4	2	40.502439	-89.988767
G72S	--	11/19/2008	617.61	617.61	Top of Riser	615.03	30.16	34.64	584.87	580.39	35.09	575.60	4.5	2	40.502439	-89.988785

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TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G73L	--	02/06/2009	617.64	617.64	Top of Riser	614.78	24.63	33.98	590.15	580.80	34.76	580.00	9.4	2	40.502492	-89.987727
P60	UA/PMP	03/15/2017	622.22	622.22	Top of Riser	619.82	29.55	34.14	590.27	585.68	34.60	585.20	4.6	2	40.506753	-89.987023
P61	UA/PMP	09/23/2021	613.96	613.96	Top of PVC	611.09	7.55	18.37	602.38	592.72	18.76	591.09	9.66	2	40.507167	-89.986146
P62	UA/PMP	09/23/2021	613.54	613.54	Top of PVC	610.81	11.18	15.78	599.63	595.03	16.30	594.51	4.6	2	40.507762	-89.986782
P63	UA/PMP	09/23/2021	614.47	614.47	Top of PVC	612.33	13.04	17.63	599.29	594.70	18.25	594.08	4.59	2	40.508145	-89.986768
P64	UA/PMP	09/23/2021	616.47	616.47	Top of PVC	614.04	6.17	15.96	607.87	598.08	16.47	597.57	9.79	2	40.508911	-89.986794
R61L	PMP	03/14/2017	622.39	622.39	Top of Riser	619.66	18.54	28.17	601.12	591.49	28.70	591.00	9.6	2	40.507228	-89.987014
R72S	--	11/09/2016	617.57	617.57	Top of Riser	614.81	29.83	34.49	584.98	580.32	35.00	579.90	4.7	2	40.502442	-89.988803
X301	S	--	--	--	--	--	--	--	--	--	--	--	--	--	40.504777	-89.990046
XTPW02	CCR	06/23/2021	617.20	617.20	Top of PVC Casing	615.00	3.02	5.02	611.98	609.98	5.14	609.50	2	1	40.519976	-89.98991

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
BGS = below ground surface
BR = bedrock
CCR = coal combustion residuals
ft = foot or feet
HSU = Hydrostratigraphic Unit
PMP = potential migration pathway
PVC = polyvinyl chloride
S = source water
UA = uppermost aquifer
UA/PMP = uppermost aquifer/potential migration pathway

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TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Date	G51L Groundwater Elevation (ft NAVD88) PMP	G51S Groundwater Elevation (ft NAVD88) UA	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
4/14/2021	610.50	610.69	-0.19	12.68	-0.01	up
4/28/2021	609.12	609.35	-0.23	12.68	-0.02	up
5/10/2021	610.72	610.93	-0.21	12.68	-0.02	up
6/1/2021	609.14	609.44	-0.30	12.68	-0.02	up
6/10/2021	606.57	606.98	-0.41	12.68	-0.03	up
6/21/2021	608.97	609.37	-0.40	12.68	-0.03	up
7/12/2021	610.66	610.91	-0.25	12.68	-0.02	up
7/26/2021	608.51	608.84	-0.33	12.68	-0.03	up
8/5/2021	605.95	606.34	-0.39	12.68	-0.03	up
			Middle of screen elevation G51L			602.4
			Middle of screen elevation G51S			589.7

Date	G54L Groundwater Elevation (ft NAVD88) PMP	G54S Groundwater Elevation (ft NAVD88) UA	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
4/14/2021	591.47	590.44	1.03	16.97	0.06	down
4/28/2021	591.11	590.52	0.59	16.61	0.04	down
5/10/2021	591.22	590.53	0.69	16.72	0.04	down
6/1/2021	591.52	590.80	0.72	17.02	0.04	down
6/10/2021	591.78	591.07	0.71	17.28	0.04	down
6/21/2021	592.11	591.23	0.88	17.61	0.05	down
7/12/2021	592.97	591.76	1.21	13.66	0.09	down
7/26/2021	592.50	591.98	0.52	18.00	0.03	down
8/5/2021	592.79	592.55	0.24	18.29	0.01	down
			Middle of screen elevation G54L			588.2
			Middle of screen elevation G54S			574.5

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TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Date	G54S Groundwater Elevation (ft NAVD88)	G54C Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	UA	BCU				
4/14/2021	590.44	581.99	8.45	51.04	0.17	down
4/28/2021	590.52	581.10	9.42	51.04	0.18	down
5/10/2021	590.53	580.11	10.42	51.04	0.20	down
6/1/2021	590.80	581.00	9.80	51.04	0.19	down
6/10/2021	591.07	580.47	10.60	51.04	0.21	down
6/21/2021	591.23	579.83	11.40	51.04	0.22	down
7/12/2021	591.76	582.36	9.40	51.04	0.18	down
7/26/2021	591.98	581.64	10.34	51.04	0.20	down
8/5/2021	592.55	578.99	13.56	51.04	0.27	down
			Middle of screen elevation G54S			574.5
			Middle of screen elevation G54C			523.5

Date	G57L Groundwater Elevation (ft NAVD88)	G57S Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	PMP	UA				
4/14/2021	603.07	601.83	1.24	13.35	0.09	down
4/28/2021	602.15	601.99	0.16	12.43	0.01	down
5/10/2021	604.41	602.61	1.80	14.69	0.12	down
6/1/2021	603.88	603.89	-0.01	14.16	0.00	flat
6/10/2021	603.17	603.20	-0.03	13.45	0.00	up
6/21/2021	602.45	602.52	-0.07	12.73	-0.01	up
7/12/2021	604.81	604.68	0.13	12.68	0.01	down
7/26/2021	604.43	604.41	0.02	14.71	0.00	flat
8/5/2021	603.00	603.51	-0.51	13.28	-0.04	up
			Middle of screen elevation G57L			602.4
			Middle of screen elevation G57S			589.7

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TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Date	G60L Groundwater Elevation (ft NAVD88)	G60S Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	PMP	UA				
4/14/2021	606.78	590.16	16.62	11.36	1.5	down
4/28/2021	603.75	589.76	13.99	11.36	1.2	down
5/10/2021	606.16	590.34	15.82	11.36	1.4	down
6/1/2021	605.20	590.54	14.66	11.36	1.3	down
6/10/2021	603.76	590.02	13.74	11.36	1.2	down
6/21/2021	603.43	589.48	13.95	11.36	1.2	down
7/12/2021	609.27	591.02	18.25	11.36	1.6	down
7/26/2021	605.97	590.71	15.26	11.36	1.3	down
8/5/2021	604.40	590.05	14.35	11.36	1.3	down
			Middle of screen elevation G60L			590.2
			Middle of screen elevation G60S			578.8

[O:EDP 8/26/21 U: LDC 09/09/21, C: SSW 09/17/21]

Notes:
1. Distance change was calculated using the midpoint of the piezometer screen and water table surface. If the water table surface was above the top of the monitoring well screen, then distance change was calculated using the midpoint of both screens.
2. Vertical gradients between ±0.0015 are considered flat, and typically have less than 0.02 foot difference in groundwater elevation between wells.

-- = Not calculated
BCU = bedrock confining unit
dh = head change
dl = distance change
ft = feet
NAVD88 = North American Vertical Datum of 1988
PMP = potential migration pathway
UA = uppermost aquifer

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TABLE 3-3. FIELD HYDRAULIC CONDUCTIVITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well ID	Gradient Position	Bottom of Screen Elevation (ft NAVD88)	Screen Length [1] (ft)	Field Identified Screened Material	Slug Type	Analysis Method	Falling Head (Slug In) K (cm/s)	Rising Head (Slug Out) K (cm/s)	Minimum Hydraulic Conductivity (cm/s)	Maximum Hydraulic Conductivity (cm/s)	Hydraulic Conductivity Geometric Mean (cm/s)
Uppermost Aquifer (Peoria/Roxana Loess, Upper Radnor Till, Shallow Sand)											
G50L	U	604.53	4.70	ML/CL	Solid	KGS Model	2.30E-03	2.10E-03	3.00E-05	3.90E-03	3.6E-04
G51L	U	600.01	4.80	ML/CL	Solid	KGS Model	3.00E-05	---			
G53L	D	594.02	9.40	CL/ML	Solid	KGS Model	1.10E-04	1.10E-04			
G54L	D	583.43	9.40	CL/ML	Solid	Bouwer-Rice	4.90E-05	2.20E-04			
G60L	D	587.78	4.80	CL/ML	Solid	KGS Model	2.30E-04	2.60E-04			
G50S	U	586.85	4.80	S(ML), CL/ML	Solid	KGS Model	6.50E-05	1.50E-04			
G51S	U	588.04	4.80	CL/ML, SP	Solid	Bouwer-Rice / KGS Model	7.20E-05	1.10E-04			
G53S	D	585.23	4.50	ML/CL, SP	Solid	KGS Model	3.80E-03	3.20E-03			
G54S	D	572.28	4.50	ML/CL, SP	Solid	Bouwer-Rice	1.20E-04	2.10E-04			
G57S	D	586.02	4.50	SP, S(CL), ML/CL	Solid	KGS Model	2.60E-03	6.80E-04			
G60S	D	576.42	4.80	ML/CL, SP	Solid	KGS Model	3.90E-03	3.50E-03			
G63S	D	580.97	4.50	ML, ML/CL, SP	Solid	KGS Model	3.00E-04	2.90E-04			
Bedrock Confining Unit											
G54C	D	518.09	9.07	Shale	Solid	Hvorslev	1.60E-04	1.40E-04	1.40E-04	1.60E-04	1.50E-04

[O: EDP 8/25/21, C: SSW 09/17/21]

Notes:
1. All wells are constructed from 2 inch PVC with 0.01 inch slotted screens.
- - - = no data collected on date / no vertical gradient calculated
CL/ML = Silty clay
cm/s = centimeters per second
D = downgradient
GMF = Gypsum Management Facility
ft = foot/feet
K = hydraulic conductivity
KGS = Kansas Geological Survey
ML = Silt
NAVD88 = North American Vertical Datum of 1988
U = upgradient

USCS = Unified Soil Classification System
ML/CL = Clayey silt
S(CL) = Sandy clay
S(ML) = Sandy silt
SM = Silty sand
SP= Poorly graded sand

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TABLE 3-4. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

$V = K i / n_e$ V = Groundwater Velocity
K = Hydraulic Conductivity [1]
i = hydraulic gradient
n_e = Effective Porosity [2]

Northern GMF Pond Uppermost Aquifer (G50S to G64S)

Distance between Wells (ft): 1008
Hydraulic Conductivity (ft/day): 0.66
Effective Porosity (%): 17.5 Assumes: clay/sand

Date	G50S Groundwater Elevation (ft NAVD88)	G64S Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	612.98	599.04	13.94	0.0138	0.052
4/28/2021	611.54	599.38	12.16	0.0121	0.045
5/10/2021	612.71	599.64	13.07	0.0130	0.049
6/1/2021	611.87	600.28	11.59	0.0115	0.043
6/10/2021	611.15	599.97	11.18	0.0111	0.042
6/21/2021	611.57	599.51	12.06	0.0120	0.045
7/12/2021	613.25	600.50	12.75	0.0126	0.048
7/26/2021	612.06	600.60	11.46	0.0114	0.043
8/5/2021	611.21	600.04	11.17	0.0111	0.042
			Average	0.0121	0.045

Central GMF Pond Uppermost Aquifer (G50S to G60S)

Distance between Wells (ft): 1269
Hydraulic Conductivity (ft/day): 5.46
Effective Porosity (%): 15 Assumes: silt/sand

Date	G50S Groundwater Elevation (ft NAVD88)	G60S Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	612.98	590.16	22.82	0.0180	0.654
4/28/2021	611.54	589.76	21.78	0.0172	0.624
5/10/2021	612.71	590.34	22.37	0.0176	0.641
6/1/2021	611.87	590.54	21.33	0.0168	0.611
6/10/2021	611.15	590.02	21.13	0.0167	0.606
6/21/2021	611.57	589.48	22.09	0.0174	0.633
7/12/2021	613.25	591.02	22.23	0.0175	0.637
7/26/2021	612.06	590.71	21.35	0.0168	0.612
8/5/2021	611.21	590.05	21.16	0.0167	0.606
			Average	0.0172	0.625

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TABLE 3-4. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Southern GMF Pond Uppermost Aquifer (G51S to G54S)

Distance between Wells (ft): 906
Hydraulic Conductivity (ft/day): 0.36
Effective Porosity (%): 17.5 Assumes: clay/sand

Date	G51S Groundwater Elevation (ft NAVD88)	G54S Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	610.69	590.44	20.25	0.0224	0.046
4/28/2021	609.35	590.52	18.83	0.0208	0.042
5/10/2021	610.93	590.53	20.40	0.0225	0.046
6/1/2021	609.44	590.80	18.64	0.0206	0.042
6/10/2021	606.98	591.07	15.91	0.0176	0.036
6/21/2021	609.37	591.23	18.14	0.0200	0.041
7/12/2021	610.91	591.76	19.15	0.0211	0.043
7/26/2021	608.84	591.98	16.86	0.0186	0.038
8/5/2021	606.34	592.55	13.79	0.0152	0.031
			Average	0.0199	0.041

[O: EDP 8/28/21, C: LDC 09/17/21]

Notes:

[1] Hydraulic conductivity values used above are the geometric mean of hydrostratigraphic unit hydraulic conductivity values calculated from slug tests completed in April 2021 by Ramboll.

[2] Effective porosity used in these calculations was derived from an average between estimated values of 0.20 for silt material, 0.267 for gravel, 0.07 for clay, and 0.28 for sand from Morris, D.A and A.I. Johnson, 1967. Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey. U.S. Geological Survey Water-Supply Paper 1839-D, 42p. and Heath, R.C., 1983. Basic ground-water hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p. Effective porosity may be as high as maximum total porosity (56%) calculated in Table 2-1.

% = percent
ft/day = feet per day
ft/ft = feet per feet
ft= feet
NAVD88 = North American Vertical Datum of 1988
UA = uppermost aquifer

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G02S	12/02/2015	<0.003	0.0077	0.2	<0.001	0.13	<0.001	97	3.2	<0.004	<0.002	0.359	0.0015	<0.01	<0.0002	<0.001	6.6	1.86	<0.001	<1	<0.001	400
G02S	02/03/2016	<0.003	0.0071	0.22	<0.001	0.044	<0.001	92	3	0.0046	<0.002	0.274	0.002	<0.01	<0.0002	0.0042	6.6	0.371	<0.001	<1	<0.001	390
G02S	04/20/2016	<0.003	0.0059	0.23	<0.001	0.039	<0.001	110	2.7	<0.004	<0.002	0.365	0.0011	<0.01	<0.0002	<0.001	6.6	0.827	<0.001	<1	<0.001	600
G02S	08/18/2016	<0.003	0.0041	0.17	<0.001	0.03	<0.001	98	2.6	<0.004	<0.002	0.33	0.0012	<0.01	<0.0002	<0.001	6.8	2.26	<0.001	<1	<0.001	350
G02S	10/19/2016	<0.003	0.0069	0.19	<0.001	0.034	<0.001	97	2.5	<0.004	<0.002	0.366	0.0011	<0.01	<0.0002	<0.001	6.9	0.191	<0.001	<1	<0.001	400
G02S	01/12/2017	<0.003	0.0077	0.22	<0.001	0.039	<0.001	94	3.7	<0.004	<0.002	0.564	<0.001	<0.01	<0.0002	<0.001	6.9	1.18	<0.001	<1	<0.001	420
G02S	04/22/2017	<0.003	0.0051	0.16	<0.001	0.04	<0.001	89	2.9	<0.004	<0.002	0.315	<0.001	<0.01	0.0024	<0.001	6.8	0.347	<0.001	<1	<0.001	440
G02S	06/28/2017	<0.003	0.0067	0.22	<0.001	0.042	<0.001	89	2.6	<0.004	<0.002	0.374	<0.001	<0.01	<0.0002	<0.001	6.8	0.761	<0.001	<1	<0.001	370
G02S	11/10/2017	--	--	--	--	0.036	--	95	3.1	--	--	0.41	--	--	--	--	6.9	--	--	2.9	--	390
G02S	01/17/2018	--	--	--	--	--	--	--	2.7	--	--	--	--	--	--	--	6.9	--	--	--	--	--
G02S	06/06/2018	--	--	--	--	0.042	--	95	2.4	--	--	0.369	--	--	--	--	6.9	--	--	<1	--	340
G02S	07/06/2018	--	--	--	--	--	--	--	2.9	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G02S	10/04/2018	--	--	--	--	0.046	--	97	2.7	--	--	0.285	--	--	--	--	7.1	--	--	<1	--	340
G02S	02/06/2019	--	--	--	--	0.048	--	99	2.5	--	--	0.379	--	--	--	--	7.0	--	--	<1	--	400
G02S	07/08/2019	--	--	--	--	0.05	--	96	<5	--	--	0.394	--	--	--	--	7.0	--	--	<1	--	420
G02S	01/06/2020	--	--	--	--	0.044	--	100	<5	--	--	0.476	--	--	--	--	6.6	--	--	<1	--	440
G02S	08/11/2020	--	--	--	--	0.049	--	97	<5	--	--	0.27	--	--	--	--	6.4	--	--	<1	--	420
G02S	02/19/2021	--	--	--	--	0.037	--	95	2.6	--	--	0.411	--	--	--	--	6.5	--	--	<1	--	340
G02S	04/14/2021	<0.003	0.0092	0.29	<0.001	0.11	<0.001	89	2.3	<0.004	<0.002	0.336	<0.001	<0.02	<0.0002	<0.001	6.7	0.992	<0.001	<1	<0.001	380
G02S	04/29/2021	<0.003	0.0059	0.16	<0.001	0.047	<0.001	96	1.6	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	6.8	0.194	<0.001	<1	<0.001	370
G02S	05/12/2021	<0.003	0.0061	0.15	<0.001	0.091	<0.001	96	2.5	<0.004	<0.002	0.35	<0.001	<0.02	<0.0002	<0.001	6.7	0	<0.001	<1	<0.001	290
G02S	06/01/2021	<0.003	0.0069	0.17	<0.001	0.12	<0.001	94	8.2	<0.004	<0.002	0.358	<0.001	<0.02	<0.0002	<0.001	6.8	0.0133	<0.001	2.7	<0.001	450

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G02S	06/15/2021	<0.003	0.0078	0.18	<0.001	0.064	<0.001	100	4	<0.004	<0.002	0.307	<0.001	<0.02	<0.0002	<0.001	6.8	0.618	<0.001	2.1	<0.001	390
G02S	06/21/2021	<0.003	0.0063	0.17	<0.001	0.11	<0.001	98	3.5	<0.004	<0.002	0.498	<0.001	<0.02	<0.0002	<0.001	6.8	0.268	<0.001	1.1	<0.001	440
G02S	07/12/2021	<0.003	0.0064	0.18	<0.001	0.043	<0.001	96	1.9	<0.004	<0.002	0.322	<0.001	<0.02	<0.0002	<0.001	6.7	0.372	<0.001	<1	<0.001	420
G02S	07/28/2021	<0.003	0.0059	0.17	<0.001	0.17	<0.001	99	1.4	<0.004	<0.002	0.324	<0.001	<0.02	<0.0002	<0.001	6.9	2	0.0012	<1	<0.001	440
G50S	01/30/2015	--	0.0016	--	--	0.021	--	94	4.5	--	--	--	0.0011	--	--	--	6.8	--	--	25	--	--
G50S	04/17/2015	--	<0.001	--	--	0.02	--	91	4.6	--	--	--	<0.001	--	--	--	7.3	--	--	23	--	--
G50S	07/24/2015	--	0.0012	--	--	0.015	--	96	5.4	--	--	--	0.0014	--	--	--	7.4	--	--	23	--	--
G50S	10/15/2015	--	<0.001	--	--	0.025	--	85	5.2	--	--	--	<0.001	--	--	--	7.4	--	--	19	--	--
G50S	12/03/2015	<0.003	0.005	0.12	<0.001	0.022	<0.001	98	6	<0.004	<0.002	0.311	0.0015	<0.01	<0.0002	0.001	6.9	0.865	<0.001	22	<0.001	340
G50S	01/29/2016	<0.003	<0.001	0.072	<0.001	0.024	<0.001	77	5.4	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	<0.001	7.4	0.652	<0.001	21	<0.001	300
G50S	04/25/2016	<0.003	<0.001	0.063	<0.001	0.025	<0.001	81	5.3	<0.004	<0.002	0.373	<0.001	<0.01	<0.0002	<0.001	7.3	0.325	<0.001	21	<0.001	360
G50S	08/10/2016	<0.003	<0.001	0.074	<0.001	0.017	<0.001	86	6.3	<0.004	<0.002	0.284	<0.001	<0.01	0.00031	<0.001	7.3	0.455	<0.001	22	<0.001	320
G50S	10/21/2016	<0.003	<0.001	0.073	<0.001	<0.01	<0.001	76	5.9	<0.004	<0.002	0.297	<0.001	<0.01	<0.0002	<0.001	7.3	0.733	<0.001	23	<0.001	280
G50S	01/21/2017	<0.003	<0.001	0.07	<0.001	0.018	<0.001	60	6	<0.004	<0.002	0.261	<0.001	<0.01	<0.0002	<0.001	7.3	0.0182	<0.001	23	<0.001	340
G50S	04/07/2017	<0.003	0.0016	0.089	<0.001	0.011	<0.001	90	5.6	0.0058	<0.002	0.284	0.0016	<0.01	<0.0002	0.001	7.3	0.529	<0.001	24	<0.001	340
G50S	06/28/2017	<0.003	<0.001	0.08	<0.001	<0.01	<0.001	75	6.6	<0.004	<0.002	0.255	0.0017	<0.01	<0.0002	0.0015	7.1	0.371	<0.001	26	0.001	330
G50S	11/08/2017	--	--	--	--	0.012	--	83	5.9	--	--	0.369	--	--	--	--	7.1	--	--	22	--	310
G50S	06/04/2018	--	--	--	--	0.067	--	87	7.3	--	--	0.301	--	--	--	--	7.1	--	--	33	--	320
G50S	07/13/2018	--	--	--	--	0.018	--	88	--	--	--	0.333	--	--	--	--	7.1	--	--	--	--	350
G50S	10/11/2018	--	--	--	--	0.018	--	97	9.6	--	--	0.264	--	--	--	--	7.2	--	--	34	--	340
G50S	02/05/2019	--	--	--	--	0.016	--	86	7.6	--	--	<0.25	--	--	--	--	7.1	--	--	27	--	360
G50S	07/08/2019	--	--	--	--	0.018	--	88	9.6	--	--	0.351	--	--	--	--	7.4	--	--	34	--	420

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G50S	01/13/2020	--	--	--	--	0.018	--	97	8.6	--	--	0.311	--	--	--	--	6.9	--	--	30	--	360
G50S	08/10/2020	--	--	--	--	0.016	--	91	8.5	--	--	0.28	--	--	--	--	6.8	--	--	38	--	370
G50S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G50S	02/19/2021	--	--	--	--	0.015	--	95	12	--	--	0.335	--	--	--	--	7.0	--	--	41	--	330
G50S	04/14/2021	<0.003	<0.001	0.071	<0.001	0.034	<0.001	88	15	<0.004	<0.002	0.279	<0.001	<0.02	<0.0002	<0.001	7.2	0.644	<0.001	52	<0.001	400
G50S	04/29/2021	<0.003	<0.001	0.071	<0.001	0.025	<0.001	98	14	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.1	0.0455	<0.001	50	<0.001	350
G50S	05/13/2021	<0.003	0.0011	0.076	<0.001	0.016	<0.001	95	13	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0	<0.001	47	<0.001	380
G50S	06/01/2021	<0.003	<0.001	0.066	<0.001	0.041	<0.001	93	12	<0.004	<0.002	0.3	<0.001	<0.02	<0.0002	0.0023	7.0	0.798	<0.001	49	<0.001	410
G50S	06/10/2021	<0.003	<0.001	0.068	<0.001	0.016	<0.001	93	16	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0.342	<0.001	48	<0.001	390
G50S	06/21/2021	<0.003	<0.001	0.071	<0.001	0.04	<0.001	94	11	<0.004	<0.002	0.372	<0.001	<0.02	<0.0002	<0.001	7.1	0	<0.001	44	<0.001	430
G50S	07/13/2021	<0.003	<0.001	0.071	<0.001	0.023	<0.001	92	13	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0.884	<0.001	46	<0.001	420
G50S	07/28/2021	<0.003	<0.001	0.071	<0.001	0.015	<0.001	95	13	<0.004	<0.002	0.323	<0.001	<0.02	<0.0002	<0.001	7.1	1.13	<0.001	46	<0.001	390
G51L	01/30/2015	--	<0.001	--	--	0.18	--	130	18	--	--	--	<0.001	--	--	--	6.9	--	--	130	--	--
G51L	04/17/2015	--	<0.001	--	--	0.14	--	120	15	--	--	--	<0.001	--	--	--	7.0	--	--	120	--	--
G51L	07/24/2015	--	0.0042	--	--	0.047	--	98	17	--	--	--	<0.001	--	--	--	7.1	--	--	110	--	--
G51L	10/15/2015	--	<0.001	--	--	0.17	--	100	15	--	--	--	<0.001	--	--	--	7.1	--	--	95	--	--
G51L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
G51L	02/19/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G51S	01/30/2015	--	0.0061	--	--	0.015	--	100	11	--	--	--	<0.001	--	--	--	7.0	--	--	53	--	--
G51S	04/17/2015	--	0.0094	--	--	0.017	--	100	9.1	--	--	--	<0.001	--	--	--	7.2	--	--	51	--	--
G51S	07/24/2015	--	0.0085	--	--	<0.01	--	92	11	--	--	--	<0.001	--	--	--	7.1	--	--	40	--	--
G51S	10/15/2015	--	0.0051	--	--	0.021	--	91	8.5	--	--	--	<0.001	--	--	--	7.2	--	--	38	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G51S	12/03/2015	<0.003	0.0086	0.13	<0.001	0.02	<0.001	110	10	<0.004	<0.002	0.277	0.002	<0.01	<0.0002	0.0023	7.0	1.28	<0.001	39	<0.001	400
G51S	01/29/2016	<0.003	0.0042	0.097	<0.001	0.02	<0.001	89	11	<0.004	<0.002	<0.25	<0.001	<0.01	0.0004	0.0021	7.0	1.21	<0.001	52	<0.001	380
G51S	04/25/2016	<0.003	0.0048	0.096	<0.001	<0.01	<0.001	92	13	<0.004	<0.002	0.337	<0.001	<0.01	<0.0002	0.0016	7.1	0.517	<0.001	45	<0.001	400
G51S	08/10/2016	<0.003	0.0047	0.11	<0.001	0.014	<0.001	92	25	<0.004	<0.002	0.29	<0.001	<0.01	<0.0002	<0.001	7.1	0.921	<0.001	97	<0.001	350
G51S	10/21/2016	<0.003	0.0054	0.11	<0.001	<0.01	<0.001	89	13	<0.004	<0.002	0.27	<0.001	<0.01	<0.0002	0.0012	7.4	1.46	<0.001	44	<0.001	300
G51S	01/21/2017	<0.003	0.0034	0.083	<0.001	<0.01	<0.001	67	13	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0017	7.3	0.719	<0.001	48	<0.001	380
G51S	04/07/2017	<0.003	0.0029	0.089	<0.001	0.01	<0.001	94	13	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.002	7.0	0.313	<0.001	50	<0.001	380
G51S	06/28/2017	<0.003	0.005	0.11	0.0013	<0.01	<0.001	82	14	<0.004	<0.002	<0.25	0.0015	<0.01	0.00034	0.0029	6.8	1.11	0.0014	41	0.0028	400
G51S	11/08/2017	--	--	--	--	0.013	--	96	12	--	--	0.368	--	--	--	--	7.1	--	--	34	--	320
G51S	06/04/2018	--	--	--	--	0.039	--	97	11	--	--	0.266	--	--	--	--	7.0	--	--	52	--	380
G51S	07/13/2018	--	--	--	--	0.014	--	96	--	--	--	0.31	--	--	--	--	6.9	--	--	--	--	390
G51S	10/11/2018	--	--	--	--	0.015	--	99	13	--	--	0.264	--	--	--	--	7.1	--	--	51	--	380
G51S	02/05/2019	--	--	--	--	0.012	--	90	14	--	--	0.33	--	--	--	--	6.8	--	--	50	--	380
G51S	07/08/2019	--	--	--	--	0.039	--	100	16	--	--	0.332	--	--	--	--	7.0	--	--	48	--	460
G51S	01/14/2020	--	--	--	--	0.016	--	100	13	--	--	<0.25	--	--	--	--	7.1	--	--	53	--	440
G51S	08/10/2020	--	--	--	--	0.01	--	99	8.2	--	--	<0.25	--	--	--	--	6.9	--	--	26	--	390
G51S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G51S	02/19/2021	--	--	--	--	0.022	--	100	19	--	--	0.316	--	--	--	--	7.2	--	--	52	--	410
G51S	04/14/2021	<0.003	0.0042	0.1	<0.001	0.017	<0.001	88	14	<0.004	<0.002	0.258	0.012	<0.02	<0.0002	0.0012	7.1	0	<0.001	51	<0.001	380
G51S	04/29/2021	<0.003	0.0038	0.11	<0.001	0.019	<0.001	100	15	0.0059	<0.002	0.25	0.015	<0.02	<0.0002	0.0013	7.1	0.825	<0.001	51	<0.001	400
G51S	05/13/2021	<0.003	0.0012	0.089	<0.001	0.013	<0.001	94	15	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0	<0.001	55	<0.001	350
G51S	06/01/2021	<0.003	0.0017	0.091	<0.001	0.022	<0.001	94	17	<0.004	<0.002	0.292	0.0046	<0.02	<0.0002	0.002	7.2	0.655	<0.001	51	<0.001	400

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G51S	06/15/2021	<0.003	0.0023	0.11	<0.001	0.022	<0.001	110	12	<0.004	<0.002	<0.25	0.0019	<0.02	<0.0002	<0.001	7.0	0.0656	<0.001	54	<0.001	410
G51S	06/21/2021	<0.003	0.0013	0.092	<0.001	0.037	<0.001	96	14	<0.004	<0.002	0.415	0.0017	<0.02	<0.0002	<0.001	7.1	0	<0.001	53	<0.001	410
G51S	07/12/2021	<0.003	0.0055	0.11	<0.001	0.014	<0.001	95	16	<0.004	<0.002	<0.25	0.0056	<0.02	<0.0002	0.0013	7.0	0.75	<0.001	51	<0.001	460
G51S	07/27/2021	<0.003	0.002	0.12	<0.001	0.016	<0.001	85	14	<0.004	<0.002	0.265	0.0017	<0.02	0.00098	<0.001	7.1	0.281	<0.001	51	<0.001	360
G52L	01/30/2015	--	<0.001	--	--	0.03	--	190	27	--	--	--	<0.001	--	--	--	6.6	--	--	160	--	--
G52L	04/17/2015	--	0.0015	--	--	0.021	--	230	22	--	--	--	<0.001	--	--	--	6.6	--	--	140	--	--
G52L	07/24/2015	--	<0.001	--	--	0.011	--	220	23	--	--	--	<0.001	--	--	--	6.6	--	--	120	--	--
G52L	10/15/2015	--	<0.001	--	--	0.026	--	220	22	--	--	--	<0.001	--	--	--	7.1	--	--	120	--	--
G52L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G52L	02/19/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.4	--	--	--	--	--
G52S	01/30/2015	--	0.019	--	--	0.04	--	150	14	--	--	--	0.041	--	--	--	6.8	--	--	110	--	--
G52S	04/17/2015	--	0.023	--	--	1.9	--	180	11	--	--	--	0.041	--	--	--	6.9	--	--	95	--	--
G52S	07/24/2015	--	0.012	--	--	0.019	--	160	12	--	--	--	0.023	--	--	--	6.9	--	--	97	--	--
G52S	10/15/2015	--	0.0083	--	--	0.036	--	150	9.7	--	--	--	0.01	--	--	--	6.9	--	--	89	--	--
G53L	01/30/2015	--	<0.001	--	--	0.12	--	110	65	--	--	--	<0.001	--	--	--	6.8	--	--	120	--	--
G53L	04/16/2015	--	<0.001	--	--	0.097	--	110	72	--	--	--	<0.001	--	--	--	6.9	--	--	140	--	--
G53L	07/24/2015	--	<0.001	--	--	0.11	--	110	70	--	--	--	<0.001	--	--	--	6.9	--	--	120	--	--
G53L	10/16/2015	--	<0.001	--	--	0.17	--	110	75	--	--	--	<0.001	--	--	--	6.9	--	--	140	--	--
G53L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G53L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G53S	01/30/2015	--	0.03	--	--	0.027	--	110	15	--	--	--	0.0049	--	--	--	7.0	--	--	79	--	--
G53S	04/16/2015	--	0.022	--	--	0.02	--	110	16	--	--	--	0.0056	--	--	--	7.1	--	--	86	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G53S	07/24/2015	--	0.0096	--	--	0.012	--	120	12	--	--	--	0.003	--	--	--	7.0	--	--	71	--	--
G53S	10/16/2015	--	0.02	--	--	0.024	--	110	11	--	--	--	0.0011	--	--	--	7.2	--	--	75	--	--
G53S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
G53S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G54C	04/14/2021	<0.003	0.0038	0.43	<0.001	0.16	<0.001	110	2.9	0.0081	0.0026	0.41	0.0014	<0.02	<0.0002	0.041	7.3	0.714	<0.001	50	<0.001	660
G54C	04/29/2021	<0.003	0.002	0.39	<0.001	0.13	<0.001	110	2.7	<0.004	<0.002	0.384	<0.001	<0.02	<0.0002	0.032	7.3	1.32	<0.001	45	<0.001	640
G54C	05/12/2021	<0.003	0.0029	0.47	<0.001	0.35	<0.001	110	2.9	<0.004	<0.002	0.465	0.0011	<0.02	<0.0002	0.035	7.2	0	0.0018	55	<0.001	630
G54C	06/01/2021	<0.003	0.0046	0.37	<0.001	0.12	<0.001	110	1.8	<0.004	<0.002	0.404	<0.001	<0.02	<0.0002	0.03	7.3	0.51	<0.001	47	<0.001	650
G54C	06/14/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.38	--	--	--	--
G54L	10/14/2015	--	0.028	--	--	0.041	--	180	11	--	--	--	0.0035	--	--	--	6.6	--	--	1.2	--	--
G54L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G54L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G54L	04/14/2021	<0.003	0.0058	0.18	<0.001	0.022	<0.001	150	21	<0.004	0.0044	<0.25	<0.001	<0.02	<0.0002	0.0027	6.6	0.299	<0.001	95	<0.001	900
G54L	04/29/2021	<0.003	0.01	0.21	<0.001	0.023	<0.001	170	20	<0.004	0.0026	<0.25	<0.001	<0.02	<0.0002	0.0011	6.6	0.516	<0.001	81	<0.001	800
G54L	05/12/2021	<0.003	0.014	0.24	<0.001	0.031	<0.001	160	21	0.0079	<0.002	<0.25	<0.001	<0.02	<0.0002	0.002	6.5	0.873	<0.001	70	<0.001	520
G54L	06/01/2021	<0.003	0.0069	0.16	<0.001	0.024	<0.001	160	21	<0.004	0.0029	<0.25	<0.001	<0.02	<0.0002	<0.001	6.6	0.508	<0.001	65	<0.001	780
G54L	06/14/2021	<0.003	0.006	0.16	<0.001	0.018	<0.001	160	22	<0.004	0.0021	<0.25	<0.001	<0.02	<0.0002	<0.001	6.7	0.766	<0.001	55	<0.001	750
G54L	06/21/2021	<0.003	0.0056	0.19	<0.001	0.03	<0.001	160	19	<0.004	0.0022	0.383	<0.001	<0.02	<0.0002	<0.001	6.5	1.21	<0.001	46	<0.001	700
G54L	07/13/2021	<0.003	0.0033	0.13	<0.001	0.023	<0.001	140	23	<0.004	0.0029	<0.25	<0.001	<0.02	<0.0002	0.002	6.4	0.246	<0.001	97	<0.001	850
G54L	07/27/2021	<0.003	0.0017	0.15	<0.001	0.027	<0.001	120	5.2	<0.004	<0.002	<0.25	<0.001	<0.02	0.00027	0.0047	6.6	1.65	<0.001	100	<0.001	720
G54S	01/30/2015	--	0.0013	--	--	0.045	--	120	<5	--	--	--	<0.001	--	--	--	6.8	--	--	47	--	--
G54S	04/16/2015	--	0.0014	--	--	0.029	--	140	2.2	--	--	--	<0.001	--	--	--	6.8	--	--	51	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G54S	07/23/2015	--	0.0011	--	--	0.05	--	130	2.3	--	--	--	<0.001	--	--	--	6.9	--	--	40	--	--
G54S	10/14/2015	--	0.0021	--	--	0.048	--	140	2.3	--	--	--	<0.001	--	--	--	6.9	--	--	41	--	--
G54S	12/04/2015	<0.003	<0.001	0.2	<0.001	0.027	<0.001	130	4.5	<0.004	<0.002	<0.25	<0.001	0.01	<0.0002	0.0016	6.5	1.28	<0.001	43	<0.001	600
G54S	01/29/2016	<0.003	0.0014	0.25	<0.001	0.046	<0.001	130	2.6	<0.004	<0.002	<0.25	<0.001	0.01	<0.0002	0.0019	6.9	0.787	<0.001	47	<0.001	570
G54S	05/02/2016	<0.003	<0.001	0.23	<0.001	0.036	<0.001	140	3	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0019	6.7	1.01	<0.001	45	<0.001	520
G54S	08/12/2016	<0.003	0.002	0.24	<0.001	0.03	<0.001	120	2.3	<0.004	<0.002	0.269	<0.001	0.012	<0.0002	0.0019	7.1	0.476	<0.001	43	<0.001	480
G54S	10/21/2016	<0.003	0.0023	0.27	<0.001	0.022	<0.001	120	2.5	<0.004	<0.002	0.259	<0.001	<0.01	0.00021	0.0023	7.2	1.27	<0.001	43	<0.001	520
G54S	01/24/2017	<0.003	0.0017	0.25	<0.001	0.03	<0.001	120	2	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0017	7.5	0.661	<0.001	44	<0.001	550
G54S	04/07/2017	<0.003	0.001	0.22	<0.001	0.028	<0.001	120	2.6	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0017	6.9	0.44	<0.001	45	<0.001	540
G54S	06/28/2017	<0.003	0.0059	0.28	<0.001	0.022	<0.001	110	2.5	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0025	7.1	1.19	<0.001	43	<0.001	520
G54S	11/08/2017	--	--	--	--	0.035	--	130	2.2	--	--	0.342	--	--	--	--	7.1	--	--	42	--	480
G54S	01/18/2018	--	--	--	--	0.052	--	120	--	--	--	--	--	--	--	--	6.9	--	--	--	--	380
G54S	06/04/2018	--	--	--	--	0.059	--	130	2.3	--	--	<0.25	--	--	--	--	7.1	--	--	43	--	500
G54S	07/13/2018	--	--	--	--	0.033	--	130	--	--	--	0.29	--	--	--	--	7.1	--	--	--	--	540
G54S	10/16/2018	--	--	--	--	0.037	--	130	2.5	--	--	<0.25	--	--	--	--	7.2	--	--	44	--	460
G54S	02/05/2019	--	--	--	--	0.032	--	130	2.3	--	--	0.283	--	--	--	--	7.1	--	--	44	--	590
G54S	07/15/2019	--	--	--	--	0.057	--	130	1.5	--	--	<0.25	--	--	--	--	7.1	--	--	46	--	590
G54S	01/14/2020	--	--	--	--	0.043	--	150	2.6	--	--	<0.25	--	--	--	--	6.9	--	--	45	--	620
G54S	08/10/2020	--	--	--	--	0.034	--	140	1.1	--	--	<0.25	--	--	--	--	6.8	--	--	21	--	460
G54S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G54S	02/22/2021	--	--	--	--	0.045	--	120	2.5	--	--	<0.25	--	--	--	--	6.8	--	--	39	--	500
G54S	06/21/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	590

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G55L	01/30/2015	--	<0.001	--	--	0.018	--	100	17	--	--	--	<0.001	--	--	--	6.8	--	--	56	--	--
G55L	04/16/2015	--	<0.001	--	--	<0.01	--	130	23	--	--	--	<0.001	--	--	--	6.8	--	--	67	--	--
G55L	07/23/2015	--	<0.001	--	--	0.02	--	130	20	--	--	--	<0.001	--	--	--	6.9	--	--	59	--	--
G55L	10/14/2015	--	<0.001	--	--	0.02	--	130	18	--	--	--	<0.001	--	--	--	6.9	--	--	63	--	--
G55L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G55L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G55S	01/30/2015	--	0.0053	--	--	0.046	--	130	5.1	--	--	--	0.0075	--	--	--	6.9	--	--	33	--	--
G55S	04/16/2015	--	0.0086	--	--	0.05	--	150	5.1	--	--	--	0.015	--	--	--	7.0	--	--	37	--	--
G55S	07/23/2015	--	0.0033	--	--	0.046	--	140	4.8	--	--	--	0.0047	--	--	--	7.1	--	--	27	--	--
G55S	10/14/2015	--	0.0033	--	--	0.031	--	130	5.5	--	--	--	0.0042	--	--	--	7.0	--	--	28	--	--
G55S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G55S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G56L	07/22/2015	--	<0.001	--	--	0.062	--	130	29	--	--	--	0.0012	--	--	--	6.9	--	--	46	--	--
G56L	10/16/2015	--	0.0047	--	--	0.028	--	130	27	--	--	--	0.0062	--	--	--	7.0	--	--	44	--	--
G56L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G56L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G56S	02/04/2015	--	0.014	--	--	0.049	--	120	--	--	--	--	0.0057	--	--	--	7.2	--	--	58	--	--
G56S	04/16/2015	--	0.013	--	--	0.019	--	190	17	--	--	--	0.014	--	--	--	6.8	--	--	65	--	--
G56S	07/22/2015	--	0.051	--	--	0.053	--	150	13	--	--	--	0.0086	--	--	--	6.9	--	--	57	--	--
G56S	10/16/2015	--	0.012	--	--	0.022	--	130	11	--	--	--	0.0046	--	--	--	6.9	--	--	56	--	--
G56S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G56S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G57L	02/04/2015	--	0.018	--	--	0.05	--	120	19	--	--	--	0.0047	--	--	--	7.2	--	--	320	--	--
G57L	02/25/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.2	--	--	--	--	--
G57L	04/16/2015	--	0.0069	--	--	0.019	--	150	22	--	--	--	0.0026	--	--	--	6.9	--	--	300	--	--
G57L	07/22/2015	--	0.0034	--	--	0.083	--	97	13	--	--	--	0.0026	--	--	--	6.9	--	--	96	--	--
G57L	10/16/2015	--	0.0054	--	--	0.042	--	100	13	--	--	--	0.0026	--	--	--	6.7	--	--	110	--	--
G57L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G57L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G57S	02/04/2015	--	<0.001	--	--	0.019	--	100	19	--	--	--	<0.001	--	--	--	7.1	--	--	53	--	--
G57S	04/16/2015	--	<0.001	--	--	<0.01	--	130	23	--	--	--	<0.001	--	--	--	7.2	--	--	64	--	--
G57S	07/22/2015	--	0.0019	--	--	0.05	--	140	18	--	--	--	0.0058	--	--	--	7.0	--	--	53	--	--
G57S	10/16/2015	--	<0.001	--	--	0.013	--	110	17	--	--	--	<0.001	--	--	--	7.1	--	--	56	--	--
G57S	12/04/2015	<0.003	<0.001	0.14	<0.001	<0.01	<0.001	130	18	<0.004	<0.002	<0.25	0.0012	<0.01	<0.0002	<0.001	6.8	0.804	<0.001	54	<0.001	570
G57S	01/29/2016	<0.003	<0.001	0.13	<0.001	0.021	<0.001	110	19	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	<0.001	6.8	0.194	<0.001	58	<0.001	510
G57S	05/02/2016	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	120	20	<0.004	<0.002	0.277	<0.001	<0.01	<0.0002	<0.001	6.9	0.471	<0.001	56	<0.001	500
G57S	08/12/2016	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	120	20	<0.004	<0.002	0.304	<0.001	<0.01	<0.0002	<0.001	7.0	0.302	<0.001	58	<0.001	480
G57S	10/28/2016	<0.003	<0.001	0.14	<0.001	0.019	<0.001	100	19	<0.004	<0.002	0.321	<0.001	<0.01	<0.0002	<0.001	7.1	0.124	<0.001	55	<0.001	550
G57S	02/03/2017	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	120	20	<0.004	<0.002	0.268	<0.001	<0.01	<0.0002	<0.001	7.2	1.32	<0.001	52	<0.001	530
G57S	05/01/2017	0.0064	<0.001	0.13	0.0027	<0.01	0.0016	110	18	<0.004	<0.002	0.284	0.0032	<0.01	<0.0002	0.0034	7.1	0.0112	<0.001	52	0.0033	510
G57S	06/28/2017	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	130	22	<0.004	<0.002	0.276	<0.001	<0.01	<0.0002	<0.001	7.3	0.607	<0.001	53	<0.001	520
G57S	11/08/2017	--	--	--	--	<0.01	--	120	19	--	--	0.39	--	--	--	--	7.0	--	--	51	--	450
G57S	01/18/2018	--	--	--	--	--	--	180	--	--	--	<0.25	--	--	--	--	7.1	--	--	--	--	370
G57S	06/04/2018	--	--	--	--	0.027	--	120	19	--	--	0.28	--	--	--	--	7.2	--	--	52	--	500

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G57S	07/21/2018	--	--	--	--	0.024	--	110	--	--	--	<0.25	--	--	--	--	7.2	--	--	--	--	540
G57S	10/17/2018	--	--	--	--	0.014	--	130	22	--	--	<0.25	--	--	--	--	7.3	--	--	53	--	470
G57S	02/06/2019	--	--	--	--	0.016	--	130	23	--	--	0.349	--	--	--	--	7.2	--	--	54	--	520
G57S	07/15/2019	--	--	--	--	0.055	--	140	18	--	--	0.327	--	--	--	--	7.1	--	--	55	--	680
G57S	01/14/2020	--	--	--	--	0.011	--	150	20	--	--	<0.25	--	--	--	--	6.8	--	--	55	--	700
G57S	08/10/2020	--	--	--	--	<0.01	--	150	15	--	--	0.292	--	--	--	--	6.6	--	--	51	--	600
G57S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	590
G57S	02/22/2021	--	--	--	--	0.013	--	120	1.8	--	--	0.313	--	--	--	--	6.9	--	--	54	--	680
G58L	04/15/2015	--	0.026	--	--	0.016	--	150	27	--	--	--	0.0072	--	--	--	6.9	--	--	320	--	--
G58L	07/22/2015	--	0.0027	--	--	0.051	--	120	29	--	--	--	0.0023	--	--	--	7.0	--	--	180	--	--
G58L	10/14/2015	--	0.013	--	--	0.024	--	140	23	--	--	--	0.012	--	--	--	7.0	--	--	190	--	--
G58L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G58L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G58S	02/04/2015	--	<0.001	--	--	0.018	--	180	20	--	--	--	<0.001	--	--	--	6.8	--	--	520	--	--
G58S	04/15/2015	--	<0.001	--	--	0.014	--	190	21	--	--	--	<0.001	--	--	--	6.6	--	--	540	--	--
G58S	07/22/2015	--	0.0092	--	--	0.044	--	180	19	--	--	--	0.018	--	--	--	6.8	--	--	250	--	--
G58S	10/14/2015	--	0.0025	--	--	0.18	--	170	17	--	--	--	0.0033	--	--	--	6.9	--	--	300	--	--
G58S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G58S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G59L	07/22/2015	--	0.0029	--	--	0.057	--	100	<25	--	--	--	0.0023	--	--	--	6.7	--	--	110	--	--
G59L	10/14/2015	--	0.013	--	--	0.043	--	110	19	--	--	--	0.014	--	--	--	7.0	--	--	84	--	--
G59L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G59L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G59S	02/04/2015	--	0.02	--	--	0.038	--	210	8.8	--	--	--	0.016	--	--	--	6.9	--	--	110	--	--
G59S	04/15/2015	--	0.011	--	--	0.026	--	190	9.3	--	--	--	0.012	--	--	--	6.9	--	--	110	--	--
G59S	07/22/2015	--	0.0061	--	--	0.071	--	150	15	--	--	--	0.0046	--	--	--	6.9	--	--	150	--	--
G59S	10/14/2015	--	0.021	--	--	0.056	--	230	12	--	--	--	0.014	--	--	--	7.1	--	--	95	--	--
G59S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G59S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G60L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.3	--	--	--	--	--
G60L	02/23/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.2	--	--	--	--	--
G60L	04/14/2021	<0.003	<0.001	0.019	<0.001	0.034	<0.001	110	19	<0.004	0.0052	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	1.14	<0.001	<250	<0.001	550
G60L	04/29/2021	<0.003	<0.001	0.017	<0.001	0.029	<0.001	120	19	<0.004	0.0038	<0.25	<0.001	<0.02	<0.0002	<0.001	6.1	0.0999	<0.001	160	<0.001	580
G60L	05/13/2021	<0.003	<0.001	0.017	<0.001	0.025	<0.001	110	19	<0.004	0.0023	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	0	<0.001	180	<0.001	580
G60L	06/01/2021	<0.003	<0.001	0.014	<0.001	0.029	<0.001	110	20	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	6.3	1.08	<0.001	170	<0.001	560
G60L	06/15/2021	<0.003	<0.001	0.015	<0.001	0.029	<0.001	110	16	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	0.347	<0.001	180	<0.001	530
G60L	06/21/2021	<0.003	<0.001	0.018	<0.001	0.068	<0.001	110	18	<0.004	0.0031	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	0.8	<0.001	180	<0.001	580
G60L	07/12/2021	<0.003	<0.001	0.027	<0.001	0.027	<0.001	110	18	<0.004	0.008	<0.25	<0.001	<0.02	<0.0002	<0.001	6.0	0.168	<0.001	180	<0.001	580
G60L	07/28/2021	<0.003	<0.001	0.019	<0.001	0.022	<0.001	110	15	<0.004	0.0039	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	2.36	<0.001	160	<0.001	530
G60S	02/04/2015	--	0.0042	--	--	0.024	--	120	12	--	--	--	0.0046	--	--	--	6.8	--	--	62	--	--
G60S	04/15/2015	--	0.018	--	--	0.028	--	250	11	--	--	--	0.022	--	--	--	6.8	--	--	63	--	--
G60S	07/22/2015	--	0.0032	--	--	0.035	--	150	9.6	--	--	--	0.003	--	--	--	6.8	--	--	58	--	--
G60S	10/14/2015	--	0.002	--	--	0.064	--	130	8.6	--	--	--	<0.001	--	--	--	7.1	--	--	60	--	--
G60S	12/04/2015	<0.003	0.0097	0.24	<0.001	0.024	<0.001	180	8.4	0.012	0.0049	0.264	0.0099	0.018	<0.0002	0.0016	6.6	1.74	0.0031	61	<0.001	610

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R001006

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G60S	01/29/2016	<0.003	0.0016	0.14	<0.001	0.024	<0.001	120	8.8	<0.004	<0.002	<0.25	0.0012	<0.01	<0.0002	<0.001	6.7	0.987	<0.001	65	<0.001	500
G60S	05/02/2016	<0.003	0.0032	0.17	<0.001	0.015	<0.001	160	7.9	0.0052	<0.002	0.276	0.0024	<0.01	<0.0002	<0.001	6.7	0.34	<0.001	64	<0.001	550
G60S	08/20/2016	<0.003	<0.001	0.14	<0.001	<0.01	<0.001	130	8.6	<0.004	<0.002	0.307	<0.001	<0.01	<0.0002	<0.001	6.7	0.876	<0.001	62	<0.001	560
G60S	10/28/2016	<0.003	0.004	0.18	<0.001	0.029	<0.001	120	8.1	<0.004	<0.002	0.331	<0.001	<0.01	<0.0002	0.001	6.6	1.29	<0.001	64	<0.001	540
G60S	02/03/2017	<0.003	<0.001	0.13	<0.001	0.011	<0.001	130	11	<0.004	<0.002	0.268	<0.001	<0.01	<0.0002	<0.001	6.5	1.27	<0.001	60	<0.001	580
G60S	04/25/2017	<0.003	<0.001	0.14	<0.001	0.01	<0.001	120	8.7	<0.004	<0.002	0.287	<0.001	<0.01	<0.0002	<0.001	6.8	0.946	<0.001	61	<0.001	580
G60S	06/29/2017	<0.003	0.0021	0.15	<0.001	<0.01	<0.001	110	10	<0.004	<0.002	0.328	<0.001	<0.01	<0.0002	<0.001	7.0	1.54	<0.001	68	<0.001	580
G60S	11/08/2017	--	--	--	--	0.01	--	120	11	--	--	0.351	--	--	--	--	6.9	--	--	67	--	460
G60S	01/19/2018	--	--	--	--	--	--	100	--	--	--	0.313	--	--	--	--	6.9	--	--	--	--	520
G60S	06/04/2018	--	--	--	--	0.035	--	150	11	--	--	0.316	--	--	--	--	6.9	--	--	73	--	490
G60S	07/21/2018	--	--	--	--	0.022	--	120	--	--	--	<0.25	--	--	--	--	7.0	--	--	--	--	540
G60S	10/17/2018	--	--	--	--	0.018	--	120	12	--	--	<0.25	--	--	--	--	6.9	--	--	72	--	440
G60S	02/06/2019	--	--	--	--	0.04	--	270	19	--	--	0.327	--	--	--	--	7.0	--	--	200	--	760
G60S	04/08/2019	--	--	--	--	--	--	160	13	--	--	--	--	--	--	--	7.0	--	--	240	--	860
G60S	07/15/2019	--	--	--	--	0.024	--	140	10	--	--	0.319	--	--	--	--	6.8	--	--	190	--	800
G60S	01/14/2020	--	--	--	--	0.026	--	150	11	--	--	<0.25	--	--	--	--	6.7	--	--	200	--	790
G60S	08/10/2020	--	--	--	--	0.015	--	140	6.8	--	--	<0.25	--	--	--	--	6.6	--	--	120	--	600
G60S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	110	--	630
G60S	02/23/2021	--	--	--	--	0.019	--	130	9.1	--	--	<0.25	--	--	--	--	6.6	--	--	67	--	620
G61S	02/04/2015	--	0.002	--	--	0.051	--	150	22	--	--	--	0.003	--	--	--	7.0	--	--	330	--	--
G61S	04/15/2015	--	0.0022	--	--	0.034	--	120	22	--	--	--	0.0028	--	--	--	7.0	--	--	220	--	--
G61S	07/21/2015	--	0.0012	--	--	0.029	--	120	18	--	--	--	0.0012	--	--	--	6.9	--	--	140	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G61S	10/13/2015	--	0.0012	--	--	0.027	--	140	20	--	--	--	<0.001	--	--	--	7.0	--	--	160	--	--
G61S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G61S	02/23/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G62L	02/04/2015	--	0.0031	--	--	0.083	--	120	19	--	--	--	0.0029	--	--	--	6.8	--	--	89	--	--
G62L	04/15/2015	--	0.0025	--	--	0.068	--	160	20	--	--	--	0.0015	--	--	--	6.9	--	--	150	--	--
G62L	07/22/2015	--	0.0016	--	--	0.13	--	68	9.2	--	--	--	0.0011	--	--	--	7.0	--	--	57	--	--
G62L	10/13/2015	--	0.0018	--	--	0.12	--	140	12	--	--	--	0.0023	--	--	--	7.2	--	--	87	--	--
G62L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G62L	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G63L	04/15/2015	--	0.0033	--	--	0.03	--	210	26	--	--	--	0.0035	--	--	--	6.9	--	--	350	--	--
G63L	07/22/2015	--	0.0021	--	--	0.091	--	190	13	--	--	--	0.0011	--	--	--	6.9	--	--	230	--	--
G63L	10/13/2015	--	0.0063	--	--	0.04	--	210	24	--	--	--	0.0083	--	--	--	7.2	--	--	270	--	--
G63L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G63L	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G63S	02/04/2015	--	0.003	--	--	0.023	--	110	3.6	--	--	--	0.0016	--	--	--	7.1	--	--	40	--	--
G63S	04/15/2015	--	<0.001	--	--	0.017	--	110	3.2	--	--	--	<0.001	--	--	--	7.0	--	--	36	--	--
G63S	07/22/2015	--	0.0018	--	--	0.036	--	110	3.4	--	--	--	<0.001	--	--	--	7.2	--	--	38	--	--
G63S	10/13/2015	--	0.0013	--	--	0.02	--	110	3.7	--	--	--	<0.001	--	--	--	7.3	--	--	45	--	--
G63S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G63S	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G64L	02/04/2015	--	0.0019	--	--	0.014	--	100	3.1	--	--	--	0.0023	--	--	--	6.9	--	--	26	--	--
G64L	04/15/2015	--	<0.001	--	--	0.012	--	96	2.9	--	--	--	<0.001	--	--	--	7.1	--	--	25	--	--

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R001008

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G64L	07/22/2015	--	<0.001	--	--	0.034	--	110	4.5	--	--	--	<0.001	--	--	--	7.0	--	--	120	--	--
G64L	10/13/2015	--	0.0031	--	--	0.11	--	110	3.9	--	--	--	0.0037	--	--	--	7.1	--	--	93	--	--
G64L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	--	--	--	--	--
G64L	02/25/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G64S	02/04/2015	--	0.0033	--	--	0.023	--	100	4.1	--	--	--	0.0034	--	--	--	7.1	--	--	28	--	--
G64S	04/15/2015	--	0.0038	--	--	0.018	--	110	3.9	--	--	--	0.0033	--	--	--	7.0	--	--	25	--	--
G64S	07/22/2015	--	0.011	--	--	0.037	--	120	3.7	--	--	--	0.0049	--	--	--	7.0	--	--	27	--	--
G64S	10/13/2015	--	0.0037	--	--	0.022	--	110	4.4	--	--	--	<0.001	--	--	--	7.1	--	--	77	--	--
G64S	12/04/2015	<0.003	0.004	0.2	<0.001	0.017	<0.001	110	3.6	<0.004	<0.002	0.3	0.0017	<0.01	<0.0002	0.0019	6.8	0.607	0.0013	25	<0.001	500
G64S	01/29/2016	<0.003	0.0031	0.17	<0.001	0.03	<0.001	98	4.1	<0.004	<0.002	<0.25	0.0033	<0.01	<0.0002	0.0018	7.0	0.634	<0.001	27	<0.001	420
G64S	05/02/2016	<0.003	0.0017	0.17	<0.001	0.017	<0.001	110	4.1	<0.004	<0.002	0.303	0.0015	<0.01	<0.0002	0.0018	7.1	1.43	<0.001	27	<0.001	400
G64S	08/20/2016	<0.003	0.0035	0.21	<0.001	0.011	<0.001	110	4	0.015	<0.002	0.317	0.0028	<0.01	<0.0002	0.0023	7.1	0.782	<0.001	26	<0.001	430
G64S	10/28/2016	<0.003	0.0045	0.22	<0.001	0.036	<0.001	92	3.7	<0.004	<0.002	0.375	0.0051	<0.01	<0.0002	0.002	7.2	1.08	<0.001	28	<0.001	440
G64S	02/03/2017	<0.003	0.0023	0.18	<0.001	0.015	<0.001	99	3.6	<0.004	<0.002	0.314	<0.001	<0.01	<0.0002	0.0016	7.2	1.11	<0.001	26	<0.001	460
G64S	05/01/2017	0.0037	0.0037	0.2	<0.001	0.015	<0.001	100	3.7	<0.004	<0.002	0.32	<0.001	<0.01	<0.0002	0.0023	6.9	0.748	<0.001	32	<0.001	450
G64S	06/29/2017	<0.003	0.0028	0.17	<0.001	<0.01	<0.001	80	3.7	<0.004	<0.002	0.376	<0.001	<0.01	<0.0002	0.0013	6.8	1.19	<0.001	26	<0.001	460
G64S	11/08/2017	--	--	--	--	0.014	--	95	3.5	--	--	0.401	--	--	--	--	6.8	--	--	25	--	380
G64S	01/19/2018	--	--	--	--	--	--	--	--	--	--	0.367	--	--	--	--	6.9	--	--	--	--	--
G64S	06/04/2018	--	--	--	--	0.029	--	91	3.6	--	--	0.316	--	--	--	--	6.9	--	--	25	--	380
G64S	07/21/2018	--	--	--	--	0.019	--	83	--	--	--	0.318	--	--	--	--	6.9	--	--	--	--	390
G64S	10/20/2018	--	--	--	--	0.021	--	98	3.8	--	--	0.256	--	--	--	--	6.9	--	--	28	--	420
G64S	02/06/2019	--	--	--	--	0.024	--	140	4.1	--	--	0.38	--	--	--	--	6.8	--	--	25	--	420

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R001009

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G64S	07/15/2019	--	--	--	--	0.023	--	100	3.2	--	--	0.333	--	--	--	--	7.2	--	--	25	--	490
G64S	01/15/2020	--	--	--	--	0.024	--	110	3.4	--	--	0.34	--	--	--	--	6.8	--	--	21	--	480
G64S	08/11/2020	--	--	--	--	0.019	--	100	3.7	--	--	0.287	--	--	--	--	7.0	--	--	26	--	440
G64S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G64S	02/24/2021	--	--	--	--	0.021	--	100	3.6	--	--	0.385	--	--	--	--	7.0	--	--	22	--	500
G64S	06/21/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	--	--	--	--	450
P60	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.3	--	--	--	--	--
P60	03/24/2021	--	0.02	--	--	0.056	<0.001	150	32	--	--	--	0.036	--	--	--	6.6	--	--	53	--	--
R61L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
R61L	02/23/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--

Notes:
Detected at concentration greater than the GWPS
-- = data not available
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method. Estimated concentrations below the reporting limit and associated qualifiers are not provided since they are not utilized in statistics to determine exceedances above Part 845 standards.
35 I.A.C. 845.600 = Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845

R001010

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G02S	12/02/2015	0	-103	6.6	785	12.7	226
G02S	02/03/2016	0	-90	6.6	750	11.4	495
G02S	04/20/2016	0	-105	6.6	812	13.2	1000
G02S	08/18/2016	0	-101	6.8	922	16.5	1000
G02S	10/19/2016	0	-126	6.9	829	15.8	1000
G02S	01/12/2017	0	-148	6.9	920	13.0	1000
G02S	04/22/2017	0	-154	6.8	957	13.9	1000
G02S	06/28/2017	0	-137	6.8	892	18.8	1000
G02S	11/10/2017	0	-146	6.9	917	12.9	1000
G02S	01/17/2018	0	-115	6.9	961	10.8	1000
G02S	06/06/2018	0	-118	6.9	1060	16.2	792
G02S	07/06/2018	0	-119	7.0	1020	14.1	779
G02S	10/04/2018	0	-120	7.1	1080	16.3	790
G02S	02/06/2019	0	-122	7.0	1028	12.0	104
G02S	07/08/2019	0	-128	7.0	1028	16.3	97.9
G02S	01/06/2020	0.12	-144	6.6	792.1	10.8	39.7
G02S	08/11/2020	1.00	-54.7	6.4	801	14.2	70.7
G02S	02/19/2021	0.08	-53.1	6.5	766.2	8.3	116
G02S	04/14/2021	0.32	-79.8	6.7	788.2	11.8	85.6
G02S	04/29/2021	1.00	-83.5	6.8	697	13.0	19.5
G02S	05/12/2021	0.16	-64.1	6.6	789	14.5	38.9
G02S	06/01/2021	0.02	-123	6.8	789	15.4	7.5
G02S	06/15/2021	0.34	-116	6.8	673	13.7	6.07
G02S	06/21/2021	0.09	-125	6.8	788.8	12.8	5.68
G02S	07/12/2021	0.14	-108	6.7	796	17.7	0
G02S	07/28/2021	0.58	-88.5	6.9	766	16.8	20.7
G50S	01/30/2015	--	--	6.8	704	--	--
G50S	04/17/2015	--	--	7.3	1118	--	--
G50S	07/24/2015	--	--	7.4	622	--	--
G50S	10/15/2015	--	--	7.4	718	--	--
G50S	12/03/2015	0	-76	6.9	622	13.1	38.7
G50S	01/29/2016	0	-70	7.4	710	11.3	49.3
G50S	04/25/2016	0	-77	7.3	841	13.3	62.1
G50S	08/10/2016	0	-95	7.3	930	17.0	46.1
G50S	10/21/2016	0	-92	7.3	860	15.7	48.5
G50S	01/21/2017	0	-101	7.3	935	14.2	59
G50S	04/07/2017	0	-79	7.3	701	13.4	38.8
G50S	06/28/2017	0	-87	7.1	796	19.2	50.1
G50S	11/08/2017	0	-84	7.1	782	12.5	8.5
G50S	06/04/2018	0	-77	7.1	790	15.3	57.1
G50S	07/13/2018	0	-78	7.1	820	15.0	48
G50S	10/11/2018	0	-86	7.2	780	15.4	34.3
G50S	02/05/2019	0	-90	7.1	819	12.0	47.1
G50S	07/08/2019	0	-64	7.4	654	16.0	48.1

R001011

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G50S	01/13/2020	0.95	67.2	6.9	707.5	11.4	69
G50S	08/10/2020	2.30	80.1	6.8	720	16.1	9.83
G50S	11/18/2020	--	--	7.0	656	--	--
G50S	02/19/2021	1.20	50.7	7.0	573.7	9.4	304
G50S	04/14/2021	4.00	119	7.2	699.8	12.4	27.8
G50S	04/29/2021	6.20	41.3	7.1	738.9	13.5	4.44
G50S	05/13/2021	5.00	112	7.2	677	15.0	54.5
G50S	06/01/2021	4.20	78.7	7.0	702.4	14.9	4.89
G50S	06/10/2021	3.60	109	7.2	699	18.6	60.2
G50S	06/21/2021	2.50	53.8	7.1	611	14.9	0.46
G50S	07/13/2021	2.50	82.5	7.2	575	17.2	15.2
G50S	07/28/2021	3.00	73.4	7.1	737	22.1	6.7
G51L	01/30/2015	--	--	6.9	942	--	--
G51L	04/17/2015	--	--	7.0	1390	--	--
G51L	07/24/2015	--	--	7.1	772	--	--
G51L	10/15/2015	--	--	7.1	823	--	--
G51L	11/18/2020	--	--	6.9	845	--	--
G51L	02/19/2021	--	--	6.8	566	--	--
G51S	01/30/2015	--	--	7.0	766	--	--
G51S	04/17/2015	--	--	7.2	1061	--	--
G51S	07/24/2015	--	--	7.1	720	--	--
G51S	10/15/2015	--	--	7.2	758	--	--
G51S	12/03/2015	0	-95	7.0	700	12.7	738
G51S	01/29/2016	0	-69	7.0	780	11.9	539
G51S	04/25/2016	0	-60	7.1	870	12.8	1000
G51S	08/10/2016	0	-67	7.1	863	17.3	1000
G51S	10/21/2016	0	-92	7.4	928	14.9	1000
G51S	01/21/2017	0	-82	7.3	935	14.5	1000
G51S	04/07/2017	0	-72	7.0	852	13.3	8.5
G51S	06/28/2017	0	-74	6.8	880	17.6	3.8
G51S	11/08/2017	0	-61	7.1	848	12.9	4.2
G51S	06/04/2018	0	-42	7.0	902	16.1	8.9
G51S	07/13/2018	0	-71	6.9	910	14.2	11
G51S	10/11/2018	8.60	-110	7.1	812	15.3	22.1
G51S	02/05/2019	0	-59	6.8	900	11.9	14.1
G51S	07/08/2019	0	-60	7.0	716	16.3	52.1
G51S	01/14/2020	4.40	62.7	7.1	686.6	11.4	111
G51S	08/10/2020	2.30	-9.5	6.9	752.8	20.7	42.5
G51S	11/18/2020	--	--	7.0	673	--	--
G51S	02/19/2021	5.80	-9	7.2	686.9	9.3	299
G51S	04/14/2021	1.90	-8.3	7.1	559	15.1	48.5
G51S	04/29/2021	1.80	4.3	7.1	728.8	17.0	17.9
G51S	05/13/2021	2.20	-5.8	7.2	720	13.8	10.6
G51S	06/01/2021	1.10	50.1	7.2	720.1	16.2	25.6

R001012

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G51S	06/15/2021	1.90	-29.4	7.0	747	15.4	19.6
G51S	06/21/2021	0.30	-38.8	7.1	713	14.2	26
G51S	07/12/2021	0.36	-59.4	7.0	720	16.6	72.7
G51S	07/27/2021	1.60	53.9	7.1	688	19.8	20.2
G52L	01/30/2015	--	--	6.6	1807	--	--
G52L	04/17/2015	--	--	6.6	2220	--	--
G52L	07/24/2015	--	--	6.5	1277	--	--
G52L	10/15/2015	--	--	7.1	922	--	--
G52L	11/18/2020	--	--	6.5	1642	--	--
G52L	02/19/2021	--	--	6.4	1444	--	--
G52S	01/30/2015	--	--	6.8	1064	--	--
G52S	04/17/2015	--	--	6.9	1099	--	--
G52S	07/24/2015	--	--	6.9	873	--	--
G52S	10/15/2015	--	--	6.9	845	--	--
G53L	01/30/2015	--	--	6.8	942	--	--
G53L	04/16/2015	--	--	6.9	890	--	--
G53L	07/24/2015	--	--	6.9	858	--	--
G53L	10/16/2015	--	--	6.9	952	--	--
G53L	11/18/2020	--	--	6.6	1312	--	--
G53L	02/22/2021	--	--	6.8	1235	--	--
G53S	01/30/2015	--	--	7.0	903	--	--
G53S	04/16/2015	--	--	7.1	814	--	--
G53S	07/24/2015	--	--	7.0	763	--	--
G53S	10/16/2015	--	--	7.2	893	--	--
G53S	11/18/2020	--	--	6.9	988	--	--
G53S	02/22/2021	--	--	6.8	698	--	--
G54C	04/14/2021	0.99	-103	7.3	1158	13.3	167
G54C	04/29/2021	0.50	-79.9	7.3	1200	14.5	76.7
G54C	05/12/2021	1.60	-66.9	7.2	1172	15.8	39.2
G54C	06/01/2021	1.60	-70.3	7.3	1200	16.8	27.6
G54L	10/14/2015	--	--	6.6	992	--	--
G54L	11/17/2020	--	--	6.5	1290	--	--
G54L	02/22/2021	--	--	6.6	1216	--	--
G54L	04/14/2021	0.64	-14	6.6	1508	14.1	35.7
G54L	04/29/2021	0.71	-32.1	6.6	1426	15.9	16
G54L	05/12/2021	2.20	-40.2	6.5	1423	19.5	26.6
G54L	06/01/2021	1.20	-72.4	6.6	1370	21.7	5.74
G54L	06/14/2021	1.80	-82.6	6.7	1344	20.8	16.4
G54L	06/21/2021	1.60	-44.6	6.5	1329	15.3	25.8
G54L	07/13/2021	2.00	-23.9	6.4	1351	25.1	33
G54L	07/27/2021	2.20	37.9	6.6	1383	16.4	24.7
G54S	01/30/2015	--	--	6.8	1044	--	--
G54S	04/16/2015	--	--	6.8	936	--	--
G54S	07/23/2015	--	--	6.9	885	--	--

R001013

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G54S	10/14/2015	--	--	6.9	806	--	--
G54S	12/04/2015	0	-15	6.5	992	12.6	8.4
G54S	01/29/2016	0	-17	6.9	925	11.6	8.5
G54S	05/02/2016	0	-21	6.7	951	13.1	7.3
G54S	08/12/2016	0	-29	7.1	980	17.7	12.8
G54S	10/21/2016	0	-52	7.2	970	16.0	11.4
G54S	01/24/2017	0	-60	7.5	1115	15.6	25.1
G54S	04/07/2017	0	-63	6.9	840	13.5	14.2
G54S	06/28/2017	0	-58	7.1	913	19.2	17.9
G54S	11/08/2017	0	-61	7.1	799	13.3	19.4
G54S	01/18/2018	0	-72	6.9	855	11.3	24.2
G54S	06/04/2018	0	-52	7.1	930	15.6	15
G54S	07/13/2018	0	-58	7.1	910	14.8	25.4
G54S	10/16/2018	0	-59	7.2	898	14.1	17.8
G54S	02/05/2019	0	-61	7.1	892	12.0	20.3
G54S	07/15/2019	0	-71	7.1	960	15.9	15.2
G54S	01/14/2020	4.80	27.7	6.9	1010	10.8	111
G54S	08/10/2020	1.90	-12.8	6.8	1046	20.6	28.7
G54S	11/17/2020	--	--	6.7	999	--	--
G54S	02/22/2021	1.00	-10	6.8	961.2	12.2	43.3
G54S	06/21/2021	0.39	-23.6	7.0	875	15.0	17.1
G55L	01/30/2015	--	--	6.8	956	--	--
G55L	04/16/2015	--	--	6.8	663	--	--
G55L	07/23/2015	--	--	6.9	843	--	--
G55L	10/14/2015	--	--	6.9	747	--	--
G55L	11/17/2020	--	--	6.5	1023	--	--
G55L	02/22/2021	--	--	6.7	1020	--	--
G55S	01/30/2015	--	--	6.9	893	--	--
G55S	04/16/2015	--	--	7.0	808	--	--
G55S	07/23/2015	--	--	7.1	788	--	--
G55S	10/14/2015	--	--	7.0	696	--	--
G55S	11/17/2020	--	--	6.6	801	--	--
G55S	02/22/2021	--	--	6.8	843	--	--
G56L	07/22/2015	--	--	6.9	885	--	--
G56L	10/16/2015	--	--	7.0	803	--	--
G56L	11/17/2020	--	--	6.7	1266	--	--
G56L	02/22/2021	--	--	6.5	1253	--	--
G56S	02/04/2015	--	--	7.2	918	--	--
G56S	04/16/2015	--	--	6.8	855	--	--
G56S	07/22/2015	--	--	6.9	760	--	--
G56S	10/16/2015	--	--	6.9	885	--	--
G56S	11/17/2020	--	--	6.7	878	--	--
G56S	02/22/2021	--	--	6.6	900	--	--
G57L	02/04/2015	--	--	7.2	570	--	--

R001014

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G57L	02/25/2015	--	--	7.2	570	--	--
G57L	04/16/2015	--	--	6.9	908	--	--
G57L	07/22/2015	--	--	6.9	825	--	--
G57L	10/16/2015	--	--	6.7	932	--	--
G57L	11/17/2020	--	--	7.0	797	--	--
G57L	02/22/2021	--	--	6.8	978	--	--
G57S	02/04/2015	--	--	7.1	973	--	--
G57S	04/16/2015	--	--	7.2	920	--	--
G57S	07/22/2015	--	--	7.0	803	--	--
G57S	10/16/2015	--	--	7.1	888	--	--
G57S	12/04/2015	10.00	13	6.8	925	13.0	7.6
G57S	01/29/2016	0	19	6.8	880	12.9	9.1
G57S	05/02/2016	0	30	6.9	930	13.4	11.9
G57S	08/12/2016	0	56	7.0	970	18.9	19.2
G57S	10/28/2016	0	75	7.1	1046	14.6	19.4
G57S	02/03/2017	0	69	7.2	1005	14.8	18
G57S	05/01/2017	0	62	7.1	932	14.2	12.1
G57S	06/28/2017	0	79	7.3	1040	18.3	15.9
G57S	11/08/2017	0	78	7.0	1020	13.1	12.1
G57S	01/18/2018	0	64	7.1	895	12.7	16
G57S	06/04/2018	0	89	7.2	1100	17.0	14.3
G57S	07/21/2018	0	73	7.2	1005	15.0	38.1
G57S	10/17/2018	0	71	7.3	1060	14.0	17
G57S	02/06/2019	0	79	7.2	1033	11.7	18.5
G57S	07/15/2019	0	-60	7.1	1096	16.1	18.6
G57S	01/14/2020	0.83	159	6.8	1115	12.0	128
G57S	08/10/2020	0.67	60.8	6.6	1161	16.3	18.3
G57S	11/17/2020	2.30	56.9	7.0	1029	12.8	3.86
G57S	02/22/2021	2.10	12.5	6.9	1236	11.0	10.9
G58L	04/15/2015	--	--	6.9	1294	--	--
G58L	07/22/2015	--	--	7.0	935	--	--
G58L	10/14/2015	--	--	7.0	955	--	--
G58L	11/18/2020	--	--	7.0	1063	--	--
G58L	02/22/2021	--	--	6.8	1087	--	--
G58S	02/04/2015	--	--	6.8	1487	--	--
G58S	04/15/2015	--	--	6.5	1450	--	--
G58S	07/22/2015	--	--	6.8	946	--	--
G58S	10/14/2015	--	--	6.9	996	--	--
G58S	11/18/2020	--	--	6.6	949	--	--
G58S	02/22/2021	--	--	6.6	974	--	--
G59L	07/22/2015	--	--	6.7	871	--	--
G59L	10/14/2015	--	--	7.0	1043	--	--
G59L	11/18/2020	--	--	6.8	983	--	--
G59L	02/22/2021	--	--	6.6	971	--	--

R001015

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G59S	02/04/2015	--	--	6.9	949	--	--
G59S	04/15/2015	--	--	6.9	967	--	--
G59S	07/22/2015	--	--	6.9	877	--	--
G59S	10/14/2015	--	--	7.1	1032	--	--
G59S	11/18/2020	--	--	6.7	842	--	--
G59S	02/22/2021	--	--	6.8	913	--	--
G60L	11/17/2020	--	--	6.3	998	--	--
G60L	02/23/2021	--	--	6.2	1069	--	--
G60L	04/14/2021	2.50	144	6.2	959.1	11.5	55.1
G60L	04/29/2021	2.10	111	6.1	974	12.4	60.6
G60L	05/13/2021	1.70	86	6.2	899.4	15.2	1.97
G60L	06/01/2021	2.40	111	6.3	917	14.6	1.01
G60L	06/15/2021	1.30	90.1	6.2	908	15.9	1.28
G60L	06/21/2021	0.97	87.7	6.2	914.4	13.8	11.8
G60L	07/12/2021	0.42	64.1	6.0	937	17.3	11.5
G60L	07/28/2021	0.63	106	6.2	840	17.0	22.4
G60S	02/04/2015	--	--	6.8	973	--	--
G60S	04/15/2015	--	--	6.8	999	--	--
G60S	07/22/2015	--	--	6.8	804	--	--
G60S	10/14/2015	--	--	7.1	849	--	--
G60S	12/04/2015	0	-41	6.6	958	12.3	75.9
G60S	01/29/2016	0	-65	6.7	990	12.1	38.9
G60S	05/02/2016	0	-42	6.7	1040	12.7	63.6
G60S	08/20/2016	0	-51	6.7	1015	18.0	56
G60S	10/28/2016	0	-45	6.6	916	14.1	70.8
G60S	02/03/2017	0	-47	6.5	948	14.4	70.2
G60S	04/25/2017	0	-62	6.8	735	14.1	30.5
G60S	06/29/2017	0	-58	7.0	710	17.5	36.4
G60S	11/08/2017	0	-52	6.9	718	13.6	27.4
G60S	01/19/2018	0	-60	6.9	701	12.6	39.7
G60S	06/04/2018	0	-68	6.9	802	15.9	43.4
G60S	07/21/2018	0	-60	7.0	724	15.2	41.8
G60S	10/17/2018	0	-51	6.9	764	14.4	38.4
G60S	02/06/2019	0	-65	7.0	698	12.0	42.4
G60S	04/08/2019	0	-60	7.0	1030	14.5	41.7
G60S	07/15/2019	0	-60	6.8	1150	15.8	14
G60S	01/14/2020	0.57	122	6.6	1226	12.2	33.5
G60S	08/10/2020	1.90	57.4	6.6	1110	21.0	1230
G60S	11/17/2020	0.99	-0.6	6.8	978	11.8	75.3
G60S	02/23/2021	1.20	-2.1	6.6	937.2	11.9	15.7
G61S	02/04/2015	--	--	7.0	1679	--	--
G61S	04/15/2015	--	--	7.0	1533	--	--
G61S	07/21/2015	--	--	6.9	1059	--	--
G61S	10/13/2015	--	--	7.0	1095	--	--

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G61S	11/18/2020	--	--	6.6	1514	--	--
G61S	02/23/2021	--	--	6.5	1511	--	--
G62L	02/04/2015	--	--	6.8	1356	--	--
G62L	04/15/2015	--	--	6.9	1507	--	--
G62L	07/22/2015	--	--	7.0	643	--	--
G62L	10/13/2015	--	--	7.2	790	--	--
G62L	11/18/2020	--	--	6.8	1578	--	--
G62L	02/24/2021	--	--	6.7	1275	--	--
G63L	04/15/2015	--	--	6.9	1767	--	--
G63L	07/22/2015	--	--	6.9	1117	--	--
G63L	10/13/2015	--	--	7.2	852	--	--
G63L	11/18/2020	--	--	7.0	1615	--	--
G63L	02/24/2021	--	--	6.7	1123	--	--
G63S	02/04/2015	--	--	7.1	866	--	--
G63S	04/15/2015	--	--	7.0	890	--	--
G63S	07/22/2015	--	--	7.2	718	--	--
G63S	10/13/2015	--	--	7.3	919	--	--
G63S	11/18/2020	--	--	7.0	548	--	--
G63S	02/24/2021	--	--	7.0	918	--	--
G64L	02/04/2015	--	--	6.9	818	--	--
G64L	04/15/2015	--	--	7.1	818	--	--
G64L	07/22/2015	--	--	7.0	858	--	--
G64L	10/13/2015	--	--	7.1	955	--	--
G64L	11/18/2020	--	--	7.1	1054	--	--
G64L	02/25/2021	--	--	7.0	1009	--	--
G64S	02/04/2015	--	--	7.1	819	--	--
G64S	04/15/2015	--	--	7.0	881	--	--
G64S	07/22/2015	--	--	7.0	807	--	--
G64S	10/13/2015	--	--	7.1	870	--	--
G64S	12/04/2015	2.80	-60	6.8	773	12.7	234
G64S	01/29/2016	0	-57	7.0	788	11.3	296
G64S	05/02/2016	0	-79	7.1	695	13.1	124
G64S	08/20/2016	0	-70	7.1	688	18.9	97.3
G64S	10/28/2016	0	-84	7.2	731	15.0	110
G64S	02/03/2017	0	-62	7.2	710	14.5	101
G64S	05/01/2017	0	-65	6.9	859	14.3	15.3
G64S	06/29/2017	0	-90	6.8	818	19.2	21.6
G64S	11/08/2017	0	-79	6.8	798	13.9	21.9
G64S	01/19/2018	0	-72	6.9	825	12.6	21.7
G64S	06/04/2018	0	-68	6.9	851	16.1	21.4
G64S	07/21/2018	0	-91	6.9	840	15.4	25.1
G64S	10/20/2018	0	-74	6.9	855	13.7	24.5
G64S	02/06/2019	0	-91	6.8	802	11.8	27.5
G64S	07/15/2019	0	70	7.2	750	16.0	14.7

R001017

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G64S	01/15/2020	0.83	-12.3	6.8	781.2	11.4	41.4
G64S	08/11/2020	4.30	-1.3	7.0	688.9	18.5	42.8
G64S	11/18/2020	--	--	7.0	769	--	--
G64S	02/24/2021	3.00	-55.9	7.0	727.4	11.4	60.7
G64S	06/21/2021	0.76	-57.1	7.1	761	16.2	21.3
P60	02/24/2021	3.40	54	6.3	830	16.4	236
P60	03/24/2021	3.60	41.4	6.6	862	--	1620
R61L	11/18/2020	--	--	6.7	1162	--	--
R61L	02/23/2021	--	--	6.6	1058	--	--

Notes:
Field readings are reported with as many significant figures as provided by analytical laboratory.
-- = data not available
cm = centimeter
deg. C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTU = nephelometric turbidity units
SU = standard units

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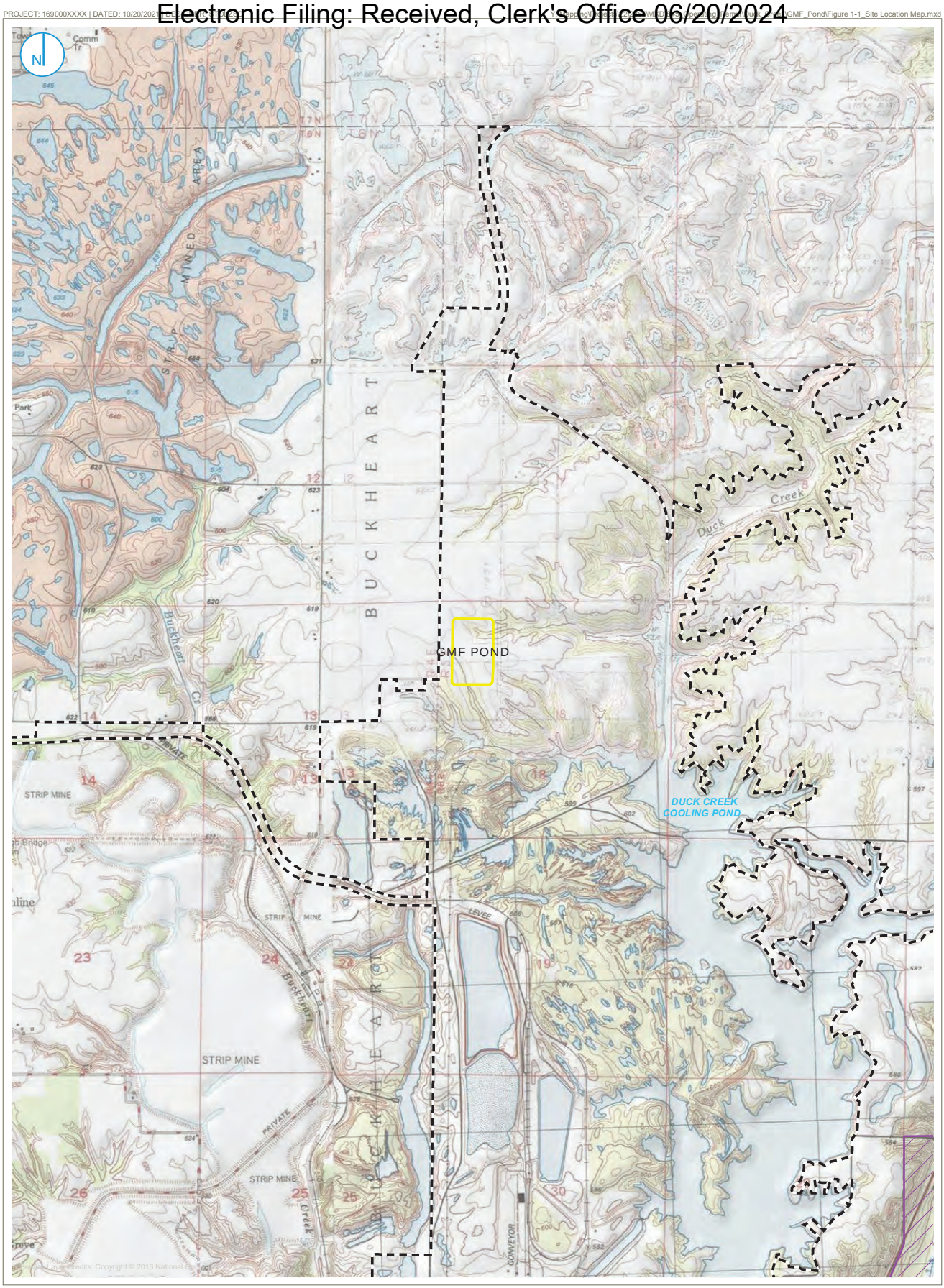
Electronic Filing: Received, Clerk's Office 06/20/2024

FIGURES

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/20/2021 | DESIGNER: [illegible] | Y:\Mapping\[illegible]\GMF_Pond\Figure 1-1_Site Location Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY
COFFEEN LAKE STATE FISH AND WILDLIFE AREA

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-1

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: CLEARS | CLASS: | Y:\Projects\2021\2021\Ameren\Duck_Creek\GMF_Pond\Figure 1-2_Site Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SITE MAP

FIGURE 1-2

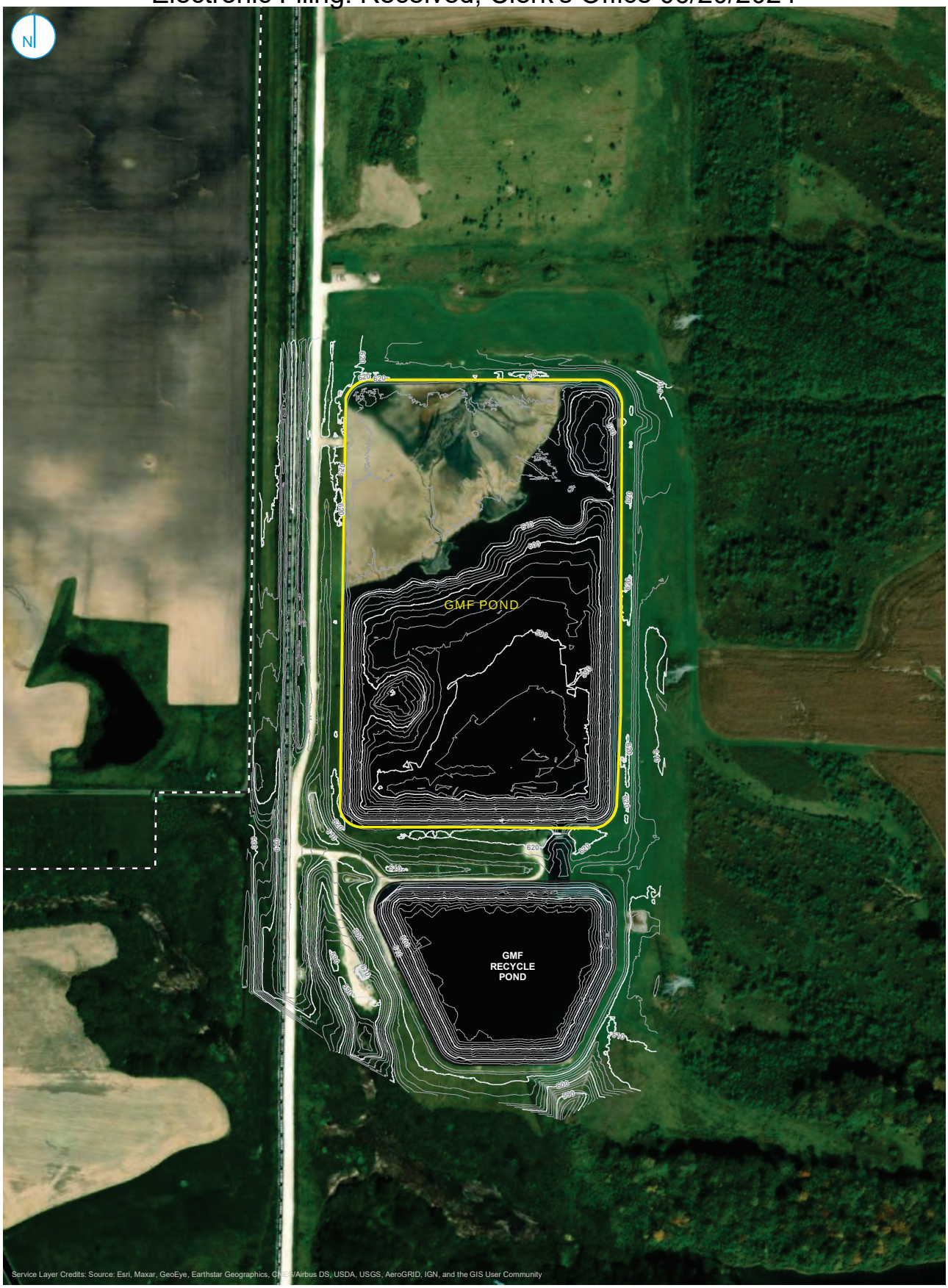
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: CLERK | CLASS: | \\MAPS\Projects\22\22-Ramboll\Duck Creek\GMF_Pond\Figure 2-1_Topo Map.mxd



10 FOOT ELEVATION CONTOUR (NAVD88)
2 FOOT ELEVATION CONTOUR (NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SITE TOPOGRAPHIC MAP

FIGURE 2-1

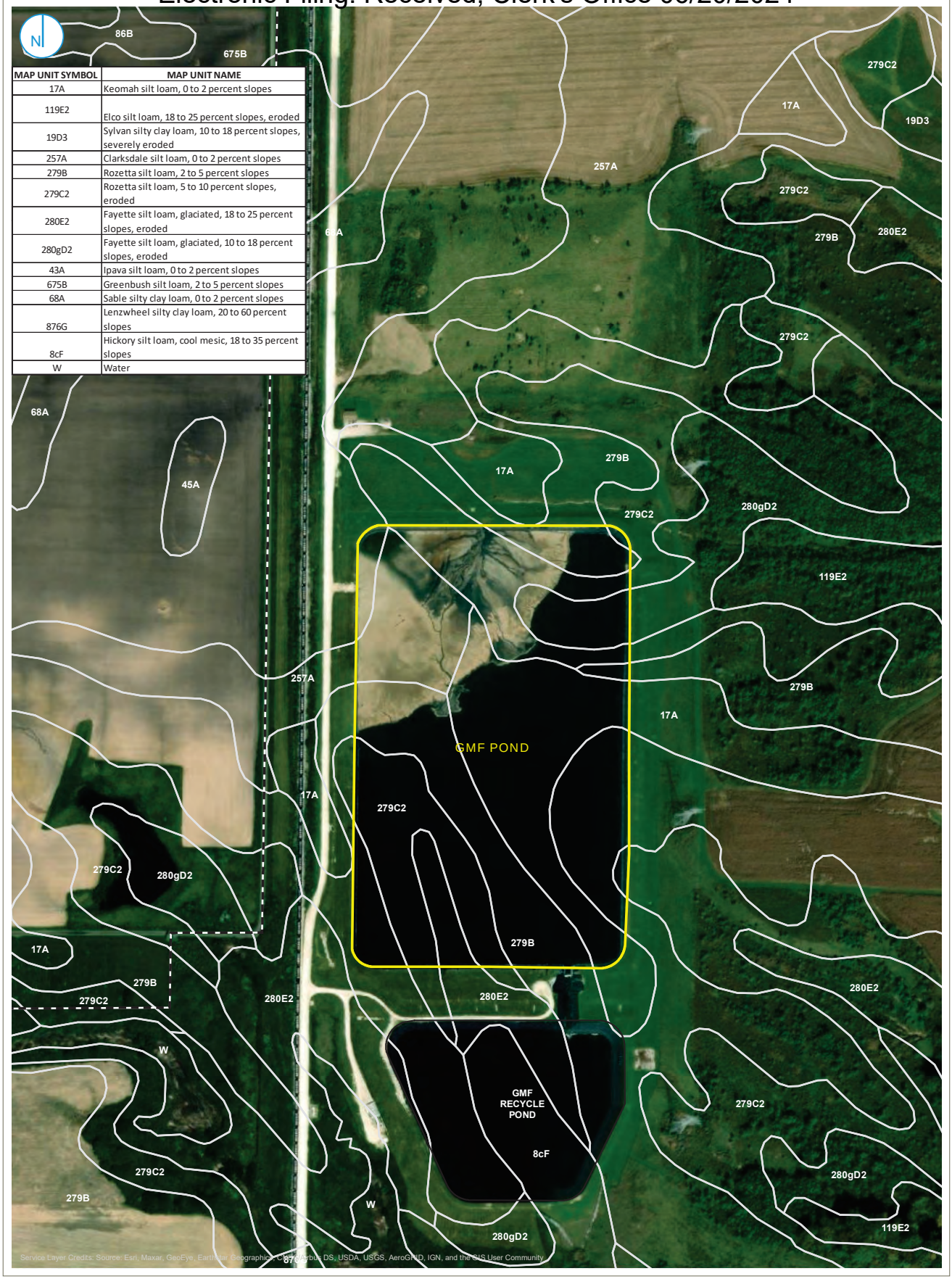
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: ... | Y:\Maps\...\Creek\GMF_Pond\Figure 2-2_Soil Survey.mxd



MAP UNIT SYMBOL	MAP UNIT NAME
17A	Keomah silt loam, 0 to 2 percent slopes
119E2	Elco silt loam, 18 to 25 percent slopes, eroded
19D3	Sylvan silty clay loam, 10 to 18 percent slopes, severely eroded
257A	Clarksdale silt loam, 0 to 2 percent slopes
279B	Rozetta silt loam, 2 to 5 percent slopes
279C2	Rozetta silt loam, 5 to 10 percent slopes, eroded
280E2	Fayette silt loam, glaciated, 18 to 25 percent slopes, eroded
280gD2	Fayette silt loam, glaciated, 10 to 18 percent slopes, eroded
43A	Ipava silt loam, 0 to 2 percent slopes
675B	Greenbush silt loam, 2 to 5 percent slopes
68A	Sable silty clay loam, 0 to 2 percent slopes
876G	Lenzwheel silty clay loam, 20 to 60 percent slopes
8cF	Hickory silt loam, cool mesic, 18 to 35 percent slopes
W	Water

PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY
NRCS SOIL SURVEY MAP UNIT BOUNDARY

0 150 300 Feet

SOIL SURVEY MAP

FIGURE 2-2

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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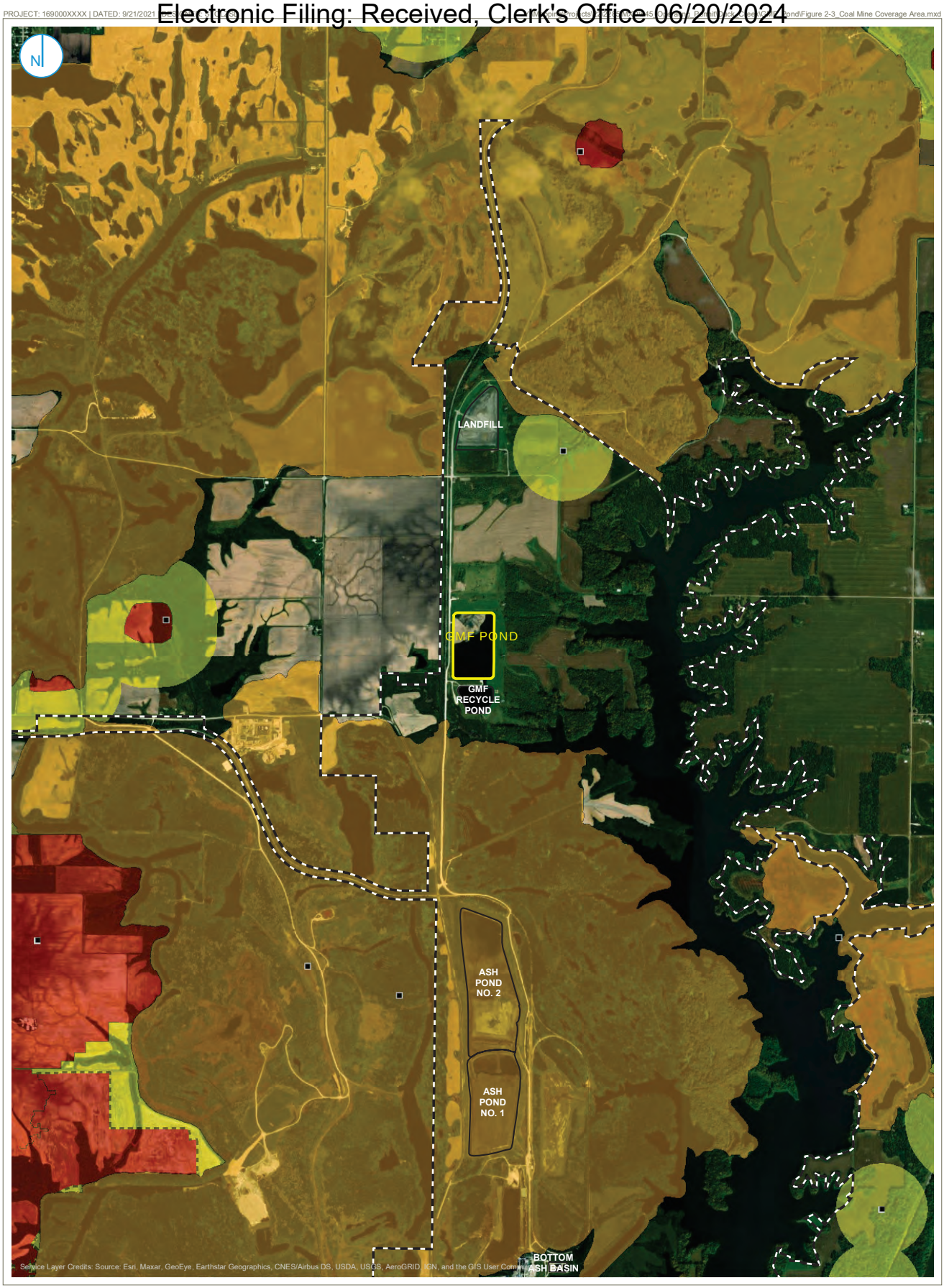
PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: ... | Coal Mine Coverage Area.mxd



- COAL MINE SHAFT
- SURFACE COAL MINE
- UNDERGROUND COAL MINE
- UNDERGROUND MINE BUFFER REGION
- PART 845 REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- PROPERTY BOUNDARY

0 1,000 2,000 Feet

COAL MINE COVERAGE AREA

FIGURE 2-3

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: ... | Figure 2-4_Surficial Geologic Deposits.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY
RADNOR TILL MEMBER

0 150 300 Feet

SURFICIAL GEOLOGIC DEPOSITS

FIGURE 2-4

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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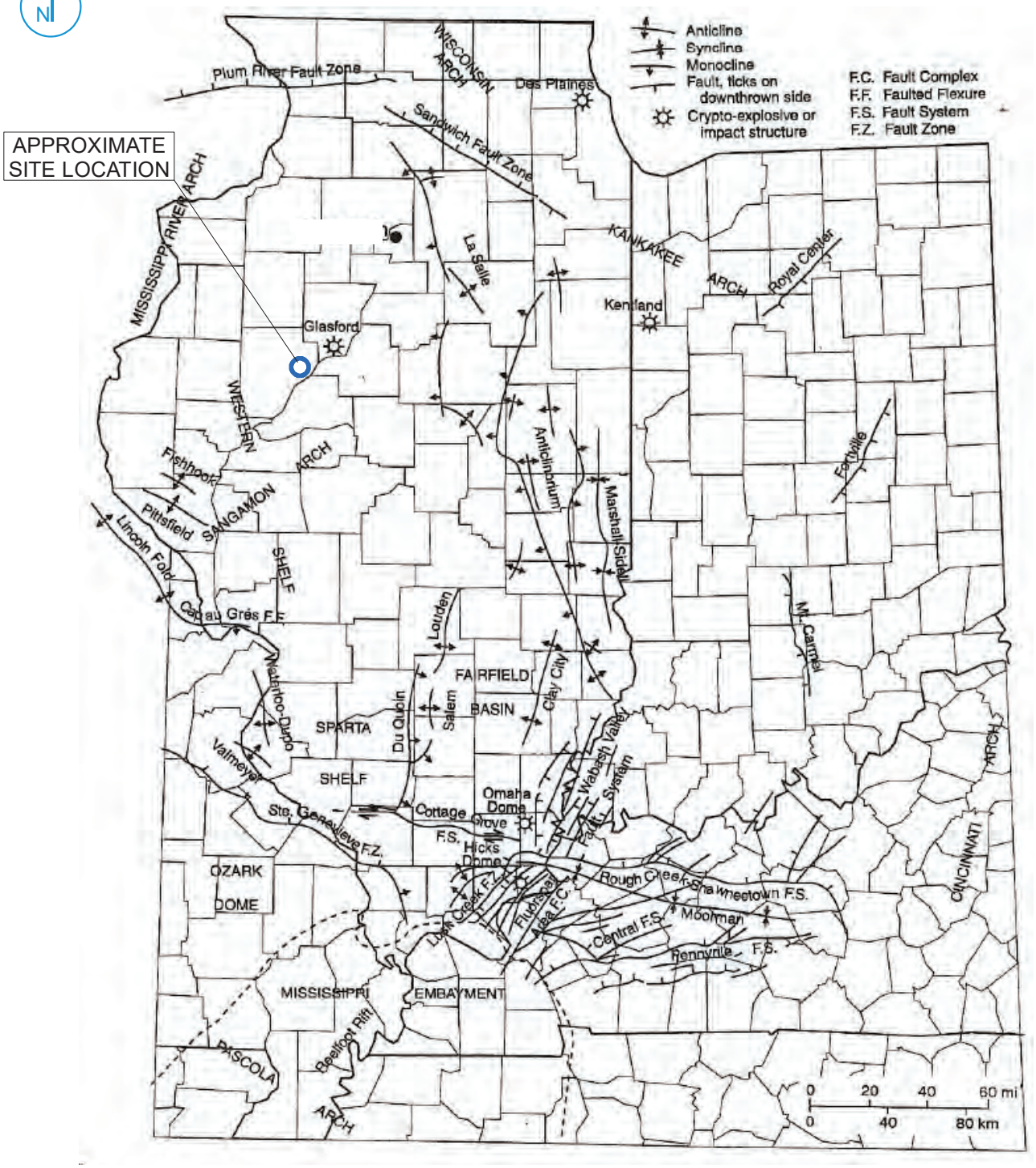

SOURCE NOTE: MODIFIED FROM "NELSON, W.J. 1995, STRUCTURAL FEATURES IN ILLINOIS, ILLINOIS STATE GEOLOGICAL SURVEY, BULLETIN 100, CchampaIGN, ILLINOIS."

Service Layer Credits:

Y:\Mapping\Projects\22285\MXD\845_Operating_Permit\Duck_Creek\GMF_Pond\Figure 2-5_Major Structural Features of Illinois.mxd

PROJECT: 169000XXXX | DATED: 9/17/2021 | DESIGNER: STOLZSD

MAJOR STRUCTURAL FEATURES OF ILLINOIS

FIGURE 2-5

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGNED BY: CLS | Figure 2-6_Field Investigation Location Map.mxd



MONITORING WELL
SOLID SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

FIELD INVESTIGATION LOCATION MAP

FIGURE 2-6

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

R001027

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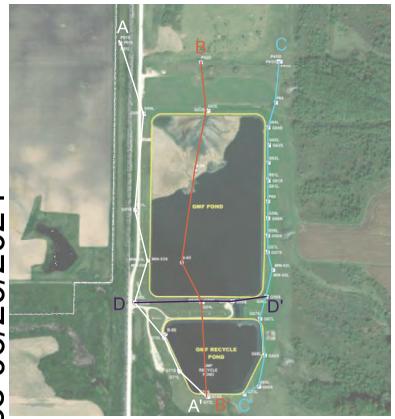
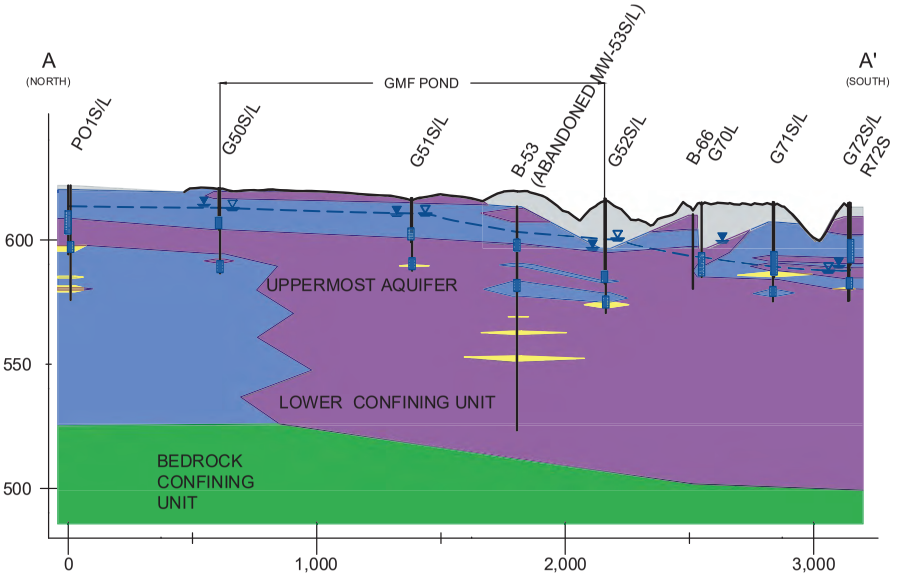
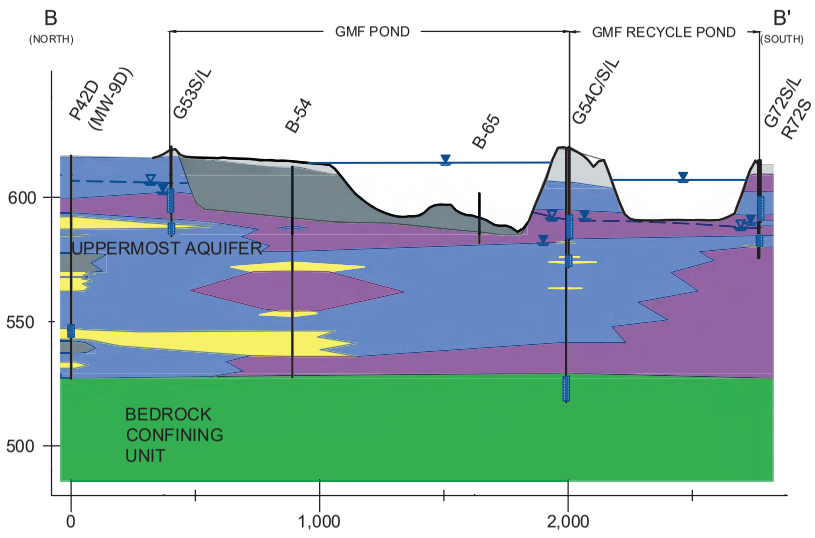


NOTES

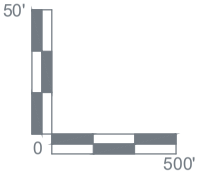
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on April 14, 2021.





LEGEND

- COAL COMBUSTION RESIDUAL (CCR) (GYPSUM)
- FILL
- CLAY (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- WELL SCREEN INTERVAL
- UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
- UPPER AQUIFER GROUNDWATER ELEVATION
- BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)
- SURFACE WATER



GEOLOGIC CROSS SECTIONS
A-A' & B-B'

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 2-7

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

R001028

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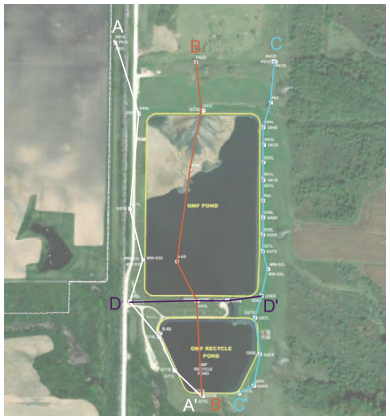
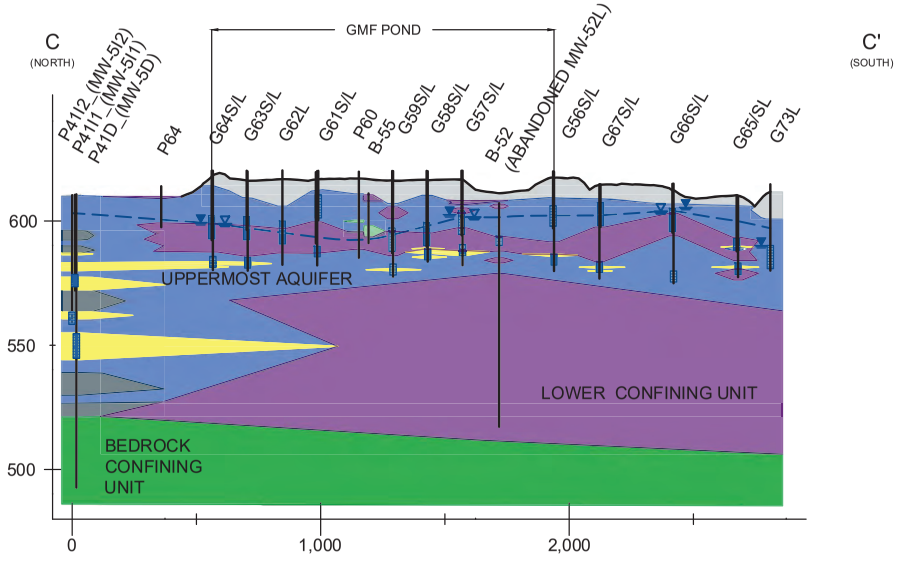
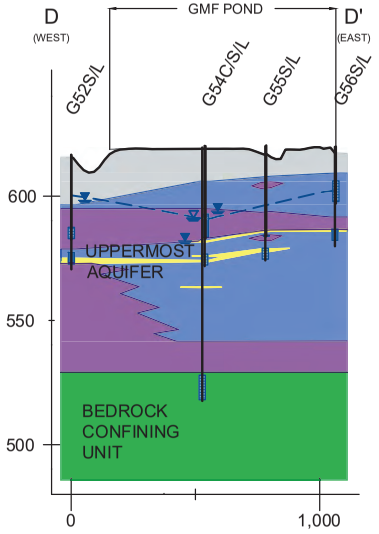


NOTES

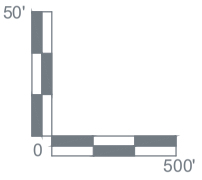
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on April 14, 2021.





LEGEND

- COAL COMBUSTION RESIDUAL (CCR) (GYPSUM)
- FILL
- CLAY (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- PEAT
- WELL SCREEN INTERVAL
- UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
- UPPER AQUIFER GROUNDWATER ELEVATION
- BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)



GEOLOGIC CROSS SECTIONS
C-C' & D-D'

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 2-8

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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PROJECT: 169000XXXX | DATED: 10/12/2021 | DESIGNER: Kristina Ali | X:\Mapping\Projects\2022\MXD\8_Figures\Figure_Pond\Figure 2-9_Bottom of CCR Map.mxd



10 FOOT CONSTRUCTION ELEVATION CONTOUR
2 FOOT CONSTRUCTION ELEVATION CONTOUR
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

BOTTOM OF CCR MAP

FIGURE 2-9

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/19/2021 | DESIGNER: STOUGHTON | Figure 3-1_Monitoring Well Location Map.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

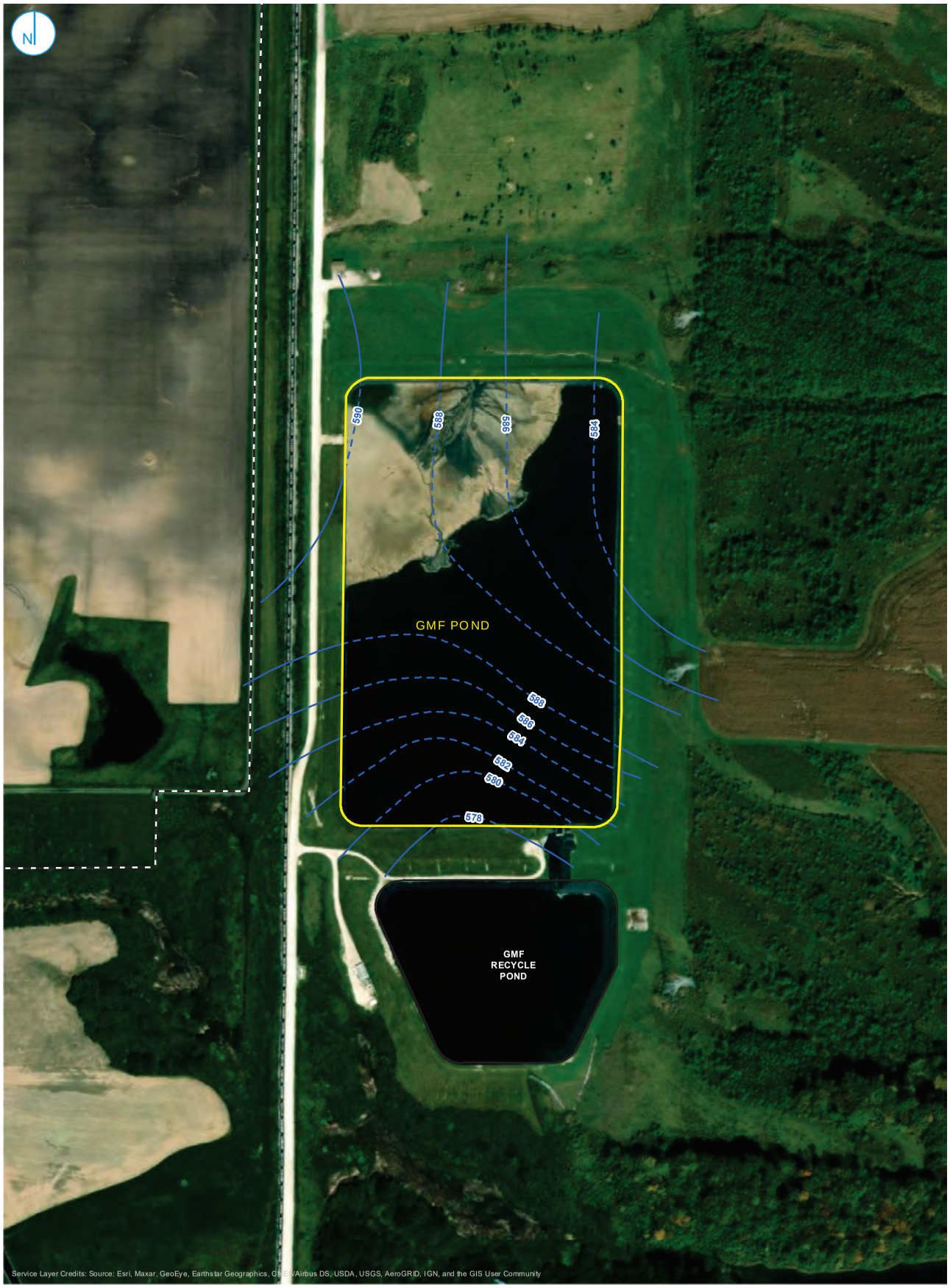
MONITORING WELL LOCATION MAP

FIGURE 3-1

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



UPPERMOST AQUIFER ELEVATION, TOP OF SAND (2-FOOT CONTOUR)

INFERRED UPPERMOST AQUIFER ELEVATION, TOP OF SAND (2-FOOT CONTOUR)

PART 845 REGULATED UNIT (SUBJECT UNIT)

SITE FEATURE

PROPERTY BOUNDARY

0 150 300 Feet

TOP OF UPPERMOST AQUIFER

FIGURE 3-2

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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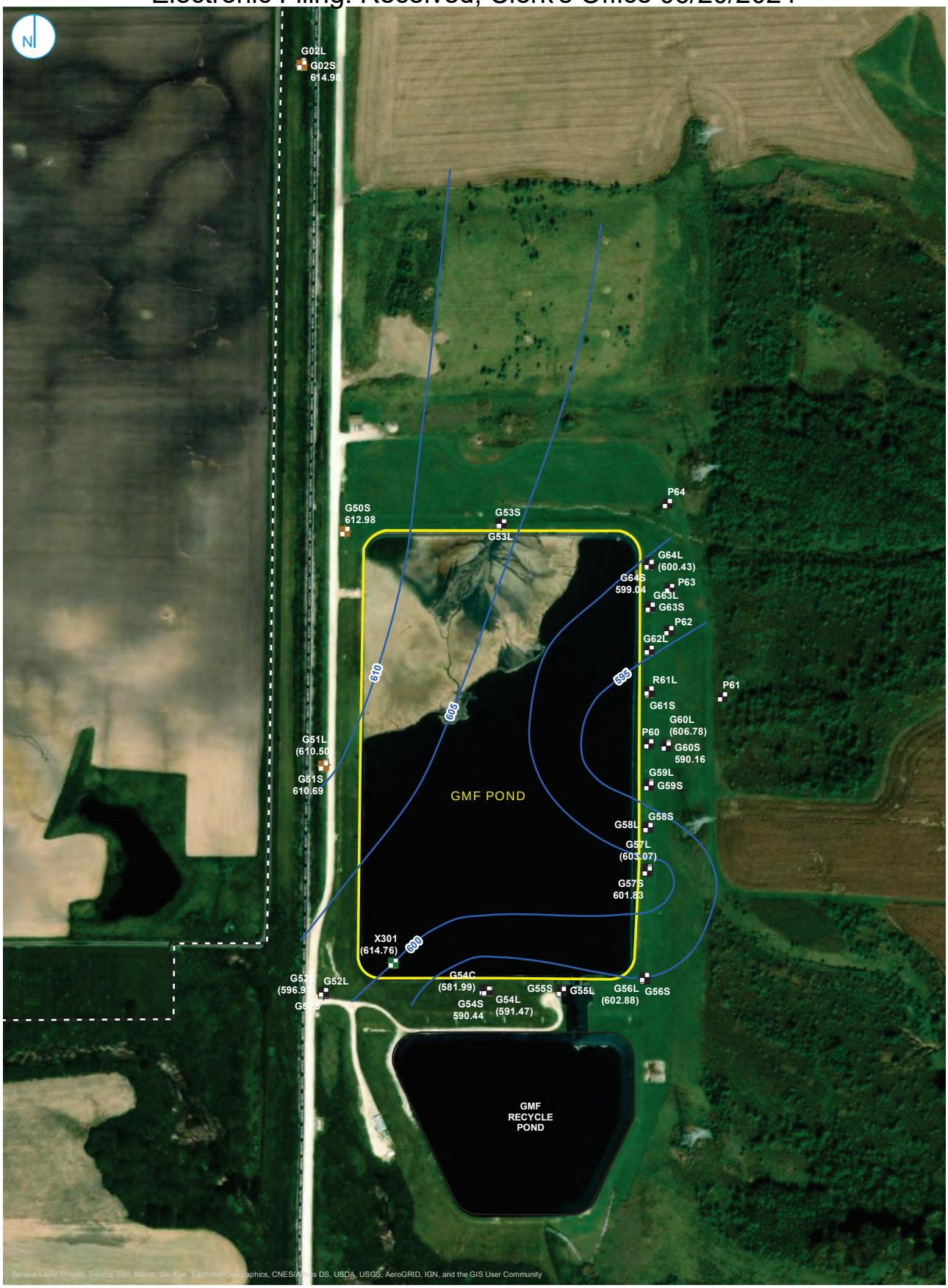
PROJECT: 169000XXXX | DATED: 9/23/2021 | DESIGN: CLERK | Mapping Projects 2022 | GMF Pond\Figure 3-3_GWE Contours 20210414.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

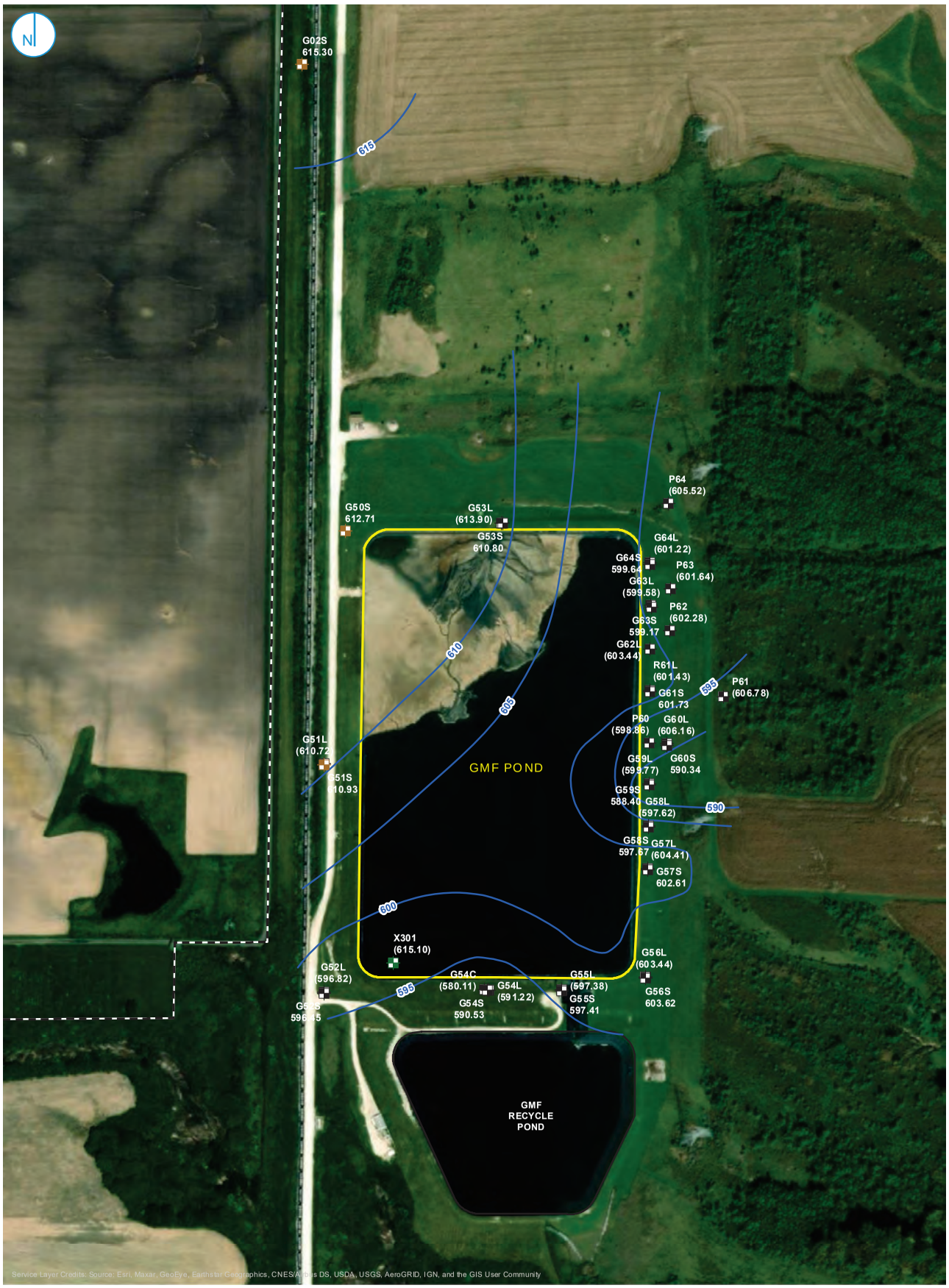
UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS APRIL 14, 2021

FIGURE 3-3

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300
Feet

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS MAY 10, 2021

FIGURE 3-4

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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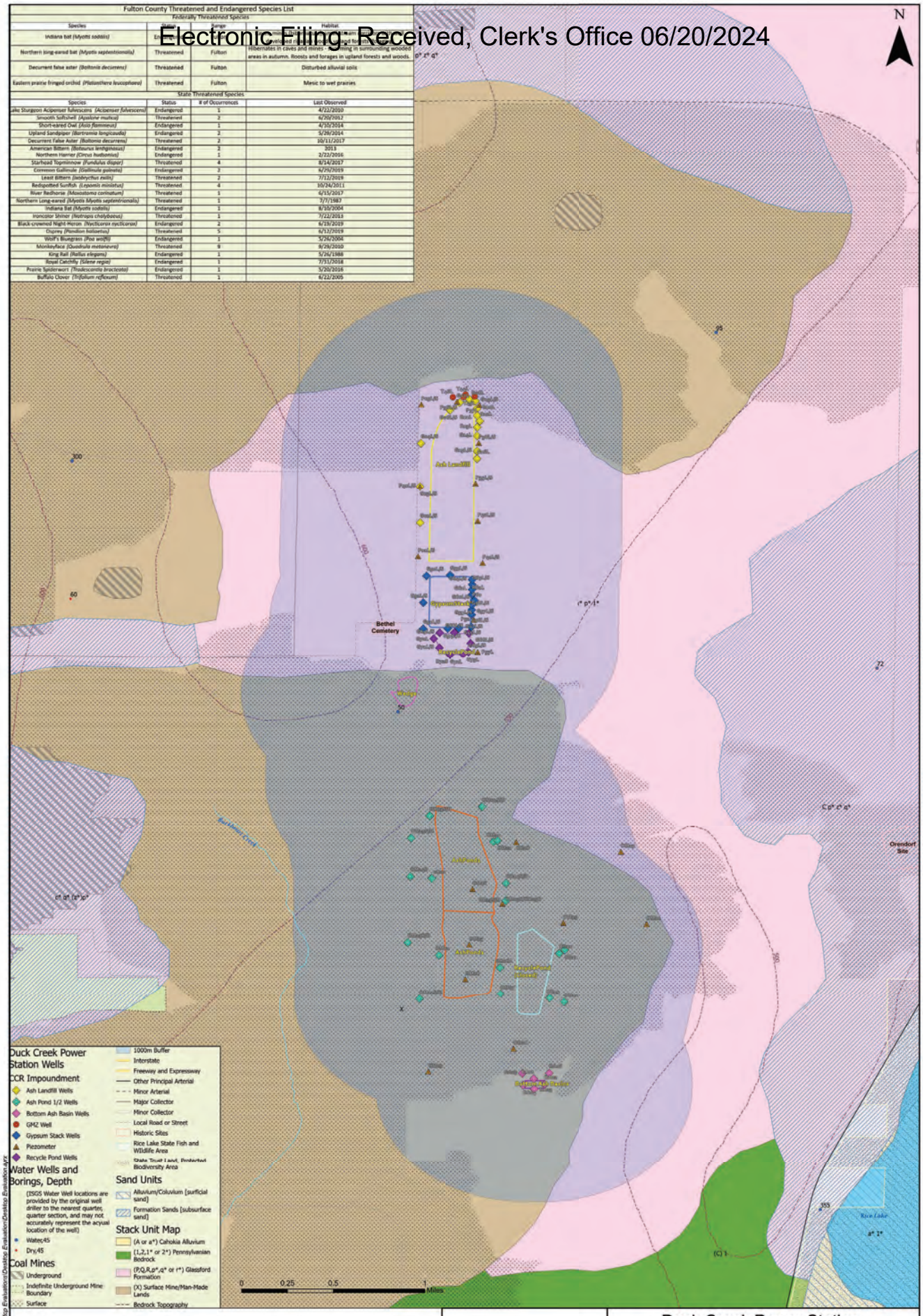
APPENDICES

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX A
INFORMATION PERTINENT TO 35 I.A.C. § 845.220(a)(3)

Electronic Filing: Received, Clerk's Office 06/20/2024

Fulton County Threatened and Endangered Species List			
Federally Threatened Species			
Species	Status	Range	Habitat
Indiana bat (*Myotis sodalis*)	Endangered	Fulton	[illegible]
Northern long-eared bat (*Myotis septentrionalis*)	Threatened	Fulton	Hibernates in caves and mines - [illegible] in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods.
Decurrent false aster (*Boltonia decurrens*)	Threatened	Fulton	Disturbed alluvial soils
Eastern prairie fringed orchid (*Platanthera leucophaea*)	Threatened	Fulton	Mesic to wet prairies
State Threatened Species			
Species	Status	# of Occurrences	Last Observed
Lake Sturgeon Acipenser fulvescens (*Acipenser fulvescens*)	Endangered	1	4/22/2010
Smooth Softshell (*Apalone mutica*)	Threatened	2	6/20/2012
Short-eared Owl (*Asio flammeus*)	Endangered	1	4/10/2014
Upland Sandpiper (*Bartramia longicauda*)	Endangered	2	5/28/2014
Decurrent False Aster (*Boltonia decurrens*)	Threatened	2	10/11/2017
American Bittern (*Botaurus lentiginosus*)	Endangered	2	2013
Northern Harrier (*Circus hudsonius*)	Endangered	1	2/22/2016
Starhead Topminnow (*Fundulus dispar*)	Threatened	4	8/14/2017
Common Gallinule (*Gallinula galeata*)	Endangered	2	6/29/2019
Least Bittern (*Ixobrychus exilis*)	Threatened	2	7/12/2019
Redspotted Sunfish (*Lepomis miniatus*)	Threatened	4	10/24/2011
River Redhorse (*Moxostoma carinatum*)	Threatened	1	6/15/2017
Northern Long-eared (*Myotis Myotis septentrionalis*)	Threatened	1	7/7/1987
Indiana Bat (*Myotis sodalis*)	Endangered	1	8/10/2004
Ironcolor Shiner (*Notropis chalybaeus*)	Threatened	1	7/22/2013
Black-crowned Night-Heron (*Nycticorax nycticorax*)	Endangered	2	6/19/2019
Osprey (*Pandion haliaetus*)	Threatened	5	6/12/2019
Wolf's Bluegrass (*Poa wolfii*)	Endangered	1	5/26/2004
Monkeyface (*Quadrula metanevra*)	Threatened	9	9/29/2010
King Rail (*Rallus elegans*)	Endangered	1	5/26/1988
Royal Catchfly (*Silene regia*)	Endangered	1	7/31/2018
Prairie Spiderwort (*Tradescantia bracteata*)	Endangered	1	5/20/2016
Buffalo Clover (*Trifolium reflexum*)	Threatened	1	6/22/2005



HANSON
Hanson Professional Services Inc.

Duck Creek Power Station

Work Plan Desktop Evaluation
Fulton County
Canton, Illinois

Job Number: 20E0111A

Sheet 1

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX B
BORING LOGS AND WELL CONSTRUCTION LOGS

Electronic Filing: Received, Clerk's Office 06/20/2024

BORING AND WELL LOCATIONS MAP

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/14/2021 | DESIGNER: [illegible] | Y:\Maps\[illegible]\Soil Boring and Well Location Mapmxd.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SOIL BORING AND WELL LOCATION MAP

FIGURE B-1

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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BORING LOGS

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	18/24 75%	SS	2-2 4-5 N=6			1.5	0	Fill - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% yellowish brown (10YR4/6) mottles, moist SILT with little clay, trace roots, and trace sand.		618	
	21/24 88%	SS	2-5 6-7 N=11			2.0	2	Fill - Yellowish brown (10YR5/6) with 30% light brownish gray (10YR6/2) mottles, moist, soft SILT with little clay, trace sand, and trace gravel.		616	
	22/24 92%	SS	2-7 10-12 N=17			2.5	4	Fill - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, firm SILT with little clay and trace sand.		614	
	19/24 79%	SS	3-7 9-11 N=16			4.5	6	Fill - Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		612	
	20/24 83%	SS	3-7 9-10 N=16			4.5	8	Grayish brown (10YR5/2) firm SILT with little clay, trace sand, and trace gravel.		610	
	21/24 88%	SS	3-4 7-10 N=11			4.5	10	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/6) mottles, firm SILT with little clay, trace sand, and trace gravel.		608	
	21/24 88%	SS	3-7 12-15 N=19			4.5	12	Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		606	
ST8	20/24 83%	SH				4.0	14			604	
	18/24 75%	SS	1-4 4-5 N=8			0.5	16	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, soft SILT with little clay.		602	
	19/24 79%	SS	1-3 4-4 N=7			1.0	18			600	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	18/24 75%	SS	1-2 4-5 N=6			1.0	22	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft SILT with little clay.		598	
	20/24 83%	SS	1-3 4-7 N=7			1.0	24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft SILT with little clay.		596	
	19/24 79%	SS	1-3 3-4 N=6			1.5		Grayish brown (10YR5/2) moist, soft, CLAY with little silt.		594	
	22/24 92%	SS	woh-1 3-3 N=4			1.5	26	Gray (10YR5/1) moist, soft, CLAY with little silt.		592	
	21/24 88%	SS	1-2 3-4 N=5			1.0	28	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) soft CLAY with little silt.		590	
	22/24 92%	SS	1-3 5-5 N=8			2.0	30			588	
ST17	24/24 100%	SH				0.5	32			586	
	21/24 88%	SS	2-3 4-3 N=7			1.0	34	Gray (10YR6/1) wet, soft CLAY with little silt and trace sand.		584	
	21/24 88%	SS	1-4 5-8 N=9			1.5	36			582	
	20/24 83%	SS	woh-1 3-4 N=4			1.0	38	Dark gray (10YR4/1) wet, fine SAND with trace silt.		580	
							40	Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	4/24 17%	SS	1-2 5-10 N=7					Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand. *[Continued from previous page]*			
							42			578	
	23/24 96%	SS	2-6 12-11 N=18			3.0					
							44	Dark grayish brown (10YR4/2) moist, firm SILT with little clay, trace sand, and trace gravel.		576	
ST23	23/24 96%	SH				4.5					
							46			574	
	24/24 100%	SS	3-6 8-14 N=14			4.5					
							48			572	
	24/24 100%	SS	3-8 13-20 N=21			4.5					
							50	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.		570	
	24/24 100%	SS	3-10 14-19 N=24			4.5					
							52			568	
	24/24 100%	SS	6-9 15-16 N=24			4.5					
							54			566	
	24/24 100%	SS	4-10 28-50/3" N=38			4.5		Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.			
							56			564	
	24/24 100%	SS	10-47 50/3.25-50/1.25			2.5		Dark gray (10YR4/1) wet, soft SAND with little clay and trace silt.			
							58	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.		562	
	24/24 100%	SS	19-29 44-72 N=73			4.5					
							60			560	

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	14-29 42-54 N=71			4.5	62	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel. *[Continued from previous page]*		558	
	23/24 96%	SS	12-14 30-48 N=44			4.5	64			556	
	23/24 96%	SS	10-22 25-34 N=47			4.5	66			554	
	24/24 100%	SS	10-19 26-34 N=45			4.5	68			552	
	24/24 100%	SS	11-19 24-33 N=43			4.5		Dark gray (10YR4/1) firm SILT with little clay, trace sand, and trace gravel.			
	23/24 96%	SS	11-22 22-34 N=44			4.5	70			550	
	24/24 100%	SS	9-13 20-22 N=33			4.5	72			548	
	24/24 100%	SS	6-8 12-15 N=20			4.5	74			546	
ST39	11/24 46%	SH				4.5	76	Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt.		544	
	14/24 58%	SS	7-10 17-20 N=27			4.5	78	Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel.		542	
							80			540	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	6-8 11-15 N=19			4.5		Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel. *[Continued from previous page]*			
							82			538	
	24/24 100%	SS	3-7 9-10 N=16			4.5		Dark gray (10YR4/1) firm CLAY with trace silt and gravel.			
							84			536	
	24/24 100%	SS	4-8 12-15 N=20			4.5		Dark gray (10YR4/1) with 5% gray (10YR5/1) mottles, firm, CLAY with little silt, trace sand, and trace gravel.			
							86			534	
	24/24 100%	SS	5-7 11-14 N=18			4.0					
							88	Dark gray (10YR4/1) CLAY with little silt, trace sand, and trace gravel.		532	
	24/24 100%	SS	5-8 11-14 N=19			4.5					
							90			530	
	24/24 100%	SS	5-9 13-15 N=22			4.5					
							92	Grayish green (5GY5/2) with 30% dark grayish green (5GY4/2) mottles, firm, CLAY with trace silt and gravel. (WEATHERED SHALE)		528	
	24/24 100%	SS	4-7 10-13 N=17			4.5					
							94			526	
	24/24 100%	SS	3-6 8-11 N=14			4.0					
							96	Very dark grayish green (5GY3/2) firm, CLAY with trace silt. (WEATHERED SHALE)		524	
	24/24 100%	SS	4-8 11-13 N=19			3.0					
							98			522	
	21/24 88%	SS	5-7 10-12 N=17			3.0		Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE)			
							100			520	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 *100%*	ss	*3-7* *9-11* N=16			*2.5*		Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE) *[Continued from previous page]*		518	
							102	**End of boring = 102 feet**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P61
Well ID: P61
Surface Elev: 611.09 ft. MSL
Completion: 20.00 ft. BGS
Station: 1,398,670.81N
2,346,779.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---					Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		610	
							2				
2A	19/24 79%	SS	1-3 3-3 N=6					Yellowish brown (10YR5/6) with 5% gray (10YR5/1) mottles, moist, medium CLAY with some silt and trace sand.		608	
							4				
3A	21/24 88%	SS	2-4 4-5 N=8					Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		606	
							6				
4A	19/24 79%	SS	woh-2 4-4 N=6					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, soft, SILT with few clay and trace sand.		604	
							▼ 8				
5A	10/24 42%	SS	1-2 2-3 N=4					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.		602	
							10	Yellowish brown (10YR5/8), moist, soft, SILT with few clay and trace sand.			
6A	17/24 71%	SS	2-2 3-3 N=5					Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, soft, SILT with few clay and trace sand.		600	
							12				
7A	24/24 100%	SS	woh-1 2-2 N=3					Brown (10YR4/3), wet, soft, SILT with few clay and trace sand.		598	
							14				
8A	24/24 100%	SS	1-2 3-3 N=5					Black (10YR2/1), moist, medium, CLAY with few silt and trace sand.		596	
							16				
9A	24/24 100%	SS	1-3 3-4 N=6					Gray (10YR5/1), moist, medium CLAY with some silt and trace sand.		594	
							18				
10A	24/24 100%	SS	1-1 3-3 N=4							592	
							20	**End of boring = 20 ft.**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P62
Well ID: P62
Surface Elev: 610.81 ft. MSL
Completion: 16.30 ft. BGS
Station: 1,398,887.32N
2,346,602.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---					Yellowish brown (10YR5/6), moist, medium, SILT with some clay and trace sand.		610	
							2	Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.			
2A	23/24 96%	SS	1-7 9-9 N=16					Yellowish brown (10YR5/6), moist, hard, SILT with few clay, trace sand, and trace gravel.		608	
							4				
3A	24/24 100%	SS	2-5 5-6 N=10					Gray (10YR5/1), moist, medium, SILT with few clay, trace sand, and trace gravel.		606	
							6				
4A	24/24 100%	SS	4-4 7-8 N=11					Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.		604	
							8				
5A	24/24 100%	SS	2-5 5-6 N=10					Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		602	
							10				
6A	24/24 100%	SS	3-4 6-10 N=10					Dark yellowish brown (10YR4/6), moist, medium, SILT with few clay and trace sand.		600	
							12				
7A	23/24 96%	SS	2-3 5-6 N=8					Gray (10YR5/1) with 5% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand, and trace gravel		598	
							14				
8A	24/24 100%	SS	1-2 3-4 N=5							596	
	0/4 0%	BD					16				

End of boring = 16.3 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P63
Well ID: P63
Surface Elev: 612.33 ft. MSL
Completion: 18.25 ft. BGS
Station: 1,399,026.62N
2,346,605.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---				0			612	
								Grayish brown (10R5/2), moist, medium, CLAY with some silt, trace sand, and trace gravel.			
							2			610	
2A	24/24 100%	SS	3-7 7-10 N=14								
								Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.			
							4			608	
3A	24/24 100%	SS	2-4 4-4 N=8								
								Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.			
							6			606	
4A	22/24 92%	SS	1-1 4-5 N=5								
								Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, moist, soft, SILT with few clay and trace sand.			
							▼ 8			604	
5A	21/24 88%	SS	2-2 3-4 N=5								
							10	Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, wet, soft, SILT with few clay and trace sand.		602	
6A	23/24 96%	SS	2-3 3-5 N=6								
							12			600	
7A	20/24 83%	SS	2-2 3-4 N=5					Dark yellowish brown (10YR3/4), moist, medium SILT with few clay and trace sand.			
							14			598	
8A	24/24 100%	SS	2-2 3-3 N=5					Gray (10YR5/1) with 35% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.			
							16			596	
9A	24/24 100%	SS	1-2 3-3 N=5					Yellowish brown(10YR5/6), moist, soft, CLAY with some silt, trace sand, and trace gravel.			
	0/4 0%	BD					18				

End of boring = 18.25 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/25/2021
Finish: 2/25/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P64
Well ID: P64
Surface Elev: 614.04 ft. MSL
Completion: 16.47 ft. BGS
Station: 1,399,305.91N
2,346,597.96E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 6.70 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---					Yellowish brown (10YR5/6), medium CLAY with some silt and trace sand.			
							2			612	
2A	23/24 96%	SS	2-4 4-5 N=8					Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace sand.			
							4			610	
3A	23/24 96%	SS	2-2 2-3 N=4					Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, soft, SILT with few clay, trace sand, and trace wood fragments.			
							6			608	
4A	20/24 83%	SS	1-2 4-4 N=6				▼				
							8			606	
5A	15/24 63%	SS	1-2 2-3 N=4					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.			
							10			604	
6A	19/24 79%	SS	1-2 2-3 N=4								
							12			602	
7A	24/24 100%	SS	1-1 2-3 N=3					Yellowish brown (10YR5/6), moist, soft, SILT with some clay and trace sand.			
							14			600	
8A	24/24 100%	SS	1-2 2-3 N=4					Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, soft, CLAY with some silt and trace sand.			
	0/6 0%	BD					16			598	

End of boring = 16.5 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB50
Well ID: n/a
Surface Elev: 620.9 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,399,205.58N
2,345,536.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	20/24 83%	SS	1-4 5-6 N=9			2.5	0	Very dark brown (10YR2/2) with 15% brownish yellow (10YR6/8) mottles, soft, SILT with trace roots, and gravel.		620	
	15/24 63%	SS	1-5 5-6 N=10			3.5	2	Very dark brown (10YR2/2) with 50% yellowish brown (10YR5/8) mottles, soft, CLAY with little silt and trace roots.		618	
	22/24 92%	SS	2-2 3-4 N=5			2.5	4	Yellowish brown (10YR6/8) with 30% light brownish gray (10YR6/2) mottles, firm SILT with little clay.		616	
	17/24 71%	SS	0-2 3-4 N=5			1.0	6	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR6/8) mottles, firm, wet CLAY with little silt and trace black oxidation.		614	
	14/24 58%	SS	1-3 2-4 N=5			1.0	8			612	
ST6	23/24 96%	SH				1.0	10	Grayish brown (10YR5/2) with 30% yellowish brown (10YR6/8) mottles, firm SILT with little clay and trace black oxidation.		610	
	20/24 83%	SS	1-2 3-4 N=5			1.5	12	Light brownish gray (10YR6/2) with 15% brownish yellow (10YR6/1) mottles, firm, wet, SILT with little clay and trace black oxidation.		608	
	24/24 100%	SS	1-2 3-3 N=5			1.0	14	Brown (10YR5/3) firm, moist SILT with little clay and trace black oxidation.		606	
	24/24 100%	SS	1-2 2-3 N=4			1.0	16	Yellowish brown (10YR5/4) firm, moist SILT with little clay and trace black oxidation.		604	
	24/24 100%	SS	1-2 3-4 N=5			2.0	18	Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/8) mottles, firm, moist CLAY.		602	
							20				

NOTE(S): Borehole sealed with high solids bentonite grout.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB50
Well ID: n/a
Surface Elev: 620.9 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,399,205.58N
2,345,536.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	2-2 3-4 N=5			1.8				600	
							22	Dark gray (10YR4/1), wet, CLAY with trace gravel.			
ST12	23/24 96%	SH				1.5				598	
							24				
	24/24 100%	SS	1-1 1-4 N=2			0.5		Gray (10YR6/1) with 30% brownish yellow (10YR6/6) mottles, firm, wet CLAY		596	
								Brownish yellow (10YR6/6) firm, wet CLAY with little silt.			
							26				
	24/24 100%	SS	woh-3 3-5 N=6			1.0		Brownish yellow (10YR6/6) firm, wet CLAY with trace gravel.		594	
							28				
	23/24 96%	SS	1-5 6-6 N=11			3.5		Brownish yellow (10YR6/8) with 15% gray (10YR6/1) mottles, firm CLAY with trace gravel.		592	
							30				
	23/24 96%	SS	1-3 7-8 N=10			4.5		Grayish brown (10YR5/2) firm CLAY.		590	
								Dark gray (10YR4/1) wet, firm CLAY with trace gravel.			
							32				
	18/24 75%	SS	1-2 2-4 N=4			1.5		Dark gray (10YR4/1) wet, firm CLAY with little silt and trace gravel.		588	
							34				
	22/24 92%	SS	3-5 10-16 N=15			4.0		Gray (10YR5/1) firm CLAY with trace gravel.		586	
							36				
	21/24 88%	SS	4-8 12-17 N=20			4.5		Gray (10YR5/1) firm CLAY with trace sand and trace gravel.		584	
							38				
	20/24 83%	SS	4-17 29-50 N=46			4.5		Dark grayish brown (10YR4/2) hard SILT with little clay, trace sand, and trace gravel.		582	
							40				

NOTE(S): Borehole sealed with high solids bentonite grout.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB50
Well ID: n/a
Surface Elev: 620.9 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,399,205.58N
2,345,536.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	7-35 40-42 N=75			4.5		Grayish brown (10YR5/2) with 5% brownish yellow (10YR6/6) mottles, hard SILT with little clay, trace sand, and trace gravel.		580	
	24/24 100%	SS	9-24 32-40 N=56			4.5	42	Gray (10YR5/1) hard SILT with little clay, trace sand, and trace gravel.		578	
	24/24 100%	SS	12-35 41-43 N=76			4.5	44	Dark gray (10YR4/1) hard SILT with little clay, trace sand, and trace gravel.		576	
	24/23 104%	SS	7-22 50-50 N=72			4.5	46	Grayish brown (10YR5/2) hard SILT with little clay, trace sand, and trace gravel.		574	
	24/24 100%	SS	6-21 26-36 N=47			4.5	48			572	
							50	**End of boring = 50 feet**			

NOTE(S): Borehole sealed with high solids bentonite grout.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/3/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB62
Well ID: n/a
Surface Elev: 619.8 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,398,819.94N
2,346,534.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	16/24 67%	SS	2-3 5-4 N=8			2.0	0	Fill - Yellowish brown (10YR5/6) with 5% Gray (10YR6/1) and 15% dark yellowish brown (10YR4/6) mottles, soft SILT with little clay, and trace roots.		620	
	19/24 79%	SS	1-6 9-10 N=15			2.5	2			618	
	23/24 96%	SS	4-9 10-9 N=19			4.5	4	Fill - Dark yellowish brown (10YR4/6) with 5% light brownish gray (10YR6/2) mottles, soft SILT with little clay, trace sand, and trace gravel.		616	
	23/24 96%	SS	3-6 7-9 N=13			3.5	6	Fill - Yellowish brown (10YR5/4) with 10% light brownish gray (10YR6/2) mottles, firm SILT with little clay, trace sand, and trace gravel.		614	
	23/24 96%	SS	2-5 7-8 N=12			2.5	8			612	
	23/24 96%	SS	2-5 7-8 N=12			3.0	10	Grayish brown (10YR5/2) firm SILT with little clay, trace sand, and trace gravel.		610	
ST7	15/24 63%	SH				2.5	12			608	
	21/24 88%	SS	1-4 8-12 N=12			3.0	14	Grayish brown (10YR5/2) with 30% dark yellowish brown(10YR4/6) mottles, hard SILT with little clay and trace gravel.		606	
	22/24 92%	SS	6-11 7-7 N=18			1.0	16			604	
	19/24 79%	SS	1-3 4-3 N=7			1.0	18	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, slightly moist, soft SILT with little clay.		602	
							20			600	

NOTE(S): Borehole sealed with high solids bentonite grout

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/3/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB62
Well ID: n/a
Surface Elev: 619.8 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,398,819.94N
2,346,534.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	1-3 4-4 N=7			1.5	22	Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, slightly moist, soft SILT with little clay.		598	
	21/24 88%	SS	1-2 2-4 N=4			1.0	24	Dark grayish brown (10YR4/2) CLAY with little silt and trace gravel.		596	
	24/24 100%	SS	1-2 2-3 N=4			1.0	26	Dark gray (10YR4/1) with 3% reddish yellow (10YR6/8) mottles, soft CLAY with little silt and trace gravel		594	
ST14	23/24 96%	SH				1.5	28			592	
	24/24 100%	SS	1-3 2-3 N=5			1.0	30	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft CLAY with little silt, trace sand, and trace gravel.		590	
	24/24 100%	SS	woh-1 1-2 N=2			1.0	32	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, wet, soft CLAY with little silt, trace sand, and trace gravel.		588	
	21/24 88%	SS	2-2 4-6 N=6			2.0	34	Grayish green (5GY5/2) with 5% olive gray (5Y4/2) soft CLAY with little silt, trace sand, and trace gravel.		586	
	24/24 100%	SS	3-5 7-9 N=12			4.5	36			584	
	24/24 100%	SS	3-6 7-10 N=13			4.5	38	Dark gray (10YR4/1) hard SILT with little clay, trace sand, and trace gravel.		582	
ST20	16/24 67%	SH				4.5	40			580	

NOTE(S): Borehole sealed with high solids bentonite grout

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/3/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB62
Well ID: n/a
Surface Elev: 619.8 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,398,819.94N
2,346,534.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	23/24 96%	SS	3-12 21-19 N=33			4.0		Gray (10YR5/1) hard SILT with little clay, trace sand, and trace gravel.			
							42	Gray (10YR5/1) wet, fine SAND with trace silt.		578	
	23/24 96%	SS	6-11 12-18 N=23			4.5		Gray (10YR5/1) moist, hard SILT with little clay, trace sand, and trace gravel.			
							44			576	
	24/24 100%	SS	4-18 19-23 N=37			4.5		Gray (10YR5/1) with 15% grayish olive (10Y5/2) mottles, moist, hard SILT with little clay, trace sand, and trace gravel.			
							46			574	
	24/24 100%	SS	8-24 39-48 N=63			4.5		Gray (10YR5/1) with 40% grayish olive (10Y5/2) mottles, hard SILT with little clay, trace sand, and trace gravel.			
							48			572	
	20/24 83%	SS	5-25 50-50/5" N=75			4.5		Dark grayish brown (10YR4/2) hard SILT with little clay, trace sand, and trace gravel.			
							50			570	

End of boring = 50 feet

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark brown (10YR2/2) clayey SILT, trace sand			
1A	24/24 100%	SS	2-3 3-4 N=6	24		2.52 B		Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, silty CLAY, trace sand			
										606	
1B				27				Yellowish brown (10YR5/8) with 40% dark yellowish brown (10YR4/6) mottles, very silty CLAY, trace sand			
							2				
	20/24 83%	SS	3-3 5-6 N=8					Gray (10YR6/1) with 40% yellowish brown (10YR5/8) mottles, clayey SILT, trace sand			
										604	
2A				22		1.75 BSh	4	Light brownish gray (10YR6/2) with 15% yellowish brown (10YR5/8) mottles, clayey SILT, trace sand			
	20/24 83%	SS	3-7 6-6 N=13								
										602	
3A				23		1.96 Sh	6				
	22/24 92%	SS	6-6 6-5 N=12					Dark yellowish brown (10YR4/6) with 5% very dark brown (10YR2/2) mottles, clayey SILT, trace sand			
										600	
4A				29		1.24 B	8				
	18/24 75%	SH						Dark grayish brown (10YR4/2) with 45% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand			
										598	
							10				
	20/24 83%	SS	1-2 3-3 N=5					Grayish brown (10YR5/2) with 50% yellowish brown (10YR5/8)mottles, clayey SILT, trace sand			
										596	
6A				23		2.27 B	12				
	24/24 100%	SS	5-5 6-7 N=11					Yellowish brown (10YR5/8) with 10% grayish brown (10YR5/2) mottles, clayey SILT, trace sand			
7A				25		1.75 B				594	
7B				25		1.35 B	14	Grayish brown (10YR5/2) with 50% yellowish brown (10YR5/8) silty CLAY, trace sand			
	24/24 100%	SS	1-3 4-5 N=7								
										592	
8A				23		1.31 B	▼ 16	Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/8) mottles, silty CLAY, trace sand and gravel			
9A	24/24 100%	SS	4-6 6-7 N=12	20		2.27 BSh					
										590	
9B				19		1.24 BSh	▼ 18	Dark greenish gray (10GY4/1) with 10% grayish green (5G4/1) mottles, silty CLAY, trace sand and gravel			
10A	24/24 100%	SS	1-3 4-5 N=7	16		1.75 BSh				588	
10B				13			20	Greenish gray (10Y5/1), clayey SILT, little sand and gravel			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11-1								Greenish gray (10Y5/1), clayey SILT, little sand and gravel			
11-2	19/24 *79%*	SH		17				*[Continued from previous page]*			
11-3								Dark greenish gray (10Y4/1), clayey SILT, little sand and gravel		586	
							22				
	24/24 *100%*	SS	*4-5* *8-9* N=13					Dark gray (N4/1), silty CLAY, trace sand and gravel		584	
12A				13		5.77 *B*	24				
	24/24 *100%*	SS	*4-10* *8-8* N=18					Dark gray (N4/1), clayey SILT, little sand and gravel		582	
13A				12		6.30 *Sh*	26				
	24/24 *100%*	SS	*5-6* *9-9* N=15					Dark gray (N4/1), clayey SILT, trace sand and gravel		580	
14A				25		3.30 *SP*	28				
	24/24 *100%*	SS	*5-7* *13-16* N=20							578	
15A				11		11.56 *Sh*	30				
								Dark gray (N4/1), silty CLAY, trace sand, gravel and cobbles		576	
	48/60 *80%*	CS					32				
										574	
							34				
16A				13						572	
							36				
	3/60 *5%*	CS						Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel		570	
							38				
										568	
17A				11			40				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	0/24 *0%*	ss	*27-38* *37-54* N=75							
18A				13		13.52 *Sh*	42		566	
	0/24 *0%*	ss	*18-28* *47-56* N=75						564	
19A				14		16.00 *None*	44			
20A									562	
	24/24 *100%*	ss	*30-39* *48-59* N=87							
							46		560	
	24/24 *100%*	ss	*25-19* *33-40* N=52							
21A				17		8.24 *BSh*	48		558	
	24/24 *100%*	ss	*4-8* *16-22* N=24							
22A				12		11.56 *Sh*	50	Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel *[Continued from previous page]*	556	
	24/24 *100%*	ss	*10-12* *14-19* N=26							
23A				15		9.16 *Sh*	52		554	
	24/24 *100%*	ss								
24A				15		10.72 *B*	54		552	
	24/24 *100%*	ss								
25A				12		14.02 *Sh*	56		550	
	24/24 *100%*	ss								
26A				9			58		548	
	24/24 *100%*	ss								
27A				17			60			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
28A	24/24 100%	ss	6-6 11-14 N=17				62	Dark greenish gray (10Y3/1) with 35% dark greenish gray (5G3/1) mottles, silty CLAY, trace sand and gravel		546	
29A	24/24 100%	ss					64			544	
30A	24/24 100%	ss					66	Dark green gray (10GY4/1) with 15% dark yellowish brown (10YR3/4) mottles, silty CLAY, trace sand and gravel		542	
31A	24/24 100%	ss					68			540	
32A	24/24 100%	ss					70	Dark green gray (10GY4/1) with 50% dark yellowish brown (10YR3/4) mottles, silty CLAY, trace sand and gravel		538	
33A	24/24 100%	ss					72			536	
34A	24/24 100%	ss					74	Dark yellowish brown (10YR3/4) with 20% dark greenish gray (10GY4/1) mottles, silty CLAY, trace sand and gravel		534	
35A	24/24 100%	ss					76			532	
36A	24/24 100%	ss					78	Very dark gray (N3/1), silty CLAY, trace sand and gravel		530	
37A	24/24 100%	ss					80	Dark yellowish brown (10YR3/4) with 30% dark greenish gray (10GY4/1) mottles, silty CLAY, trace sand and gravel		528	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
38A	24/24 *100%*	SS					82	Dark yellowish brown (10YR3/4) with 30% dark greenish gray (10GY4/1) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*		526	
39A	24/24 *100%*	SS					84	Dark greenish gray (10Y4/1) with 15% dark yellowish brown (10YR3/4) mottles, silty CLAY, trace sand and gravel		524	
40A	24/24 *100%*	SS					86	Dark greenish gray (10Y4/1), silty CLAY, trace sand and gravel		522	
41A	24/24 *100%*	SS					88	Very dark gray (N3/1), silty CLAY, trace sand and gravel		520	
42A	24/24 *100%*	SS					90	**End of Boring = 90.0 ft. BGS**		518	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark brown (10YR2/2), clayey SILT, trace sand			
1A	22/24 92%	SS	2-2 4-4 N=6	20		3.49 BSh		Dark grayish brown (10YR4/2), silty CLAY, trace sand		612	
1B				25		3.71 Sh	2	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/8) mottles, silty CLAY, trace sand			
2A	24/24 100%	SS	2-4 5-5 N=9	25		3.27 BSh				610	
2B				27		1.85 B	4	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/8) and trace very dark gray (10YR3/1) mottles, silty CLAY, trace sand			
3A	20/24 83%	SS	3-7 6-6 N=13	24		2.47 B		Brownish yellow (10YR6/8) with 20% light gray (10YR7/1) mottles, very silty CLAY, trace sand		608	
4A	24/24 100%	SS	2-4 4-3 N=8	25		2.06 B	6				
	24/24 100%	SH					8	Yellowish brown (10YR5/8) with trace light gray (10YR7/1) mottles, clayey SILT, trace sand		606	
							▼ 10			604	
6A	19/24 79%	SS	2-2 3-4 N=5	25							
6B				25			12	Light gray (10YR7/1) with 50% yellowish brown (10YR5/8)mottles, clayey SILT, trace sand		602	
7A	19/24 79%	SS	4-4 4-4 N=8	26		2.18 BSh		Dark grayish brown (10YR4/2), clayey SILT, trace sand		600	
7B				25		2.52 BSh	14	Dark yellowish brown (10YR4/6) with 50% brown (10YR4/3) mottles, clayey SILT, trace sand			
8A	24/24 100%	SS	1-2 3-3 N=5	25		2.27 B				598	
8B				26		2.13 B	16	Grayish brown (10YR5/2) with 5% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand			
9A	24/24 100%	SS	3-4 5-6 N=9	25		2.13 B				596	
10A	22/24 92%	SS	1-3 3-5 N=6	25			18	Dark grayish brown (10YR4/2) with 50% dark yellowish brown (10YR4/6) mottles, silty CLAY, trace sand and gravel		594	
							20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SH						Dark grayish brown (10YR4/2) with 50% dark yellowish brown (10YR4/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*			
							22	Dark greenish gray (5GY4/1), silty CLAY, trace sand and gravel		592	
12A	24/24 100%	SS	3-4 5-6 N=9	21		0.39 B					
12B				16		1.75 BSh	24	Greenish gray (10Y5/1), sandy SILT, trace clay		590	
	22/24 92%	SS	3-3 3-4 N=6					Greenish gray (5GY6/1), sandy CLAY, trace silt			
13A				17		2.13 B		Dark greenish gray (10Y4/1), sandy CLAY, trace gravel		588	
13B				13		7.20 BSh	26				
	24/24 100%	SS	1-2 3-4 N=5							586	
14A				17		3.50 B	28	Very dark greenish gray (10Y3/1), sandy CLAY, trace gravel			
	24/24 100%	SS	4-6 6-8 N=12							584	
15A				14		5.24 B	30				
	24/24 100%	SS	2-3 3-3 N=6							582	
16A				30		1.16 B	32	Dark gray (10YR4/1), sandy SILT, trace gravel			
17-1	8/24 33%	SH								580	
17-2				440							
	24/24 100%	SS	3-4 7-9 N=11				34	Dark green gray (10Y4/1), sandy SILT, trace clay			
18A				13		5.04 B	36			578	
	20/24 83%	SS	2-3 7-9 N=10								
19A				14		5.24 B	38	Dark green gray (10Y4/1), sandy CLAY, trace gravel		576	
	15/24 63%	SS	3-3 5-6 N=8								
20A				13		7.86	40			574	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh		Dark green gray (10Y4/1), sandy CLAY, trace gravel			
										572	
	47/60 *78%*	CS					42	Dark green gray (10Y4/1), sandy CLAY, trace gravel *[Continued from previous page]*			
										570	
21A				18			44				
21B				14				Dark green gray (10Y4/1), silty, fine to medium SAND			
21C				12						568	
							46				
22A	53/60 *88%*	CS		12		4.83 *B*		Dark greenish gray (10Y4/1), sandy CLAY, trace gravel		566	
							48				
										564	
22B				9		4.48 *B*	50				
								Gray (10Y4/1), fine to medium SAND, trace silt			
23A				16						562	
	44/48 *92%*	CS					52	Dark green gray (10Y4/1), sandy CLAY, trace silt and gravel			
23B				11		6.40 *Sh*				560	
23C							54				
	24/24 *100%*	SS								558	
24A				11		13.52 *Sh*	56				
	24/24 *100%*	SS						Dark gray (10YR4/1), silty CLAY, little sand, trace gravel		556	
25A				10		11.78 *None*	58				
	24/24 *100%*	SS								554	
26A				11		8.73	60				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						BSh					
	16/24 *67%*	ss						Dark gray (10YR4/1), silty, fine to medium SAND		552	
27A				20			62				
	19/24 *79%*	ss								550	
28A				14		9.16 *BSh*	64				
	22/24 *92%*	ss								548	
29A				17		8.07 *BSh*	66				
	24/24 *100%*	ss								546	
30A				15		11.33 *B*	68				
	24/24 *100%*	ss								544	
31A				15		6.59 *B*	70				
	24/24 *100%*	ss						Dark gray (10YR4/1) with 15% dark greenish gray (5GY4/1) mottles, silty CLAY, trace sand and gravel		542	
32A				17		4.85 *B*	72				
	24/24 *100%*	ss								540	
33A				19		5.43 *B*	74				
	24/24 *100%*	ss								538	
34A				15		5.43 *B*	76				
	24/24 *100%*	ss								536	
35A				15		7.76 *B*	78				
	24/24 *100%*	ss								534	
36A				15		6.59	80				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						B					
	24/24 *100%*	SS									
37A				16		8.53 *BSh*	82	Dark gray (10YR4/1), silty CLAY, trace sand and gravel		532	
	24/24 *100%*	SS									
38A				19		6.59 *BSh*	84			530	
	24/24 *100%*	SS									
39A				17		5.04 *BSh*	86	Dark gray (10YR4/1) with trace yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel		528	
	24/24 *100%*	SS									
40A				17		4.12 *BSh*	88			526	
	24/24 *100%*	SS									
41A				15		8.92 *B*	90			524	

End of Boring = 83.3 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	1-3 2-3 N=5	24			0	Very dark grayish brown (10YR3/2) with 15% very dark gray (10YR3/1)mottles, silty CLAY, trace sand			
1B				30		2.33 B	2	Brown (10YR4/3) with 40% very dark grayish brown (10YR3/2) mottles, silty CLAY, trace sand		616	
2A	24/24 100%	ss	2-3 2-6 N=5	32		2.13 B	4	Yellowish brown (10YR5/8) with 30% gray (10YR6/1) and 15% dark gray brown (10YR4/2) mottles, silty CLAY, trace sand		614	
2B				28		1.94 B	6	Brownish yellow (10YR6/8) with 40% light brownish gray (10YR6/2) mottles, clayey SILT, trace sand		612	
3A	24/24 100%	ss	2-2 2-3 N=4	30		0.58 B	8			610	
4A	18/24 75%	ss	3-4 4-5 N=8	24		1.55 B	10	Dark yellowsih brown (10YR4/6) with 30% gray (10YR6/1) mottles, clayey SILT, trace sand		608	
5A	20/24 83%	ss	1-2 3-3 N=5	25			12	Gray (10YR6/1) with 10% yellowish brown (10YR5/8) mottles, clayey SILT, trace sand		606	
6A	20/24 83%	ss	0-2 3-3 N=5	31		1.75 B	14	Grayish brown (10YR5/2) with 15% yellowish brown (10YR5/8) mottles, very silty CLAY, trace sand		604	
7A	21/24 88%	ss	3-4 4-4 N=8	28		4.07 BSh		Black (10YR2/1) with 40% dark yellowish brown (10YR4/4) mottles, clayey SILT, trace sand			
7B				39		1.36 B	16	Dark grayish brown (10YR4/2) with trace yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand		602	
8A	24/24 100%	ss	1-2 3-5 N=5	25		1.16 B					
8B				25		1.75 B	18	Dark grayish brown (10YR4/2), silty CLAY, trace sand		600	
9A	24/24 100%	ss	2-4 3-3 N=7	28		1.16 B		Dark gray (10YR4/1) with 35% dark yellowish brown (10YR3/6) mottles, silty CLAY, trace sand			
10A	24/24 100%	ss	2-3 3-4 N=6	29		2.18 B	20	Dark gray (10YR4/1), silty CLAY, trace sand		598	
10B				27		1.36					

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						B					
	24/24 100%	ss	0-0 5-2 N=5					Greenish gray (5G5/1) with 50% greenish gray (10Y5/1) mottles, sandy CLAY, trace gravel		596	
11A				22		0.58 B	22				
	24/24 100%	ss	0-0 1-2 N=1					Greenish gray (5GY5/1), sandy CLAY, little silt, trace gravel		594	
12A				18			24				
13A	24/24 100%	ss	2-2 4-5 N=6	21				Green gray (10Y6/1), sandy SILT			
								Green gray (5G6/1), sandy CLAY, trace gravel		592	
13B				17		3.10 B	26				
	24/24 100%	ss	3-3 4-4 N=7					Dark gray (N4/1), very silty CLAY, trace sand and gravel		590	
14A				15		1.55 B	28				
15A	20/24 83%	ss	2-3 3-5 N=6	18		2.83 B		Greenish gray (10Y5/1), sandy CLAY, trace gravel		588	
15B				17		3.49 BSh	30				
	24/24 100%	ss						Dark greenish gray (10Y4/1), very silty CLAY, trace sand and gravel		586	
16A				17		5.36 BSh	32				
	24/24 100%	ss								584	
17A				17		4.65 B	34				
	22/24 92%	ss						Dark greenish gray (10Y4/1), sandy SILT		582	
18A				21		3.49 B	36				
	21/24 88%	ss						Dark greenish gray (10Y4/1) with 20% pale red (10R6/3) mottles, sandy SILT, trace gravel		580	
19A				12			38				
	6/24 25%	ss						Gray (10Y4/1), fine to coarse SAND, trace gravel and silt		578	
20A				14			40				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	3/24 *13%*	ss						Gray (10Y4/1), fine to coarse SAND, trace gravel and silt *[Continued from previous page]*			
21A				11			42			576	
	24/24 *100%*	ss									
22A				16		6.21 *BSh*	44			574	
	24/24 *100%*	ss									
23A				14		8.34 *B*	46			572	
	24/24 *100%*	ss									
24A				19		7.56 *BSh*	48			570	
	24/24 *100%*	ss									
25A				14			50	Dark gray (N4/1), silty CLAY, trace sand and gravel		568	
	24/24 *100%*	ss									
26A				17		5.36 *BSh*	52			566	
	22/24 *92%*	ss									
27A				14		3.93 *Sh*	54			564	
	23/24 *96%*	ss									
28A				16		4.27 *BSh*	56			562	
	16/24 *67%*	ss									
29A				19			58			560	
	4/24 *17%*	ss						Gray (10Y4/1), silty fine to medium SAND			
30A				17			60			558	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
31A	8/8 100%	ss	31-50/2"	12			62	Green gray (10Y5/1) with trace yellowish brown (10YR5/6) mottles, sandy SILT, trace clay and gravel		556	
32A	12/12 100%	ss	33-50/6"	9		7.37 B	64	Green gray (10Y5/1), sandy SILT, trace gravel and clay		554	
33A	7/7 100%	ss	39-50/1"	12			66			552	
34A	20/24 83%	ss		18			68			550	
35A	18/24 75%	ss		19			70	Greenish gray (10Y5/1), silty, fine SAND		548	
36A	15/24 63%	ss		21			72			546	
37A	15/24 63%	ss		21			74			544	
38A	16/24 67%	ss		19			76	Greenish gray (10Y5/1), silty, fine to medium SAND		542	
39A	10/24 42%	ss		14			78	Greenish gray (10GY5/1), sandy CLAY, trace gravel		540	
40A	18/24 75%	ss		11			80	Dark gray (10YR4/1), sandy CLAY, trace gravel		538	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	14/24 *58%*	ss								536	
41A				9			82	Dark gray (10YR4/1), sandy CLAY, trace gravel *[Continued from previous page]*			
	10/24 *42%*	ss								534	
42A						6.55 *BSh*	84				
	8/8 *100%*	ss						Gray (N6/1), SHALE			
43A						6.33 *BSh*		**End of Boring = 84.7 ft. BGS**			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: **Start:** 4/1/407
Finish: 4/4/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler

FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-55
Well ID: hole abandoned
Surface Elev: 611.07 ft. MSL
Completion: 20.00 ft. BGS
Station: 15,438.7N
987.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark brown, clayey TOPSOIL (OL)		610	
1A	15/18 *83%*	ss	*2-3* *3* N=6	29		1.75 *B*	2	Brown-gray, silty CLAY, trace sand (CL)		608	
2A	16/18 *89%*	ss	*3-4* *5* N=9	22		0.78 *BSh*	4			606	
3A	16/18 *89%*	ss	*3-4* *4* N=8	26			6	Brown-gray, clayey SILT, trace sand (ML)		604	
4A	15/18 *83%*	ss	*3-4* *5* N=9	26		1.94 *BSh*	8			602	
							10	Gray-brown, clayey SILT, trace sand (ML)		600	
							12			598	
5A	18/18 *100%*	ss	*2-3* *4* N=7	33		1.32 *B*	14	Black, PEAT (PT)		596	
							16			594	
							18	Gray, silty CLAY, trace sand and gravel (CL)		592	
6A	18/18 *100%*	ss	*3-4* *5* N=9	20		1.16 *BSh*	20	**End of Boring = 20.0 ft. BGS**			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 4/5/2007
Finish: 4/5/2007
WEATHER: Ptly sunny, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-65
Well ID: hole abandoned
Surface Elev: 601.57 ft. MSL
Completion: 20.00 ft. BGS
Station: 14,972.6N
301.1E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 5.50 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark brown, clayey TOPSOIL (OL)			
1A	16/18 *89%*	ss	*0-0* *2* N=2	30		1.16 *B*	2	Dark brown-brown, very silty CLAY, trace sand (CL)		600	
2A	12/18 *67%*	ss	*3-3* *3* N=6	37			4	Dark brown, clayey SILT, trace sand, (ML)		598	
							5.5 ▼			596	
3A	18/18 *100%*	ss	*2-3* *4* N=7	27		1.55 *B*	6	Gray-brown, silty CLAY, trace sand (CL)		594	
4A	14/18 *78%*	ss	*3-4* *4* N=8	26		2.06 *B*	8	Brown-gray, silty CLAY, trace sand (CL)		592	
							10			590	
							12			588	
5A	16/18 *89%*	ss	*3-3* *7* N=10	19			14	Gray-brown, silty, fine SAND, little medium to coarse sand, trace gravel (SM)		586	
							16			584	
6A	15/18 *83%*	ss	*4-6* *10* N=16	15		9.16 *Sh*	18	Gray, very silty CLAY, trace sand and gravel (CL)		582	
							20	**End of Boring = 20.0 ft. BGS**			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 4/5/2007
Finish: 4/5/2007
WEATHER: Ptly sunny, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-66
Well ID: hole abandoned
Surface Elev: 610.34 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,397.6N
173.1E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 5.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tst) / Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
								Dark brown, clayey TOPSOIL (OL)	610	
1A	14/18 *78%*	ss	*2-3* *4* N=7	27		2.89 *BSh*	2	Brown-gray, silty CLAY, trace sand (CL)	608	
2A	18/18 *100%*	ss	*2-2* *3* N=5	29		1.16 *B*	4 ▼	Brown-gray-black, very silty CLAY, trace sand (CL)	606	
3A	13/18 *72%*	ss	*2-4* *5* N=9	28		2.47 *Sh*	6	Brown-gray, clayey SILT, trace sand (ML)	604	
4A	16/18 *89%*	ss	*2-2* *3* N=5	28		2.68 *Sh*	8		602	
							10	Gray-brown, clayey SILT, trace sand (ML)	600	
							12		598	
5A	15/18 *83%*	ss	*1-2* *3* N=5	27		1.75 *B*	14	Brown, very silty CLAY, trace sand (CL)	596	
							16 ▼		594	
							18	Brown-gray, silty CLAY, trace sand and gravel (CL)	592	
6A	15/18 *83%*	ss	*2-3* *4* N=7	21		1.55	20			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 4/5/2007
Finish: 4/5/2007
WEATHER: Ptly sunny, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-66
Well ID: hole abandoned
Surface Elev: 610.34 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,397.6N
173.1E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 5.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						B		Brown-gray, silty CLAY, trace sand and gravel (CL) *[Continued from previous page]*		590	
							22				
										588	
							24	Gray-brown, very silty CLAY, little sand, trace gravel (CL)			
7A	18/18 *100%*	ss	*3-5* *6* N=11	15		2.13 *B*				586	
							26				
										584	
							28	Gray, very silty CLAY, trace sand and gravel (CL)			
										582	
8A	18/18 *100%*	ss	*3-4* *5* N=9	18		4.65 *B*	30				

End of Boring = 30.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

G02L (MW-4L)

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-10/MW-4
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	619.4
Foreman	Randy Howard	Drilling Method	HSA
Engineer/Geologist	OMI	Sampling Method	SS/Core
Weather & Temp.	Upper 60's, Cloudy	Hammer Type	Auto
Date: Start	9/22/2003 0900	Water Depth: DD	25
Finish	9/23/2003 1605	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	2.0	Top soil, brn. silt w/clay, moist.	SS-1	1.5	3.5	2-3-5-6 Rec = 18" Qp = 2.0
2.0	4.0	Brn. and gray clayey silt and silty clay, so sand.	SS-2	4.0	6.0	1-2-2-2 Rec = 24" Qp = 0.25
4.0	7.8	Reddish brn and gray silty clay, soft.	SS-3	6.5	8.5	0-2-2-2 Rec = 19.5" Qp = -
7.8	9.8	Reddish brn. and gray clayey silt, v. soft.	SS-4	9.0	11.0	1-2-3-4 Rec = 22" Qp = 3.0
9.8	12.1	Gray (sl. red) silt, tr. clay, stiff, moist.	SS-5	11.5	13.5	1-1-2-4 Rec = 24" Qp = -
12.1	15.0	Dk. brn. silty sand w/ small wood pieces, moist.	SS-6	14.0	16.0	3-3-6-5 Rec = 24" Qp = 3.0
15.0	16.5	Dk. brn. sandy silty clay (till) to sandy clayey silt, moist.	SS-7	16.5	18.5	1-1-2-2 Rec = 24" Qp = -
16.5	19.8	Dk. brn. clay, w/ so. sand and silt, soft.	SS-8	19.0	21.0	1-2-2-2 Rec = 24" Qp = 0.25
19.8	24.6	Gray sandy clay, so. silt, v. soft and moist. More sand at 21.5' (gets coarser w/ depth).	SS-9	21.5	23.5	1-2-3-5 Rec = Qp = 0.75
24.6	25.0	Gray v. coarse sand w/ clay, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 23" Qp = -
25.0	26.9	Gray sandy clayey silt (till), wet.	SS-11	26.5	28.5	1-2-2-4 Rec = 24" Qp = 3.0 (in cohesive)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.9	28.2	Gray v. coarse sand w/gravel, wet.	SS-12	29.0	31.0	1-2-4-7 Rec = 24" Qp = 3.0
28.2	31.5	Gray sandy clayey silt (till), wet.	SS-13	31.5	33.5	3-6-8-10 Rec = 24" Qp = 4.5
31.5	36.2	Gray sandy silt, tr. gravel, v. stiff.	SS-14	34.0	36.0	2-4-6-8 Rec = 24" Qp = 4.5+
36.2	36.8	Red and gray clayey silty sand.	SS-15	36.5	38.5	4-7-9-13 Rec = 24" Qp = 0.5 to 4.5+
36.8	46.5	Gray sandy silt, tr. gravel, v stiff, more sand and gravel from 41.5' to 44.1'.	SS-16	39.0	41.0	3-6-10-13 Rec = 24" Qp = 3.5
46.5	52.0	Gray silt w/gravel, sl. dry w/rough surface structure, breaks down w/small pressure.	SS-17	41.5	43.5	3-4-9-11 Rec = 24" Qp = 4.0
52.0	54.8	Brn. and gray sandy clayey silt, tr. gravel, reddish brown at bottom, sl. moist.	SS-18	44.0	46.0	6-9-15-20 Rec = 24" Qp = 4.5+
54.8	56.5	Gray v. coarse sand w/gravel, v. dense, wet.	SS-19	46.5	48.5	11-21-29-40 Rec = 24" Qp = -
56.5	57.0	Gray v.f. sand, medium dense, moist.	SS-20	49.0	50.5	19-47-50/5" Rec = Qp = -
57.0	57.5	V. coarse sand w/gravel, wet.	SS-21	51.5	53.5	22-42-31-43 Rec = Qp = 2.5
57.5	61.5	Gray v.f. sand, so. gravel, v. dense, moist. No gravel from 58.6'.	SS-22	54.0	55.75	20-42-47-50/3" Rec = 24" Qp = -
61.5	64.9	Gray v.f. sandy silt, v. dense, so. gravel from 64.5' to 64.9', wet.	SS-23	56.5	57.8	13-28-50/4" Rec = 24" Qp = -
64.9	68.4	Gray silty clay and clayey silt, v. stiff, moist. So. gravel from 66.5' to 68.4'.	SS-24	59.0	60.3	15-29-50/4" Rec = 15" Qp = -
68.4	68.5	Limestone fragments.	SS-25	61.5	62.8	20-45-50/4" Rec = 15" Qp = -
68.5	77.5	Gray clayey sandy silt w/gravel, v. stiff.	SS-26	64.0	66.0	20-16-20-31 Rec = 24" Qp = 4.5

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
77.5	80.5	Dk. gray silty sand.	SS-27	66.5	68.5	11-15-21-33 Rec = 24" Qp = 4.5+
80.5	81.5	Gray sandy silt, stiff, moist.	SS-28	69.0	71.0	15-20-37-50/5" Rec = 24" Qp = 4.5+
81.5	85.0	Gray silty sand, moist. Coal at 83.4'.	SS-29	71.5	73.5	16-29-33-38 Rec = 24" Qp = 4.5+
85.0	89.0	V. coarse sand w/rock fragments.	SS-30	74.0	76.0	12-23-32-50 Rec = 24" Qp = 4.5+
89.0	91.5	Gray siltstone, hard, moist. Auger refusal. Will core using a tricone to 91.5' and try to get another sample. SPT refusal at 91.5'.	SS-31	76.5	78.5	12-18-27-31 Rec = 24" Qp = -
		Begin Coring at 91.5'.	SS-32	79.0	81.0	12-24-35-50 Rec = 24" Qp = 2.0 (in silt)
			SS-33	81.5	83.5	9-19-28-34 Rec = 24" Qp = -
			SS-34	84.0	86.0	34-32-21-42 Rec = 18" Qp = -
			SS-35	86.5	88.5	11-13-26-20 Rec = 17" Qp = -
			SS-36	89.0	89.3	50/3" Rec = 2" Qp = -
			SS-37	91.5	91.7	50/2" Rec = Qp = -

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 1 OF 2

PROJECT NAME: Ameren Duck Creek

DATE 9/23/2003

Engineer/Geologist: Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
	Start Coring at 91.5 ft.	1	100% / 89%	1		100%	Dk. Gray	490	
92.5	Gray silty shale; thin bedded; v. soft and weathered 91.5 - 91.9 (may be slough); mod. soft; micaceous; so. plant fossils.								
93.5	Gray shaley sandstone, w/so. lt. gray partings below 91.9 ft.								
94.5									
95.5									
96.5									
97.5									
98.5		98.5'							
	Same as above.	2	100% / 99%		1' 26"	100%		500	
99.5	Core barrel plugged as soon as we resumed at 98.5 ft.							600 @ 105.5 ft	
	Temporarily plugged at 103.7 ft.				1' 30"				
100.5	Lost 2.7 ft of core (likely fell out the bottom upon retrieval). Recovered remaining 2.7 ft as part of Run #3. RQD & REC includes recovery in Run #3.			100.8' / 2	1' 51"				
101.5									

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 2 OF 2

PROJECT NAME:	DATE	Engineer/Geologist:
Ameren Duck Creek	9/23/2003	Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
102.5	Same as above.	2		1	1' 42"				
103.5					1' 25"				
104.5					4' 10"				
105.5					47"				
106.5					47"				
107.5					45"				
108.5					50"				
		108.5'							
109.5		3	100% / 100%	2	1' 23"	100%	Dk Gray	500	
110.5					1' 10"				
111.5	End Run #3 @ 111.5 ft. E.O.B. @ 111.5 ft.				1' 14"				

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G02S (P02S, MW-4S)

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-10/MW-4 G02S
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	619.4
Foreman	Randy Howard	Drilling Method	HSA
Engineer/Geologist	OMI	Sampling Method	SS/Core
Weather & Temp.	Upper 60's, Cloudy	Hammer Type	Auto
Date: Start	9/22/2003 0900	Water Depth: DD	25
Finish	9/23/2003 1605	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	2.0	Top soil, brn. silt w/clay, moist.	SS-1	1.5	3.5	2-3-5-6 Rec = 18" Qp = 2.0
2.0	4.0	Brn. and gray clayey silt and silty clay, so sand.	SS-2	4.0	6.0	1-2-2-2 Rec = 24" Qp = 0.25
4.0	7.8	Reddish brn and gray silty clay, soft.	SS-3	6.5	8.5	0-2-2-2 Rec = 19.5" Qp = -
7.8	9.8	Reddish brn. and gray clayey silt, v. soft.	SS-4	9.0	11.0	1-2-3-4 Rec = 22" Qp = 3.0
9.8	12.1	Gray (sl. red) silt, tr. clay, stiff, moist.	SS-5	11.5	13.5	1-1-2-4 Rec = 24" Qp = -
12.1	15.0	Dk. brn. silty sand w/ small wood pieces, moist.	SS-6	14.0	16.0	3-3-6-5 Rec = 24" Qp = 3.0
15.0	16.5	Dk. brn. sandy silty clay (till) to sandy clayey silt, moist.	SS-7	16.5	18.5	1-1-2-2 Rec = 24" Qp = -
16.5	19.8	Dk. brn. clay, w/ so. sand and silt, soft.	SS-8	19.0	21.0	1-2-2-2 Rec = 24" Qp = 0.25
19.8	24.6	Gray sandy clay, so. silt, v. soft and moist. More sand at 21.5' (gets coarser w/ depth).	SS-9	21.5	23.5	1-2-3-5 Rec = Qp = 0.75
24.6	25.0	Gray v. coarse sand w/ clay, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 23" Qp = -
25.0	26.9	Gray sandy clayey silt (till), wet.	SS-11	26.5	28.5	1-2-2-4 Rec = 24" Qp = 3.0 (in cohesive)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.9	28.2	Gray v. coarse sand w/gravel, wet.	SS-12	29.0	31.0	1-2-4-7 Rec = 24" Qp = 3.0
28.2	31.5	Gray sandy clayey silt (till), wet.	SS-13	31.5	33.5	3-6-8-10 Rec = 24" Qp = 4.5
31.5	36.2	Gray sandy silt, tr. gravel, v. stiff.	SS-14	34.0	36.0	2-4-6-8 Rec = 24" Qp = 4.5+
36.2	36.8	Red and gray clayey silty sand.	SS-15	36.5	38.5	4-7-9-13 Rec = 24" Qp = 0.5 to 4.5+
36.8	46.5	Gray sandy silt, tr. gravel, v stiff, more sand and gravel from 41.5' to 44.1'.	SS-16	39.0	41.0	3-6-10-13 Rec = 24" Qp = 3.5
46.5	52.0	Gray silt w/gravel, sl. dry w/rough surface structure, breaks down w/small pressure.	SS-17	41.5	43.5	3-4-9-11 Rec = 24" Qp = 4.0
52.0	54.8	Brn. and gray sandy clayey silt, tr. gravel, reddish brown at bottom, sl. moist.	SS-18	44.0	46.0	6-9-15-20 Rec = 24" Qp = 4.5+
54.8	56.5	Gray v. coarse sand w/gravel, v. dense, wet.	SS-19	46.5	48.5	11-21-29-40 Rec = 24" Qp = -
56.5	57.0	Gray v.f. sand, medium dense, moist.	SS-20	49.0	50.5	19-47-50/5" Rec = Qp = -
57.0	57.5	V. coarse sand w/gravel, wet.	SS-21	51.5	53.5	22-42-31-43 Rec = Qp = 2.5
57.5	61.5	Gray v.f. sand, so. gravel, v. dense, moist. No gravel from 58.6'.	SS-22	54.0	55.75	20-42-47-50/3" Rec = 24" Qp = -
61.5	64.9	Gray v.f. sandy silt, v. dense, so. gravel from 64.5' to 64.9', wet.	SS-23	56.5	57.8	13-28-50/4" Rec = 24" Qp = -
64.9	68.4	Gray silty clay and clayey silt, v. stiff, moist. So. gravel from 66.5' to 68.4'.	SS-24	59.0	60.3	15-29-50/4" Rec = 15" Qp = -
68.4	68.5	Limestone fragments.	SS-25	61.5	62.8	20-45-50/4" Rec = 15" Qp = -
68.5	77.5	Gray clayey sandy silt w/gravel, v. stiff.	SS-26	64.0	66.0	20-16-20-31 Rec = 24" Qp = 4.5

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
77.5	80.5	Dk. gray silty sand.	SS-27	66.5	68.5	11-15-21-33 Rec = 24" Qp = 4.5+
80.5	81.5	Gray sandy silt, stiff, moist.	SS-28	69.0	71.0	15-20-37-50/5" Rec = 24" Qp = 4.5+
81.5	85.0	Gray silty sand, moist. Coal at 83.4'.	SS-29	71.5	73.5	16-29-33-38 Rec = 24" Qp = 4.5+
85.0	89.0	V. coarse sand w/rock fragments.	SS-30	74.0	76.0	12-23-32-50 Rec = 24" Qp = 4.5+
89.0	91.5	Gray siltstone, hard, moist. Auger refusal. Will core using a tricone to 91.5' and try to get another sample. SPT refusal at 91.5'.	SS-31	76.5	78.5	12-18-27-31 Rec = 24" Qp = -
		Begin Coring at 91.5'.	SS-32	79.0	81.0	12-24-35-50 Rec = 24" Qp = 2.0 (in silt)
			SS-33	81.5	83.5	9-19-28-34 Rec = 24" Qp = -
			SS-34	84.0	86.0	34-32-21-42 Rec = 18" Qp = -
			SS-35	86.5	88.5	11-13-26-20 Rec = 17" Qp = -
			SS-36	89.0	89.3	50/3" Rec = 2" Qp = -
			SS-37	91.5	91.7	50/2" Rec = Qp = -

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 1 OF 2

PROJECT NAME: Ameren Duck Creek

DATE 9/23/2003

Engineer/Geologist: Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
	Start Coring at 91.5 ft.	1	100% / 89%	1		100%	Dk. Gray	490	
92.5	Gray silty shale; thin bedded; v. soft and weathered 91.5 - 91.9 (may be slough); mod. soft; micaceous; so. plant fossils.								
93.5	Gray shaley sandstone, w/so. lt. gray partings below 91.9 ft.								
94.5									
95.5									
96.5									
97.5									
98.5		98.5'							
	Same as above.	2	100% / 99%		1' 26"	100%		500	
99.5	Core barrel plugged as soon as we resumed at 98.5 ft.							600 @ 105.5 ft	
	Temporarily plugged at 103.7 ft.				1' 30"				
100.5	Lost 2.7 ft of core (likely fell out the bottom upon retrieval). Recovered remaining 2.7 ft as part of Run #3. RQD & REC includes recovery in Run #3.			100.8' / 2	1' 51"				
101.5									

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 2 OF 2

PROJECT NAME:	DATE	Engineer/Geologist:
Ameren Duck Creek	9/23/2003	Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
102.5	Same as above.	2		1	1' 42"				
103.5					1' 25"				
104.5					4' 10"				
105.5					47"				
106.5					47"				
107.5					45"				
108.5					50"				
		108.5'							
109.5		3	100% / 100%	2	1' 23"	100%	Dk Gray	500	
110.5					1' 10"				
111.5	End Run #3 @ 111.5 ft. E.O.B. @ 111.5 ft.				1' 14"				

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

B-51a (MW51L)

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/13/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4½" hollow stem auger - blind drilled within 10 ft of B-51
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~B-51a~~
Well ID: ~~MW51L~~
Surface Elev: 620.84 ft. MSL
Completion: 16.71 ft. BGS
Station: 16,174.9N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 5.57 - 3/29/2007
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Very dark brown (10YR2/2), clayey SILT, trace sand		620	
							2	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand		618	
							4	Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand		616	
							6 ▼			614	
							8 ▼	Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand		612	
							10			610	
							12	Grayish brown (10YR5/2), clayey SILT, trace sand		608	
							14	Brown (10YR4/3), clayey SILT, trace sand		606	
							16				

End of Boring = 16.7 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	2-3 4-5 N=7				0	Very dark brown (10YR2/2), clayey SILT, trace sand		620	
1A				21		1.28 BSh	2	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand			
	22/24 92%	ss	6-3 5-6 N=8							618	
2A				30		1.78 BSh		Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand			
2B				29		1.67 BSh	4				
	18/24 75%	ss	1-3 3-3 N=6							616	
3A				24			6				
	24/24 100%	ss	5-4 5-6 N=9				▼			614	
4A				22		1.71 B	8 ▼	Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand			
	13/24 54%	ss	1-3 5-4 N=8							612	
5A				26		1.28 BSh	10				
	15/24 63%	ss	0-1 3-3 N=4							610	
6A				27		1.36 BSh	12				
	14/24 58%	ss	4-3 5-6 N=8							608	
7A				24			14	Grayish brown (10YR5/2), clayey SILT, trace sand			
	20/24 83%	ss	0-2 2-3 N=4							606	
8A				26			16	Brown (10YR4/3), clayey SILT, trace sand			
	24/24 100%	ss	4-5 5-5 N=10							604	
9A				25			18	Dark yellowish brown (10YR4/4) with 30% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand			
	23/24 96%	ss	0-2 3-3 N=5							602	
10A				26			20	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel			
	20/24		1-3							600	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	83%	SS	3-4 N=6				22	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*			
11A				27							
	22/24 92%	SS	1-3 4-4 N=7				24	Dark yellowish brown (10YR4/6) with 30% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, silty CLAY, trace sand and gravel		598	
12A				24							
	20/24 83%	SS	2-3 5-2 N=8				26	Greenish gray (5GY5/1) with 50% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand and gravel		596	
13A				28							
	19/24 79%	SS	0-2 2-2 N=4				28	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand and gravel		594	
14A				19							
	20/24 83%	SS	1-3 5-6 N=8				30	Dark gray (N4/1), very silty CLAY, trace sand and gravel		592	
15A				15							
	24/60 40%	CS					32	Dark gray (N4/1), sandy SILT, trace clay		590	
							34			588	
16A				13		4.29 *BSh*				586	
	38/60 63%	CS					36	Dark gray (N4/1), silty CLAY, trace sand and gravel		584	
							38	Brown (10YR4/3), silty, fine to medium SAND, little gravel		582	
17A				13		6.70 *None*	40				
								Brown (10YR4/3), silty, fine SAND		580	
							42				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	19/60 *32%*	CS						Brown (10YR4/3), fine to medium SAND		578	
								Brown (10YR4/3), silty, fine to coarse SAND, little gravel			
							44	Dark yellow brown (10YR4/4), SANDSTONE			
18A				13		6.70 *None*				576	
							46	Very dark gray (N3/1), sandy SILT, trace clay and gravel			
	48/60 *80%*	CS								574	
							48	Dark gray (N4/1), SHALE			
19A				14		6.70 *None*				572	
							50	Very dark gray (N3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								570	
							52				
										568	
							54				
20A				17		6.70 *None*				566	
							56	Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								564	
							58				
										562	
21A				14				Very dark greenish gray (10Y3/1), silty, fine to coarse SAND, little gravel			
22A				15			60				
22B	18/24 *75%*	SS	*8-15* *25-32* N=40	11				Very dark gray (N3/1), sandy CLAY, little gravel		560	
22C				15				Very dark gray (N3/1), silty, fine SAND, trace medium sand			
							62	Very dark gray (N3/1), sandy CLAY, trace gravel			
	24/24		*15-31*					Very dark gray (N3/1), silty, fine to medium SAND, trace gravel		558	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
23A	100%	SS	29-19 N=60	15		5.24 BSh	64	Very dark gray (N3/1), sandy CLAY, trace gravel *[Continued from previous page]*			
								Very dark gray (N3/1), silty, fine to coarse SAND, trace gravel		556	
24A	24/24 100%	SS	7-10 14-23 N=24	15		5.24 BSh	66				
24B				15		3.30 B		Very dark gray (N3/1), silty CLAY, trace sand and gravel		554	
	24/24 100%	SS	8-17 24-22 N=41				68				
25A				16		5.13 B				552	
	24/24 100%	SS	7-9 16-15 N=25					Very dark gray (N3/1), sandy CLAY, trace gravel			
26A				12		2.57 BSP	70				
	12/12 100%	CS						Very dark gray (N3/1), sandy CLAY		550	
27A				11							
	12/12 100%	CS									
28A				12			72				
										548	
	36/36 100%	CS						Very dark gray (N3/1), silty, fine to coarse SAND, little gravel			
							74				
29				12						546	
							76				
										544	
	60/60 100%	CS						Very dark gray (N3/1), silty, fine SAND, trace gravel			
							78				
										542	
30A				19			80				

End of Boring = 80.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

G50S (MW51S)

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 3/13/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-650 Track Drill
Drilling Method: 4½" hollow stem auger - blind drilled within 10 ft of B-51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~B-51b~~
Well ID: ~~MW51S/G50S~~
Surface Elev: 620.84 ft. MSL
Completion: 34.32 ft. BGS
Station: 16,180.78N -5.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 5.86 - 3/29/2007
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0	Very dark brown (10YR2/2), clayey SILT, trace sand	620	
							2	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand		
							4	Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand	618	
							6	Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand	616, 614, 612, 610	
							8			
							10			
							12			
							14	Grayish brown (10YR5/2), clayey SILT, trace sand	608	
							16	Brown (10YR4/3), clayey SILT, trace sand	606	
							18	Dark yellowish brown (10YR4/4) with 30% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand	604	
							20	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel	602, 600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 3/13/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-650 Track Drill
Drilling Method: 4½" hollow stem auger - blind drilled within 10 ft of B-51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51b
Well ID: MW51S/G50S
Surface Elev: 620.84 ft. MSL
Completion: 34.32 ft. BGS
Station: 16,180.78N
-5.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 5.86 - 3/29/2007
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*			
							24	Dark yellowish brown (10YR4/6) with 30% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, silty CLAY, trace sand and gravel		598	
							26	Greenish gray (5GY5/1) with 50% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand and gravel		596	
							28	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand and gravel		594	
							30	Dark gray (N4/1), very silty CLAY, trace sand and gravel		592	
							32	Dark gray (N4/1), sandy SILT, trace clay		590	
							34			588	

End of Boring = 34.3 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	2-3 4-5 N=7				0	Very dark brown (10YR2/2), clayey SILT, trace sand		620	
1A				21		1.28 BSh	2	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand			
	22/24 92%	ss	6-3 5-6 N=8							618	
2A				30		1.78 BSh		Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand			
2B				29		1.67 BSh	4				
	18/24 75%	ss	1-3 3-3 N=6							616	
3A				24			6				
	24/24 100%	ss	5-4 5-6 N=9				▼			614	
4A				22		1.71 B	8 ▼	Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand			
	13/24 54%	ss	1-3 5-4 N=8							612	
5A				26		1.28 BSh	10				
	15/24 63%	ss	0-1 3-3 N=4							610	
6A				27		1.36 BSh	12				
	14/24 58%	ss	4-3 5-6 N=8							608	
7A				24			14	Grayish brown (10YR5/2), clayey SILT, trace sand			
	20/24 83%	ss	0-2 2-3 N=4					Brown (10YR4/3), clayey SILT, trace sand		606	
8A				26			16				
	24/24 100%	ss	4-5 5-5 N=10					Dark yellowish brown (10YR4/4) with 30% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand		604	
9A				25			18				
	23/24 96%	ss	0-2 3-3 N=5							602	
10A				26			20	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel			
	20/24		1-3							600	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N -5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	83%	SS	3-4 N=6				22	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*			
11A				27							
	22/24 92%	SS	1-3 4-4 N=7				24	Dark yellowish brown (10YR4/6) with 30% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, silty CLAY, trace sand and gravel		598	
12A				24							
	20/24 83%	SS	2-3 5-2 N=8				26	Greenish gray (5GY5/1) with 50% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand and gravel		596	
13A				28							
	19/24 79%	SS	0-2 2-2 N=4				28	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand and gravel		594	
14A				19							
	20/24 83%	SS	1-3 5-6 N=8				30	Dark gray (N4/1), very silty CLAY, trace sand and gravel		592	
15A				15							
	24/60 40%	CS					32	Dark gray (N4/1), sandy SILT, trace clay		590	
							34			588	
16A				13		4.29 *BSh*				586	
	38/60 63%	CS					36	Dark gray (N4/1), silty CLAY, trace sand and gravel		584	
							38	Brown (10YR4/3), silty, fine to medium SAND, little gravel		582	
17A				13		6.70 *None*	40				
								Brown (10YR4/3), silty, fine SAND		580	
							42				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	19/60 *32%*	CS						Brown (10YR4/3), fine to medium SAND		578	
								Brown (10YR4/3), silty, fine to coarse SAND, little gravel			
							44	Dark yellow brown (10YR4/4), SANDSTONE			
18A				13		6.70 *None*				576	
							46	Very dark gray (N3/1), sandy SILT, trace clay and gravel			
	48/60 *80%*	CS								574	
							48	Dark gray (N4/1), SHALE			
19A				14		6.70 *None*				572	
							50	Very dark gray (N3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								570	
							52				
										568	
							54				
20A				17		6.70 *None*				566	
							56	Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								564	
							58				
										562	
21A				14				Very dark greenish gray (10Y3/1), silty, fine to coarse SAND, little gravel			
22A				15			60				
22B	18/24 *75%*	SS	*8-15* *25-32* N=40	11				Very dark gray (N3/1), sandy CLAY, little gravel		560	
22C				15				Very dark gray (N3/1), silty, fine SAND, trace medium sand			
							62	Very dark gray (N3/1), sandy CLAY, trace gravel			
	24/24		*15-31*					Very dark gray (N3/1), silty, fine to medium SAND, trace gravel		558	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
23A	100%	SS	29-19 N=60	15		5.24 BSh	64	Very dark gray (N3/1), sandy CLAY, trace gravel *[Continued from previous page]*			
								Very dark gray (N3/1), silty, fine to coarse SAND, trace gravel		556	
24A	24/24 100%	SS	7-10 14-23 N=24	15		5.24 BSh					
24B				15		3.30 B	66	Very dark gray (N3/1), silty CLAY, trace sand and gravel		554	
	24/24 100%	SS	8-17 24-22 N=41								
25A				16		5.13 B	68				
	24/24 100%	SS	7-9 16-15 N=25					Very dark gray (N3/1), sandy CLAY, trace gravel		552	
26A				12		2.57 BSP	70				
	12/12 100%	CS						Very dark gray (N3/1), sandy CLAY		550	
27A				11							
	12/12 100%	CS									
28A				12			72				
	36/36 100%	CS						Very dark gray (N3/1), silty, fine to coarse SAND, little gravel		548	
							74				
29				12						546	
							76				
	60/60 100%	CS						Very dark gray (N3/1), silty, fine SAND, trace gravel		544	
							78				
										542	
30A				19			80				

End of Boring = 80.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/28/2008
Finish: 1/28/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 10 ft of of BG51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG51b~~
Well ID: G51L
Surface Elev: 616.9 ft. MSL
Completion: 17.7 ft. BGS
Station: 15,409.75N
-75.67E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ = 10.57 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark gray (10YR4/2) silty CLAY, moist, trace sand		616	
							1.5	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand			
							2				
							3.5	Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		614	
							4				
							5.5			612	
							6				
							7.5			610	
							8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand			
							9.5	▼		608	
							10				
							10.5	▽			
							11.5			606	
							12				
							13.5	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand		604	
							14				
							15.5			602	
							16				
							17.5	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel		600	

End of Boring = 17.72 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0	Dark gray (10YR4/2) silty CLAY, moist, trace sand	616	
1A	24/24 100%	ss	4-5 5-6 N=10	21		1.05 Sh				
1B				31		0.81 Sh	2	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand		
	23/24 96%	ss	2-3 3-5 N=6					Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand	614	
2A				23		1.24 Sh	4			
	21/24 88%	ss	1-3 2-3 N=5						612	
3A				27		0.74 BSh	6			
	24/24 100%	ss	2-3 1-3 N=4						610	
4A				29		0.74 BSh	8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand		
	22/24 92%	ss	1-2 3-3 N=5				▼		608	
5A				30		0.78 B	10			
	24/24 100%	ss	0-2 1-2 N=3						606	
6A				28		0.62 Sh	12			
7A				28		0.81 BSh				
	24/24 100%	ss	0-2 2-3 N=4						604	
							14	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand		
	24/24 100%	ss	0-1 2-2 N=3						602	
8A				27		0.81 BSh	16			
	23/24 96%	ss	1-2 3-4 N=5						600	
9A				26		1.09 BSh	18	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel		
	24/24 100%	ss	2-2 4-4 N=6						598	
10A				25		1.09	20			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/23/2008 **FIELD STAFF: Driller:** B. Williamson
Finish: 1/23/2008 **Helper:** R. Keedy
WEATHER: Overcast, windy, cold **Eng/Geo:** R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N -75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						BSh					
	24/24 *100%*	ss	*1-2* *2-3* N=4					Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		596	
11A				22			22				
12A	24/24 *100%*	ss	*3-4* *3-4* N=7	26		0.39 *B*		Olive yellow (2.5Y6/6) with 50% green gray (5GY6/1) mottles, wet, silty CLAY, trace sand and gravel		594	
12B				21		0.50 *B*	24				
	24/24 *100%*	ss	*0-2* *3-3* N=5					Olive (5Y5/3) with 50% green gray (5GY6/1) mottles, wet, very silty CLAY, trace sand and gravel		592	
13A				20		1.75 *B*	26				
14A	24/24 *100%*	ss	*5-7* *8-9* N=15	17		3.30 *BSh*		Brown yellow (10YR5/4), wet, fine to coarse SAND, little gravel		590	
14B				18							
14C				15			28	Green gray (5GY6/1), moist, very silty CLAY, trace sand			
	24/24 *100%*	ss	*1-5* *6-9* N=11							588	
15A				19		4.07 *Sh*	30				
	24/24 *100%*	ss	*3-6* *5-8* N=11					Very dark gray (N3/1), moist, silty CLAY, trace sand and gravel		586	
16A				12		4.27 *Sh*	32				
	24/24 *100%*	ss	*6-8* *9-9* N=17							584	
17A				16		4.27 *BSh*	34				
18A	24/24 *100%*	ss	*4-8* *5-6* N=13	17		4.27 *Sh*				582	
18B				15			36				
	21/24 *88%*	ss	*4-4* *6-5* N=10					Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, clayey SILT, trace sand		580	
19A				37		0.81 *B*	38				
	22/24 *92%*	ss	*3-6* *8-9* N=14					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel		578	
20A				12		2.33					
20B				13		*BSh*		Dark gray (10YR4/1), wet, fine to coarse SAND, trace			
							40				

NOTE(S):

R001100

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
20C				12		4.07 B		gravel			
	24/24 100%	ss	3-7 9-14 N=16							576	
21A				12		4.65 B	42				
	24/24 100%	ss	12-25 38-37 N=63					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel *[Continued from previous page]*		574	
22A				10		7.18 Sh	44				
	24/24 100%	ss	11-19 21-26 N=40							572	
23A				11		5.43 Sh	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/28/2008
Finish: 1/28/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG51a~~
Well ID: G51S
Surface Elev: 616.8 ft. MSL
Completion: 29.2 ft. BGS
Station: 15,405.35N
-75.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ = 10.41 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark gray (10YR4/2) silty CLAY, moist, trace sand		616	
							1	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand			
							2	Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		614	
							4			612	
							6			610	
							8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand		608	
							9.3 ▼				
							10.41 ▼				
							10			606	
							12	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand		604	
							14			602	
							16	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel		600	
							18			598	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/28/2008
Finish: 1/28/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51a
Well ID: G51S
Surface Elev: 616.8 ft. MSL
Completion: 29.2 ft. BGS
Station: 15,405.35N
-75.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ = 10.41 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		596	
							24	Olive yellow (2.5Y6/6) with 50% green gray (5GY6/1) mottles, wet, silty CLAY, trace sand and gravel		594	
							26	Olive (5Y5/3) with 50% green gray (5GY6/1) mottles, wet, very silty CLAY, trace sand and gravel		592	
								Brown yellow (10YR5/4), wet, fine to coarse SAND, little gravel		590	
							28	Green gray (5GY6/1), moist, very silty CLAY, trace sand			
								Very dark gray (N3/1), moist, silty CLAY, trace sand and gravel		588	

End of Boring = 29.16 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	4-5 5-6 N=10	21		1.05 Sh	0	Dark gray (10YR4/2) silty CLAY, moist, trace sand	616	
1B				31		0.81 Sh	2	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand		
	23/24 96%	ss	2-3 3-5 N=6					Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand	614	
2A				23		1.24 Sh	4			
	21/24 88%	ss	1-3 2-3 N=5						612	
3A				27		0.74 BSh	6			
	24/24 100%	ss	2-3 1-3 N=4						610	
4A				29		0.74 BSh	8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand		
	22/24 92%	ss	1-2 3-3 N=5				▼		608	
5A				30		0.78 B	10			
	24/24 100%	ss	0-2 1-2 N=3						606	
6A				28		0.62 Sh	12			
7A				28		0.81 BSh				
	24/24 100%	ss	0-2 2-3 N=4						604	
							14	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand		
	24/24 100%	ss	0-1 2-2 N=3						602	
8A				27		0.81 BSh	16			
	23/24 96%	ss	1-2 3-4 N=5						600	
9A				26		1.09 BSh	18	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel		
	24/24 100%	ss	2-2 4-4 N=6						598	
10A				25		1.09	20			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/23/2008 **FIELD STAFF: Driller:** B. Williamson
Finish: 1/23/2008 **Helper:** R. Keedy
WEATHER: Overcast, windy, cold **Eng/Geo:** R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						BSh					
	24/24 *100%*	ss	*1-2* *2-3* N=4					Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		596	
11A				22			22				
12A	24/24 *100%*	ss	*3-4* *3-4* N=7	26		0.39 *B*		Olive yellow (2.5Y6/6) with 50% green gray (5GY6/1) mottles, wet, silty CLAY, trace sand and gravel		594	
12B				21		0.50 *B*	24				
	24/24 *100%*	ss	*0-2* *3-3* N=5					Olive (5Y5/3) with 50% green gray (5GY6/1) mottles, wet, very silty CLAY, trace sand and gravel		592	
13A				20		1.75 *B*	26				
14A	24/24 *100%*	ss	*5-7* *8-9* N=15	17		3.30 *BSh*		Brown yellow (10YR5/4), wet, fine to coarse SAND, little gravel		590	
14B				18							
14C				15			28	Green gray (5GY6/1), moist, very silty CLAY, trace sand			
	24/24 *100%*	ss	*1-5* *6-9* N=11							588	
15A				19		4.07 *Sh*	30				
	24/24 *100%*	ss	*3-6* *5-8* N=11					Very dark gray (N3/1), moist, silty CLAY, trace sand and gravel		586	
16A				12		4.27 *Sh*	32				
	24/24 *100%*	ss	*6-8* *9-9* N=17							584	
17A				16		4.27 *BSh*	34				
18A	24/24 *100%*	ss	*4-8* *5-6* N=13	17		4.27 *Sh*				582	
18B				15			36				
	21/24 *88%*	ss	*4-4* *6-5* N=10					Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, clayey SILT, trace sand		580	
19A				37		0.81 *B*	38				
	22/24 *92%*	ss	*3-6* *8-9* N=14					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel		578	
20A				12		2.33					
20B				13		*BSh*		Dark gray (10YR4/1), wet, fine to coarse SAND, trace			
							40				

NOTE(S):

R001105

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: **Start:** 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
20C				12		4.07 B		gravel			
	24/24 100%	ss	3-7 9-14 N=16							576	
21A				12		4.65 B	42				
	24/24 100%	ss	12-25 38-37 N=63					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel *[Continued from previous page]*		574	
22A				10		7.18 Sh	44				
	24/24 100%	ss	11-19 21-26 N=40							572	
23A				11		5.43 Sh	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/22/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG52
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG52b~~
Well ID: G52L
Surface Elev: 616.7 ft. MSL
Completion: 34.2 ft. BGS
Station: 14,660.08N
-76.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 28.78 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Gray (10YR6/1) with 25% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand		616	
							6	FILL - Yellow brown (10YR5/4) with 25% very pale brown (10YR7/4) and 10% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand		610	
							8	FILL - Very dark green gray (10Y3/1) with 25% yellow brown (10YR5/4), mottles, moist, silty CLAY, trace sand and gravel		608	
							10	FILL - Yellow brown (10YR5/4) with 20% very pale brown (10YR7/4) and 15% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand and gravel		606	
							16	FILL - Dark gray (5Y4/1), moist, very silty CLAY, trace sand		600	
							18	FILL - Olive gray (5Y5/2), moist, very silty CLAY, trace sand		598	
							20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/22/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG52
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52b
Well ID: G52L
Surface Elev: 616.7 ft. MSL
Completion: 34.2 ft. BGS
Station: 14,660.08N
-76.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 28.78 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1), moist, clayey SILT, slight trace sand		596	
								Dark gray brown (10YR4/2) with 20% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand			
							22			594	
								Gray (10YR5/1) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
							24			592	
							26				
								Gray (10YR5/1) with 30% green gray (5GY5/1) mottle, moist, silty CLAY, trace sand and gravel		590	
							28				
							▼	Brown yellow (10YR6/8) with 20% green gray (5GY5/1) mottles, very moist, silty CLAY, trace sand and gravel		588	
							30				
								Brown yellow (10YR6/8) with 25% light gray (10YR7/2) mottle, very moist, very silty CLAY, little sand, trace gravel		586	
							32				
							▼			584	
								Dark gray brown (10YR4/2) with 25% dark yellow brown (10YR4/6) mottles, wet, clayey SILT, little sand, trace gravel			
							34	Dark gray (10YR4/1), very moist, silty CLAY, trace sand and gravel			

End of Boring = 34.17 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG52~~
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	20/24 83%	ss	3-3 2-4 N=5				0			616	
1A				23		1.28 BSh	2				
	24/24 100%	ss	3-3 4-4 N=7					FILL - Gray (10YR6/1) with 25% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand		614	
2A				16		2.13 Sh	4				
	21/24 88%	ss	6-6 9-13 N=15							612	
3A				19			6				
	21/24 88%	ss	6-5 8-8 N=13					FILL - Yellow brown (10YR5/4) with 25% very pale brown (10YR7/4) and 10% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand		610	
4A				14			8				
	23/24 96%	ss	5-7 9-10 N=16					FILL - Very dark green gray (10Y3/1) with 25% yellow brown (10YR5/4), mottles, moist, silty CLAY, trace sand and gravel		608	
5A				13			10				
	24/24 100%	ss	6-6 7-4 N=13							606	
6A				15			12				
	22/24 92%	ss	4-4 8-7 N=12					FILL - Yellow brown (10YR5/4) with 20% very pale brown (10YR7/4) and 15% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand and gravel		604	
7A				19			14				
	23/24 96%	ss	2-5 6-8 N=11							602	
8A				17		2.91 Sh	16				
	21/24 88%	ss	2-3 3-4 N=6					FILL - Dark gray (5Y4/1), moist, very silty CLAY, trace sand		600	
9A				25			18				
	24/24 100%	ss	2-5 5-5 N=10					FILL - Olive gray (5Y5/2), moist, very silty CLAY, trace sand		598	
10A				28		1.59	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
CONTRACTOR: Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility
Rig mfg/model: CME-650 Track Rig
Location: Canton, Fulton Co., Illinois
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/21/2008
Finish: 1/22/2008
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
WEATHER: Overcast, windy, cold
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N -76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1), moist, clayey SILT, slight trace sand			
11A	24/24 100%	ss	2-3 8-7 N=11	29		Sh				596	
								Dark gray brown (10YR4/2) with 20% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand			
11B				23		3.30 BSh	22				
										594	
	24/24 100%	ss	5-5 7-9 N=12								
12A				25		2.91 B	24	Gray (10YR5/1) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
										592	
	23/24 96%	ss	1-2 3-5 N=5								
13A				25		2.13 B	26				
										590	
	24/24 100%	ss	5-6 7-6 N=13					Gray (10YR5/1) with 30% green gray (5GY5/1) mottle, moist, silty CLAY, trace sand and gravel			
14A				19		2.33 B	28				
								Brown yellow (10YR6/8) with 20% green gray (5GY5/1) mottles, very moist, silty CLAY, trace sand and gravel		588	
15A	24/24 100%	ss	1-2 2-3 N=4	27		0.78 B					
15B				19		2.52 BSh	30				
								Brown yellow (10YR6/8) with 25% light gray (10YR7/2) mottle, very moist, very silty CLAY, little sand, trace gravel		586	
	24/24 100%	ss	1-1 2-3 N=3								
16A				22		1.24 B	32				
							▼			584	
17A	24/24 100%	ss	3-3 4-7 N=7	26		2.72 B	▼	Dark gray brown (10YR4/2) with 25% dark yellow brown (10YR4/6) mottles, wet, clayey SILT, little sand, trace gravel			
17B				26							
17C				17			34				
										582	
	24/24 100%	ss	2-5 6-8 N=11					Dark gray (10YR4/1), very moist, silty CLAY, trace sand and gravel			
18A				16		5.24 Sh	36				
										580	
	24/24 100%	ss	9-10 10-11 N=20								
19A				17		4.46					
19B				25		Sh	38	Dark gray (10YR4/1), wet, sandy SILT			
								Gray (N6/1) with 30% gray (5Y5/1) mottles, wet, sandy SILT		578	
20A	24/24 100%	ss	5-7 5-6 N=12	25							
								Gray (10YR5/1), wet, sandy SILT			
20B				30		3.69	40				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh					
	22/24 *92%*	ss	*2-3* *5-12* N=8					Gray (10YR5/1), wet, sandy SILT *[Continued from previous page]*		576	
21A				35		1.32					
						Sh					
21B				12		1.40	42				
						Sh		Dark gray (10YR4/1), wet, SAND and GRAVEL		574	
	24/24 *100%*	ss	*12-18* *18-8* N=36								
22A				13							
22B				13			44				
	24/24 *100%*	ss	*3-5* *8-11* N=13					Dark greenish gray (10Y4/1), moist, silty CLAY, trace sand and gravel		572	
23A				14		4.46 *B*	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/21/2008 **FIELD STAFF: Driller:** B. Williamson
Finish: 1/22/2008 **Helper:** R. Keedy
WEATHER: Overcast, windy, cold **Eng/Geo:** R. Hasenyager

BOREHOLE ID: ~~BG52~~
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	20/24 83%	ss	3-3 2-4 N=5							616	
1A				23		1.28 BSh	2				
	24/24 100%	ss	3-3 4-4 N=7					FILL - Gray (10YR6/1) with 25% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand		614	
2A				16		2.13 Sh	4				
	21/24 88%	ss	6-6 9-13 N=15							612	
3A				19			6				
	21/24 88%	ss	6-5 8-8 N=13					FILL - Yellow brown (10YR5/4) with 25% very pale brown (10YR7/4) and 10% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand		610	
4A				14			8				
	23/24 96%	ss	5-7 9-10 N=16					FILL - Very dark green gray (10Y3/1) with 25% yellow brown (10YR5/4), mottles, moist, silty CLAY, trace sand and gravel		608	
5A				13			10				
	24/24 100%	ss	6-6 7-4 N=13							606	
6A				15			12				
	22/24 92%	ss	4-4 8-7 N=12					FILL - Yellow brown (10YR5/4) with 20% very pale brown (10YR7/4) and 15% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand and gravel		604	
7A				19			14				
	23/24 96%	ss	2-5 6-8 N=11							602	
8A				17		2.91 Sh	16				
	21/24 88%	ss	2-3 3-4 N=6					FILL - Dark gray (5Y4/1), moist, very silty CLAY, trace sand		600	
9A				25			18				
	24/24 100%	ss	2-5 5-5 N=10					FILL - Olive gray (5Y5/2), moist, very silty CLAY, trace sand		598	
10A				28		1.59	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
CONTRACTOR: Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility
Rig mfg/model: CME-650 Track Rig
Location: Canton, Fulton Co., Illinois
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N -76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1), moist, clayey SILT, slight trace sand			
11A	24/24 100%	ss	2-3 8-7 N=11	29		Sh				596	
								Dark gray brown (10YR4/2) with 20% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand			
11B				23		3.30 BSh	22				
										594	
	24/24 100%	ss	5-5 7-9 N=12								
12A				25		2.91 B	24	Gray (10YR5/1) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
										592	
	23/24 96%	ss	1-2 3-5 N=5								
13A				25		2.13 B	26				
										590	
	24/24 100%	ss	5-6 7-6 N=13					Gray (10YR5/1) with 30% green gray (5GY5/1) mottle, moist, silty CLAY, trace sand and gravel			
14A				19		2.33 B	28				
								Brown yellow (10YR6/8) with 20% green gray (5GY5/1) mottles, very moist, silty CLAY, trace sand and gravel		588	
15A	24/24 100%	ss	1-2 2-3 N=4	27		0.78 B					
15B				19		2.52 BSh	30				
								Brown yellow (10YR6/8) with 25% light gray (10YR7/2) mottle, very moist, very silty CLAY, little sand, trace gravel		586	
	24/24 100%	ss	1-1 2-3 N=3								
16A				22		1.24 B	32				
							▼			584	
17A	24/24 100%	ss	3-3 4-7 N=7	26		2.72 B	▼	Dark gray brown (10YR4/2) with 25% dark yellow brown (10YR4/6) mottles, wet, clayey SILT, little sand, trace gravel			
17B				26							
17C				17			34				
										582	
	24/24 100%	ss	2-5 6-8 N=11					Dark gray (10YR4/1), very moist, silty CLAY, trace sand and gravel			
18A				16		5.24 Sh	36				
										580	
	24/24 100%	ss	9-10 10-11 N=20								
19A				17		4.46					
19B				25		Sh	38	Dark gray (10YR4/1), wet, sandy SILT			
								Gray (N6/1) with 30% gray (5Y5/1) mottles, wet, sandy SILT		578	
20A	24/24 100%	ss	5-7 5-6 N=12	25							
								Gray (10YR5/1), wet, sandy SILT			
20B				30		3.69	40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh					
	22/24 *92%*	ss	*2-3* *5-12* N=8					Gray (10YR5/1), wet, sandy SILT *[Continued from previous page]*		576	
21A				35		1.32					
21B				12		*Sh* 1.40 *Sh*	42	Dark gray (10YR4/1), wet, SAND and GRAVEL		574	
	24/24 *100%*	ss	*12-18* *18-8* N=36								
22A				13							
22B				13			44				
	24/24 *100%*	ss	*3-5* *8-11* N=13					Dark greenish gray (10Y4/1), moist, silty CLAY, trace sand and gravel		572	
23A				14		4.46 *B*	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G53a~~
Well ID: G53L
Surface Elev: 620.29 ft. MSL
Completion: 26.79 ft. BGS
Station: 16,199.98N
506.32E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
0	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		620	
2	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand.		618	
4	Dark gray (10YR4/1), moist, friable, clayey SILT with slight trace sand and gravel, trace roots.		616	
	Dark yellowish brown (10YR4/6) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.			
6	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		614	
8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		612	
10			610	
12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		608	
14			606	
16	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
18	Dark gray (10YR4/1), moist, soft, clayey SILT.		602	
20	Dark gray (10YR4/1) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.			

NOTE(S): See G53S Boring log for sample and testing data.

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G53a
Well ID: G53L
Surface Elev: 620.29 ft. MSL
Completion: 26.79 ft. BGS
Station: 16,199.98N
506.32E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ =
▽ =

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Dark gray (10YR4/1) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand. *[Continued from previous page]*		600, 598	
							24	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		596	
							▼ 26	Greenish gray (5GY5/1), very moist, very soft, silty CLAY with sand and slight trace gravel.			
								Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		594	

End of Boring = 26.79 ft bgs

NOTE(S): See G53S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G53~~
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	20/24 83%	ss	12-3 4-3 N=7	21			0	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		620	
2A	22/24 92%	ss	5-3 3-6 N=6	22			2	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand.		618	
3A	18/24 75%	ss	2-3 6-7 N=9	27			4	Dark gray (10YR4/1), moist, friable, clayey SILT with slight trace sand and gravel, trace roots. Dark yellowish brown (10YR4/6) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		616	
4A	24/24 100%	ss	5-4 7-11 N=11	26			6	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		614	
5A	12/24 50%	ss	1-2 4-3 N=6	24			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		612	
6A	17/24 71%	ss	1-2 4-4 N=6	23			10			610	
7A	19/24 79%	ss	6-5 4-4 N=9	25			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		608	
8A	19/24 79%	ss	1-2 2-3 N=4	26			14			606	
9A	24/24 100%	ss	3-6 5-5 N=11	25			16	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
10A	19/24 79%	ss	1-1 3-4 N=4	24			18	Dark gray (10YR4/1), moist, soft, clayey SILT.		602	
							20	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G53
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	woh-1 2-2 N=3	25			22	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand. *[Continued from previous page]*		600	
12A	24/24 100%	ss	3-3 3-3 N=6	25						598	
12B				21			24	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.			
13A	19/24 79%	ss	woh-1 1-1 N=2	23						596	
								Greenish gray (5GY5/1), very moist, very soft, silty CLAY with sand and slight trace gravel.			
							▼ 26			594	
	23/24 96%	ss	woh-woh 3-4								
14A				20			28	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
	22/24 92%	ss	1-3 6-8 N=9								
15A				16			30	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel.		590	
16A	18/24 75%	ss	woh-7 12-16 N=19	13			▼				
16B				19			32	Brown (10YR5/3), wet, dense, silty very fine- to coarse-grained SAND.		588	
17A				17							
	20/24 83%	ss	4-4 6-8 N=10								
17B				32			34	Gray (10YR5/1), very moist, soft, clayey SILT.		586	
18A	22/24 92%	ss	woh-3 3-9 N=6	30							
18B				20			36	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel. **End of Boring = 36.04 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G53~~
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	20/24 83%	ss	12-3 4-3 N=7	21			0	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		620	
2A	22/24 92%	ss	5-3 3-6 N=6	22			2	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand.		618	
3A	18/24 75%	ss	2-3 6-7 N=9	27			4	Dark gray (10YR4/1), moist, friable, clayey SILT with slight trace sand and gravel, trace roots. Dark yellowish brown (10YR4/6) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		616	
4A	24/24 100%	ss	5-4 7-11 N=11	26			6	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		614	
5A	12/24 50%	ss	1-2 4-3 N=6	24			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		612	
6A	17/24 71%	ss	1-2 4-4 N=6	23			10			610	
7A	19/24 79%	ss	6-5 4-4 N=9	25			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		608	
8A	19/24 79%	ss	1-2 2-3 N=4	26			14			606	
9A	24/24 100%	ss	3-6 5-5 N=11	25			16	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
10A	19/24 79%	ss	1-1 3-4 N=4	24			18	Dark gray (10YR4/1), moist, soft, clayey SILT.		602	
							20	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G53
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	woh-1 2-2 N=3	25			22	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand. *[Continued from previous page]*		600	
12A	24/24 100%	ss	3-3 3-3 N=6	25						598	
12B				21			24	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		596	
13A	19/24 79%	ss	woh-1 1-1 N=2	23				Greenish gray (5GY5/1), very moist, very soft, silty CLAY with sand and slight trace gravel.			
14A	23/24 96%	ss	woh-woh 3-4	20			▼ 26	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		594	
15A	22/24 92%	ss	1-3 6-8 N=9	16			28	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel.		592	
16A	18/24 75%	ss	woh-7 12-16 N=19	13			30	Brown (10YR5/3), wet, dense, silty very fine- to coarse-grained SAND.		590	
16B				19			▼ 32	Gray (10YR5/1), very moist, soft, clayey SILT.		588	
17A	20/24 83%	ss	4-4 6-8 N=10	17			34	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel. **End of Boring = 36.04 ft bgs**		586	
17B				32			36				
18A	22/24 92%	ss	woh-3 3-9 N=6	30							
18B				20							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S1	18/24 75%	SS	2-2 4-5 N=6			1.5	0	Fill - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% yellowish brown (10YR4/6) mottles, moist SILT with little clay, trace roots, and trace sand.		618	
S2	21/24 88%	SS	2-5 6-7 N=11			2.0	2	Fill - Yellowish brown (10YR5/6) with 30% light brownish gray (10YR6/2) mottles, moist, soft SILT with little clay, trace sand, and trace gravel.		616	
S3	22/24 92%	SS	2-7 10-12 N=17			2.5	4	Fill - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, firm SILT with little clay and trace sand.		614	
S4	19/24 79%	SS	3-7 9-11 N=16			4.5	6	Fill - Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		612	
S5	20/24 83%	SS	3-7 9-10 N=16			4.5	8	Grayish brown (10YR5/2) firm SILT with little clay, trace sand, and trace gravel.		610	
S6	21/24 88%	SS	3-4 7-10 N=11			4.5	10	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/6) mottles, firm SILT with little clay, trace sand, and trace gravel.		608	
S7	21/24 88%	SS	3-7 12-15 N=19			4.5	12	Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		606	
ST8	20/24 83%	SH				4.0	14			604	
S9	18/24 75%	SS	1-4 4-5 N=8			0.5	16	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, soft SILT with little clay.		602	
S10	19/24 79%	SS	1-3 4-4 N=7			1.0	18			600	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S11	18/24 75%	SS	1-2 4-5 N=6			1.0	22	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft SILT with little clay.		598	
S12	20/24 83%	SS	1-3 4-7 N=7			1.0	24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft SILT with little clay.		596	
S13	19/24 79%	SS	1-3 3-4 N=6			1.5		Grayish brown (10YR5/2) moist, soft, CLAY with little silt.			
S14	22/24 92%	SS	woh-1 3-3 N=4			1.5	26	Gray (10YR5/1) moist, soft, CLAY with little silt.		594	
S15	21/24 88%	SS	1-2 3-4 N=5			1.0	28			592	
S16	22/24 92%	SS	1-3 5-5 N=8			2.0	30	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) soft CLAY with little silt.		590	
ST17	24/24 100%	SH				0.5	32			588	
S18	21/24 88%	SS	2-3 4-3 N=7			1.0	34			586	
S19	21/24 88%	SS	1-4 5-8 N=9			1.5	36	Gray (10YR6/1) wet, soft CLAY with little silt and trace sand.		584	
S20	20/24 83%	SS	woh-1 3-4 N=4			1.0	38	Dark gray (10YR4/1) wet, fine SAND with trace silt.		582	
								Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand.		580	
							40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S21	4/24 17%	SS	1-2 5-10 N=7					Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand. *[Continued from previous page]*			
							42			578	
S22	23/24 96%	SS	2-6 12-11 N=18			3.0					
							44	Dark grayish brown (10YR4/2) moist, firm SILT with little clay, trace sand, and trace gravel.		576	
ST23	23/24 96%	SH				4.5					
							46			574	
S24	24/24 100%	SS	3-6 8-14 N=14			4.5					
							48			572	
S25	24/24 100%	SS	3-8 13-20 N=21			4.5					
							50	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.		570	
S26	24/24 100%	SS	3-10 14-19 N=24			4.5					
							52			568	
S27	24/24 100%	SS	6-9 15-16 N=24			4.5					
							54			566	
S28	24/24 100%	SS	4-10 28-50/3" N=38			4.5		Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.			
							56			564	
S29	24/24 100%	SS	10-47 50/3.25-50/1.25			2.5		Dark gray (10YR4/1) wet, soft SAND with little clay and trace silt.			
							58	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.		562	
S30	24/24 100%	SS	19-29 44-72 N=73			4.5					
							60			560	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S31	24/24 100%	SS	14-29 42-54 N=71			4.5	62	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel. *[Continued from previous page]*		558	
S32	23/24 96%	SS	12-14 30-48 N=44			4.5	64			556	
S33	23/24 96%	SS	10-22 25-34 N=47			4.5	66			554	
S34	24/24 100%	SS	10-19 26-34 N=45			4.5	68			552	
S35	24/24 100%	SS	11-19 24-33 N=43			4.5	70	Dark gray (10YR4/1) firm SILT with little clay, trace sand, and trace gravel.		550	
S36	23/24 96%	SS	11-22 22-34 N=44			4.5	72			548	
S37	24/24 100%	SS	9-13 20-22 N=33			4.5	74			546	
S38	24/24 100%	SS	6-8 12-15 N=20			4.5	76	Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt.		544	
ST39	11/24 46%	SH				4.5	78			542	
S40	14/24 58%	SS	7-10 17-20 N=27			4.5	80	Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel.		540	

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
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BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
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2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S41	24/24 100%	SS	6-8 11-15 N=19			4.5		Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel. *[Continued from previous page]*			
							82			538	
S42	24/24 100%	SS	3-7 9-10 N=16			4.5		Dark gray (10YR4/1) firm CLAY with trace silt and gravel.			
							84			536	
S43	24/24 100%	SS	4-8 12-15 N=20			4.5		Dark gray (10YR4/1) with 5% gray (10YR5/1) mottles, firm, CLAY with little silt, trace sand, and trace gravel.			
							86			534	
S44	24/24 100%	SS	5-7 11-14 N=18			4.0					
							88	Dark gray (10YR4/1) CLAY with little silt, trace sand, and trace gravel.		532	
S45	24/24 100%	SS	5-8 11-14 N=19			4.5					
							90			530	
S46	24/24 100%	SS	5-9 13-15 N=22			4.5					
							92	Grayish green (5GY5/2) with 30% dark grayish green (5GY4/2) mottles, firm, CLAY with trace silt and gravel. (WEATHERED SHALE)		528	
S47	24/24 100%	SS	4-7 10-13 N=17			4.5					
							94			526	
S48	24/24 100%	SS	3-6 8-11 N=14			4.0					
							96	Very dark grayish green (5GY3/2) firm, CLAY with trace silt. (WEATHERED SHALE)		524	
S49	24/24 100%	SS	4-8 11-13 N=19			3.0					
							98			522	
S50	21/24 88%	SS	5-7 10-12 N=17			3.0		Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE)			
							100			520	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S51	24/24 *100%*	SS	*3-7* *9-11* N=16			*2.5*		Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE) *[Continued from previous page]*			
							102	**End of boring = 102 feet**		518	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G54a~~
Well ID: G54L
Surface Elev: 620.28 ft. MSL
Completion: 37.22 ft. BGS
Station: 14,664.37N
463.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand, trace roots.		620	
							2			618	
							4	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		616	
							6	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand.		614	
							8			612	
							10	FILL - Yellowish brown (10YR5/4), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
							12			608	
							14			606	
							16	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		604	
							18			602	
							20	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, friable, clayey SILT.			

NOTE(S): See G54S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G54a
Well ID: G54L
Surface Elev: 620.28 ft. MSL
Completion: 37.22 ft. BGS
Station: 14,664.37N
463.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
							24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
							26	Gray (10YR5/1), moist, soft, silty CLAY.		596	
							28	Gray (10YR5/1), moist, soft, silty CLAY with trace sand.		594	
							30	Gray (10YR5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
							32	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		590	
							34	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
							36	Dark gray (10YR4/1), very moist, soft, clayey SILT with trace sand and slight trace gravel.		586	
								End of Boring = 37.22 ft bgs		584	

NOTE(S): See G54S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G54~~
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-2 2-2 N=4	25			0	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand, trace roots.		620	
2A	18/24 75%	ss	1-2 3-3 N=5	23			2			618	
3A	20/24 83%	ss	1-5 8-10 N=13	17			4	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		616	
4A	24/24 100%	ss	8-13 13-15 N=26	18			6	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand.		614	
5A	24/24 100%	ss	4-7 10-9 N=17	16			8			612	
6A	19/24 79%	ss	2-3 6-8 N=9	18			10	FILL - Yellowish brown (10YR5/4), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
7A	24/24 100%	ss	8-17 15-16 N=32	16			12			608	
8A	20/24 83%	ss	2-4 4-6 N=8	22			14			606	
9A	22/24 92%	ss	5-5 9-10 N=14	22			16	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		604	
10A	18/24 75%	ss	1-3 3-4 N=6	23			18			602	
							20	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, friable, clayey SILT.			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	1-2 1-3 N=3	28			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
12A	20/24 83%	ss	4-5 5-4 N=10	25			24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
13A	19/24 79%	ss	2-2 3-4 N=5	23			26	Gray (10YR5/1), moist, soft, silty CLAY.		596	
13B				24			28	Gray (10YR5/1), moist, soft, silty CLAY with trace sand.		594	
14A	20/24 83%	ss	4-4 4-5 N=8	27			30	Gray (10YR5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	14/24 58%	ss	woh-2 4-4 N=6	20			32	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		590	
16A	22/24 92%	ss	1-2 4-8 N=6	24			34	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
17A	20/24 83%	ss	4-4 7-8 N=11	21			36			586	
18A	16/24 67%	ss	woh-1 2-3 N=3	14			38	Dark gray (10YR4/1), very moist, soft, clayey SILT with trace sand and slight trace gravel.		584	
19A	14/24 58%	ss	woh-3 3-6 N=6	15			40	Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel.		582	
20A	23/24 96%	ss	woh-3 4-5 N=7	13							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	20/24 83%	SS	1-3 5-7 N=8	14				Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel. *[Continued from previous page]*		580	
21B				32			42	Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, very moist, soft, clayey SILT.		578	
22A	20/24 83%	SS	5-7 7-9 N=14	28				Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, soft, clayey SILT.			
23A	20/24 83%	SS	2-4 8-7 N=12	16			44 ▼	Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.		576	
23B				12				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.			
24A	22/24 92%	SS	7-10 13-17 N=23	19			46	Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.		574	
24B				13				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.			
	0/5 0%	BD					48			572	

End of Boring = 48.41 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G54~~
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-2 2-2 N=4	25			0	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand, trace roots.		620	
2A	18/24 75%	ss	1-2 3-3 N=5	23			2			618	
3A	20/24 83%	ss	1-5 8-10 N=13	17			4	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		616	
4A	24/24 100%	ss	8-13 13-15 N=26	18			6	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand.		614	
5A	24/24 100%	ss	4-7 10-9 N=17	16			8			612	
6A	19/24 79%	ss	2-3 6-8 N=9	18			10	FILL - Yellowish brown (10YR5/4), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
7A	24/24 100%	ss	8-17 15-16 N=32	16			12			608	
8A	20/24 83%	ss	2-4 4-6 N=8	22			14			606	
9A	22/24 92%	ss	5-5 9-10 N=14	22			16	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		604	
10A	18/24 75%	ss	1-3 3-4 N=6	23			18			602	
							20	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, friable, clayey SILT.			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	1-2 1-3 N=3	28			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
12A	20/24 83%	ss	4-5 5-4 N=10	25			24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
13A	19/24 79%	ss	2-2 3-4 N=5	23			26	Gray (10YR5/1), moist, soft, silty CLAY.		596	
13B				24			28	Gray (10YR5/1), moist, soft, silty CLAY with trace sand.		594	
14A	20/24 83%	ss	4-4 4-5 N=8	27			30	Gray (10YR5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	14/24 58%	ss	woh-2 4-4 N=6	20			32	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		590	
16A	22/24 92%	ss	1-2 4-8 N=6	24			34	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
17A	20/24 83%	ss	4-4 7-8 N=11	21			36			586	
18A	16/24 67%	ss	woh-1 2-3 N=3	14			38	Dark gray (10YR4/1), very moist, soft, clayey SILT with trace sand and slight trace gravel.		584	
19A	14/24 58%	ss	woh-3 3-6 N=6	15			40	Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel.		582	
20A	23/24 96%	ss	woh-3 4-5 N=7	13							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
21A	20/24 83%	SS	1-3 5-7 N=8	14				Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel. *[Continued from previous page]*	580	
21B				32						
							42	Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, very moist, soft, clayey SILT.	578	
22A	20/24 83%	SS	5-7 7-9 N=14	28				Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, soft, clayey SILT.		
							▼ 44			
23A	20/24 83%	SS	2-4 8-7 N=12	16				Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.	576	
23B				12				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		
							46			
24A	22/24 92%	SS	7-10 13-17 N=23	19				Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.	574	
24B				13				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		
	0/5 0%	BD					48		572	

End of Boring = 48.41 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G55a~~
Well ID: G55L
Surface Elev: 619.78 ft. MSL
Completion: 36.60 ft. BGS
Station: 14,667.70N
705.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand.		618	
							2				
							4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		616	
							6			614	
							8	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		612	
							10	FILL - Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		610	
							12	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand.		608	
							14	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		606	
							16	Very dark grayish brown (10YR3/2), slightly moist, hard, clayey SILT with slight trace sand and trace roots.		604	
							18	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, firm, silty CLAY.		602	
							20	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
								Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			

NOTE(S): See G55S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G55a
Well ID: G55L
Surface Elev: 619.78 ft. MSL
Completion: 36.60 ft. BGS
Station: 14,667.70N
705.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
							24			596	
							26	Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		594	
							28	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		592	
							30			590	
							32	Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
								Greenish gray (5GY6/1), moist, soft, sandy CLAY with slight trace gravel.			
								Medium light gray (N6/1), moist, soft, sandy CLAY with slight trace gravel.		586	
							34	Medium light gray (N6/1), wet, soft, silty, very fine- to medium-grained SAND.			
								Greenish gray (10Y6/1), very moist, soft, clayey SILT with slight trace sand and gravel.		584	
							36	Gray (N6/1), very moist, soft, sandy CLAY with slight trace gravel.			

End of Boring = 36.6 ft bgs

NOTE(S): See G55S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G55~~
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	2-3 4-3 N=7	19			0	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand.		620	
2A	17/24 71%	ss	2-3 2-2 N=5	20			2			618	
3A	12/24 50%	ss	woh-2 3-4 N=5	15			4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		616	
4A	24/24 100%	ss	6-8 12-11 N=20	15			6			614	
5A	24/24 100%	ss	4-3 3-5 N=6	18			8	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		612	
5B				17			10	FILL - Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		610	
6A	22/24 92%	ss	1-2 6-8 N=8	19			12	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand.		608	
7A	24/24 100%	ss	6-8 18-19 N=26	17			14	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		606	
8A	20/24 83%	ss	2-5 5-7 N=10	24			16	Very dark grayish brown (10YR3/2), slightly moist, hard, clayey SILT with slight trace sand and trace roots.		604	
9A	22/24 92%	ss	10-9 11-11 N=20	24			18	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, firm, silty CLAY.		602	
9B				23				Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
10A	18/24 75%	ss	2-4 4-5 N=8	22			20	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	1-2 2-4 N=4	25			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
12A	23/24 96%	ss	4-4 5-5 N=9	26			24	Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		596	
13A	17/24 71%	ss	woh-2 3-3 N=5	21			26			594	
14A	22/24 92%	ss	3-3 4-5 N=7	25			28	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		592	
15A	24/24 100%	ss	woh-2 2-3 N=4	30			30			590	
16A	20/24 83%	ss	woh-1 3-4 N=4	25			32	Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
16B				22							
17A				24				Greenish gray (5GY6/1), moist, soft, sandy CLAY with slight trace gravel.			
17B	12/24 50%	ss	2-3 4-4 N=7	16				Medium light gray (N6/1), moist, soft, sandy CLAY with slight trace gravel.		586	
18A	11/24 46%	ss	1-3 5-4 N=8	16			34	Medium light gray (N6/1), wet, soft, silty, very fine- to medium-grained SAND.			
								Greenish gray (10Y6/1), very moist, soft, clayey SILT with slight trace sand and gravel.		584	
19A	17/24 71%	ss	2-5 6-7 N=11	14			36	Gray (N6/1), very moist, soft, sandy CLAY with slight trace gravel.		582	
20A				11			38	Gray (N5/1), slightly moist, firm, clayey SILT with slight trace sand and gravel.			
20B	19/24 79%	ss	3-8 11-7 N=19	19			▼	Gray (N5/1), moist, firm, SILT.		580	
							40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	18/24 *75%*	ss	*5-8* *10-19* N=18	36				Gray (N5/1), moist, firm, SILT. *[Continued from previous page]*			
21B				16							
							42 ▼	Gray (N5/1), wet, dense, silty very fine- to medium-grained SAND.		578	
22A				11							
22B	18/24 *75%*	ss	*6-13* *21-15* N=34	10							
							44	Gray (N5/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	
23A	20/24 *83%*	ss	*6-9* *13-12* N=22	12							
										574	

End of Boring = 45.96 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G55~~
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	2-3 4-3 N=7	19			0	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand.		618	
2A	17/24 71%	ss	2-3 2-2 N=5	20			2				
3A	12/24 50%	ss	woh-2 3-4 N=5	15			4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		616	
4A	24/24 100%	ss	6-8 12-11 N=20	15			6	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		614	
5A	24/24 100%	ss	4-3 3-5 N=6	18			8	FILL - Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		612	
5B				17			10	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand.		610	
6A	22/24 92%	ss	1-2 6-8 N=8	19			12	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		608	
7A	24/24 100%	ss	6-8 18-19 N=26	17			14	Very dark grayish brown (10YR3/2), slightly moist, hard, clayey SILT with slight trace sand and trace roots.		606	
8A	20/24 83%	ss	2-5 5-7 N=10	24			16	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, firm, silty CLAY.		604	
9A	22/24 92%	ss	10-9 11-11 N=20	24			18	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		602	
9B				23							
10A	18/24 75%	ss	2-4 4-5 N=8	22			20	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	1-2 2-4 N=4	25			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
12A	23/24 96%	ss	4-4 5-5 N=9	26			24			596	
13A	17/24 71%	ss	woh-2 3-3 N=5	21				Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.			
14A	22/24 92%	ss	3-3 4-5 N=7	25			26			594	
15A	24/24 100%	ss	woh-2 2-3 N=4	30			28	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		592	
16A	20/24 83%	ss	woh-1 3-4 N=4	25			30			590	
16B				22				Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.			
17A				24			32			588	
17B	12/24 50%	ss	2-3 4-4 N=7	16				Greenish gray (5GY6/1), moist, soft, sandy CLAY with slight trace gravel.			
								Medium light gray (N6/1), moist, soft, sandy CLAY with slight trace gravel.		586	
18A	11/24 46%	ss	1-3 5-4 N=8	16			34	Medium light gray (N6/1), wet, soft, silty, very fine- to medium-grained SAND.			
								Greenish gray (10Y6/1), very moist, soft, clayey SILT with slight trace sand and gravel.		584	
19A	17/24 71%	ss	2-5 6-7 N=11	14			36	Gray (N6/1), very moist, soft, sandy CLAY with slight trace gravel.			
20A				11			38			582	
								Gray (N5/1), slightly moist, firm, clayey SILT with slight trace sand and gravel.			
20B	19/24 79%	ss	3-8 11-7 N=19	19			▼	Gray (N5/1), moist, firm, SILT.		580	
							40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	18/24 75%	ss	5-8 10-19 N=18	36				Gray (N5/1), moist, firm, SILT. *[Continued from previous page]*			
21B				16							
							▼ 42	Gray (N5/1), wet, dense, silty very fine- to medium-grained SAND.		578	
22A				11							
22B	18/24 75%	ss	6-13 21-15 N=34	10							
							44	Gray (N5/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	
23A	20/24 83%	ss	6-9 13-12 N=22	12							
										574	

End of Boring = 45.96 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G56a~~
Well ID: G56L
Surface Elev: 619.91 ft. MSL
Completion: 22.89 ft. BGS
Station: 14,708.56N
979.20E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand and gravel.		618	
							4			616	
							6	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		614	
							8			612	
							10			610	
							12	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		608	
							14			606	
							16	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		604	
							18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	

NOTE(S): See G56S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G56a
Well ID: G56L
Surface Elev: 619.91 ft. MSL
Completion: 22.89 ft. BGS
Station: 14,708.56N
979.20E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) *% Recovery*	SAMPLE Type	TESTING *Blows / 6 in* N - Value **RQD**	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. Dark grayish brown (10YR4/2), moist, soft, clayey SILT.		598	

End of Boring = 22.89 ft bgs

NOTE(S): See G56S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G56~~
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-3 4-6 N=7	20			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	6-6 6-7 N=12	16			4			616	
3A	20/24 83%	ss	1-4 7-7 N=11	15			6			614	
4A	22/24 92%	ss	9-10 11-13 N=21	19			8	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		612	
5A	20/24 83%	ss	1-4 6-8 N=10	19			10			610	
6A	22/24 92%	ss	2-4 8-8 N=12	27			12	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		608	
7A	24/24 100%	ss	9-15 13-13 N=28	26			14	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
8A	16/24 67%	ss	1-1 2-3 N=3	30			16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		604	
9A	22/24 92%	ss	3-3 5-6 N=8	23			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	19/24 79%	ss	1-3 3-2 N=6	24				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
	22/24		1-3				20	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G56
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	92%	ss	5-6 N=8	24			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		598	
12A	16/24 67%	ss	4-4 5-5 N=9	24			24	Dark grayish brown (10YR4/2), moist, soft, clayey SILT.		596	
13A	20/24 83%	ss	woh-2 2-3 N=4	23			26	Grayish brown (10YR5/2) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		594	
14A	18/24 75%	ss	woh-2 3-4 N=5	23			28	Dark greenish gray (5GY4/1), moist, soft, sandy CLAY with slight trace gravel.		592	
15A	19/24 79%	ss	woh-1 2-3 N=3	20			30	Greenish gray (5GY5/1), moist, soft, sandy CLAY with slight trace gravel.		590	
16A	18/24 75%	ss	woh-1 2-2 N=3	15			32	Gray (10YR5/1), wet, medium dense, silty fine- to coarse-grained SAND with slight trace gravel.		588	
17A	16/24 67%	ss	4-4 6-8 N=10	15			34	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		586	
18A	13/24 54%	ss	0-3 5-6 N=8	17			36	Greenish gray (10Y6/1), wet, medium dense, SILT with trace clay.		584	
19A	20/24 83%	ss	2-4 7-5 N=11	24			38	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
20A	19/24 79%	ss	woh-4 7-7 N=11	11			40	Gray (10YR5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		580	

End of Boring = 40.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G56~~
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-3 4-6 N=7	20			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	6-6 6-7 N=12	16			4			616	
3A	20/24 83%	ss	1-4 7-7 N=11	15			6			614	
4A	22/24 92%	ss	9-10 11-13 N=21	19			8	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		612	
5A	20/24 83%	ss	1-4 6-8 N=10	19			10			610	
6A	22/24 92%	ss	2-4 8-8 N=12	27			12	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		608	
7A	24/24 100%	ss	9-15 13-13 N=28	26			14	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
8A	16/24 67%	ss	1-1 2-3 N=3	30			16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		604	
9A	22/24 92%	ss	3-3 5-6 N=8	23			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	19/24 79%	ss	1-3 3-2 N=6	24				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
	22/24		1-3				20	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G56
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	92%	ss	5-6 N=8	24			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		598	
12A	16/24 67%	ss	4-4 5-5 N=9	24			24	Dark grayish brown (10YR4/2), moist, soft, clayey SILT.		596	
13A	20/24 83%	ss	woh-2 2-3 N=4	23			26	Grayish brown (10YR5/2) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		594	
14A	18/24 75%	ss	woh-2 3-4 N=5	23			28	Dark greenish gray (5GY4/1), moist, soft, sandy CLAY with slight trace gravel.		592	
15A	19/24 79%	ss	woh-1 2-3 N=3	20			30	Greenish gray (5GY5/1), moist, soft, sandy CLAY with slight trace gravel.		590	
16A	18/24 75%	ss	woh-1 2-2 N=3	15			32	Gray (10YR5/1), wet, medium dense, silty fine- to coarse-grained SAND with slight trace gravel.		588	
17A	16/24 67%	ss	4-4 6-8 N=10	15			34	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		586	
18A	13/24 54%	ss	0-3 5-6 N=8	17			36	Greenish gray (10Y6/1), wet, medium dense, SILT with trace clay.		584	
19A	20/24 83%	ss	2-4 7-5 N=11	24			38	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
20A	19/24 79%	ss	woh-4 7-7 N=11	11			40	Gray (10YR5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		580	

End of Boring = 40.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G57a~~
Well ID: G57L
Surface Elev: 619.98 ft. MSL
Completion: 26.00 ft. BGS
Station: 15,064.65N
987.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0			620	
							2	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, slightly moist, firm, clayey SILT.		618	
							4			616	
							6	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, moist, firm, clayey SILT with slight trace gravel, slight trace iron staining (10YR5/6) visible.		614	
							8			612	
							10	FILL - Dark yellowish brown (10YR4/6), moist, firm, silty CLAY.		610	
							12	Dark gray (10YR4/1), moist, firm, silty CLAY with trace gravel.		608	
							14	Dark grayish brown (10YR4/2) with gray (10YR5/1) mottles, moist, firm, clayey SILT with trace gravel.		606	
							16	Dark yellowish brown (10YR3/6), moist, firm, silty CLAY.		604	
							18	Light yellowish brown (10YR6/4), slightly moist, firm, clayey SILT, with trace iron staining (10YR4/6) visible.		602	
							20	Dark grayish brown (10YR4/2), moist, firm, clayey SILT.		600	

NOTE(S): See G57S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G57a
Well ID: G57L
Surface Elev: 619.98 ft. MSL
Completion: 26.00 ft. BGS
Station: 15,064.65N
987.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark grayish brown (10YR4/2), moist, firm, clayey SILT. *[Continued from previous page]*			
							22	Grayish brown (10YR5/2), moist, firm, clayey SILT, with trace iron staining (10YR5/6) visible.		598	
							24	Dark brown (10YR3/3), moist, firm, silty CLAY.		596	
							26	Dark yellowish brown (10YR3/6) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		594	

End of Boring = 26.00 ft bgs

NOTE(S): See G57S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G57~~
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-8 5-3 N=13	25			0			620	
2A	20/24 83%	ss	3-3 5-4 N=8	19			2	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, slightly moist, firm, clayey SILT.		618	
3A	24/24 100%	ss	3-3 4-5 N=7	17			4			616	
4A	24/24 100%	ss	8-5 5-8 N=10	20			6	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, moist, firm, clayey SILT with slight trace gravel, slight trace iron staining (10YR5/6) visible.		614	
5A	22/24 92%	ss	1-3 3-3 N=6	22			8			612	
6A	16/24 67%	ss	3-3 7-6 N=10	17			10	FILL - Dark yellowish brown (10YR4/6), moist, firm, silty CLAY.		610	
7A	24/24 100%	ss	5-6 7-6 N=13	22			12	Dark gray (10YR4/1), moist, firm, silty CLAY with trace gravel.		608	
7B				20			14	Dark grayish brown (10YR4/2) with gray (10YR5/1) mottles, moist, firm, clayey SILT with trace gravel.		606	
8A	22/24 92%	ss	5-5 7-5 N=12	22			16	Dark yellowish brown (10YR3/6), moist, firm, silty CLAY.		604	
9A	24/24 100%	ss	9-10 8-6 N=18	24			18	Light yellowish brown (10YR6/4), slightly moist, firm, clayey SILT, with trace iron staining (10YR4/6) visible.		602	
10A	24/24 100%	ss	1-2 4-4 N=6	27			20	Dark grayish brown (10YR4/2), moist, firm, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G57
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark grayish brown (10YR4/2), moist, firm, clayey SILT. *[Continued from previous page]*			
11A	24/24 *100%*	ss	*1-3* *5-3* N=8	25							
							22	Grayish brown (10YR5/2), moist, firm, clayey SILT, with trace iron staining (10YR5/6) visible.		598	
12A	24/24 *100%*	ss	*1-3* *5-4* N=8	25							
							24	Dark brown (10YR3/3), moist, firm, silty CLAY.		596	
13A	23/24 *96%*	ss	*0-2* *2-3* N=4	26							
							26	Dark yellowish brown (10YR3/6) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		594	
14A	24/24 *100%*	ss	*2-3* *3-6* N=6	26							
							28			592	
15A	24/24 *100%*	ss	*1-2* *3-5* N=5	23				Dark yellowish brown (10YR4/4) with 20% dark yellowish brown (10YR4/2) mottles, moist, firm, silty CLAY with slight trace sand and gravel.			
16A				14			30			590	
	24/24 *100%*	ss	*1-2* *5-3* N=7					Greenish gray (5G6/1), moist, soft, clayey SILT with trace sand and slight trace gravel.			
16B				18				Greenish brown (10YR5/2), wet, soft, sandy CLAY.			
17A				16			32			588	
	23/24 *96%*	ss	*6-8* *10-4* N=18					Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.			
17B				14				Gray (10YR5/1), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.			
18A	22/24 *92%*	ss	*1-3* *5-8* N=8	11			34			586	
							36	Gray (N5/1), wet, firm, clayey SILT with slight trace sand and gravel.		584	
19A	18/24 *75%*	ss	*5-13* *17-15* N=30	11							
							38			582	

End of Boring = 38.00 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G57~~
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-8 5-3 N=13	25			0			620	
2A	20/24 83%	ss	3-3 5-4 N=8	19			2	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, slightly moist, firm, clayey SILT.		618	
3A	24/24 100%	ss	3-3 4-5 N=7	17			4			616	
4A	24/24 100%	ss	8-5 5-8 N=10	20			6	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, moist, firm, clayey SILT with slight trace gravel, slight trace iron staining (10YR5/6) visible.		614	
5A	22/24 92%	ss	1-3 3-3 N=6	22			8			612	
6A	16/24 67%	ss	3-3 7-6 N=10	17			10	FILL - Dark yellowish brown (10YR4/6), moist, firm, silty CLAY.		610	
7A	24/24 100%	ss	5-6 7-6 N=13	22			12	Dark gray (10YR4/1), moist, firm, silty CLAY with trace gravel.		608	
7B				20			14	Dark grayish brown (10YR4/2) with gray (10YR5/1) mottles, moist, firm, clayey SILT with trace gravel.		606	
8A	22/24 92%	ss	5-5 7-5 N=12	22			16	Dark yellowish brown (10YR3/6), moist, firm, silty CLAY.		604	
9A	24/24 100%	ss	9-10 8-6 N=18	24			18	Light yellowish brown (10YR6/4), slightly moist, firm, clayey SILT, with trace iron staining (10YR4/6) visible.		602	
10A	24/24 100%	ss	1-2 4-4 N=6	27			20	Dark grayish brown (10YR4/2), moist, firm, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G57
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark grayish brown (10YR4/2), moist, firm, clayey SILT. *[Continued from previous page]*			
11A	24/24 100%	ss	1-3 5-3 N=8	25							
							22	Grayish brown (10YR5/2), moist, firm, clayey SILT, with trace iron staining (10YR5/6) visible.		598	
12A	24/24 100%	ss	1-3 5-4 N=8	25							
							24	Dark brown (10YR3/3), moist, firm, silty CLAY.		596	
13A	23/24 96%	ss	0-2 2-3 N=4	26							
							26	Dark yellowish brown (10YR3/6) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		594	
14A	24/24 100%	ss	2-3 3-6 N=6	26							
							28			592	
15A	24/24 100%	ss	1-2 3-5 N=5	23				Dark yellowish brown (10YR4/4) with 20% dark yellowish brown (10YR4/2) mottles, moist, firm, silty CLAY with slight trace sand and gravel.			
16A				14			30			590	
	24/24 100%	ss	1-2 5-3 N=7					Greenish gray (5G6/1), moist, soft, clayey SILT with trace sand and slight trace gravel.			
16B				18				Greenish brown (10YR5/2), wet, soft, sandy CLAY.			
17A				16			32			588	
	23/24 96%	ss	6-8 10-4 N=18					Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.			
17B				14				Gray (10YR5/1), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.			
18A	22/24 92%	ss	1-3 5-8 N=8	11			34			586	
							36	Gray (N5/1), wet, firm, clayey SILT with slight trace sand and gravel.		584	
19A	18/24 75%	ss	5-13 17-15 N=30	11							
							38			582	

End of Boring = 38.00 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G58a~~
Well ID: G58L
Surface Elev: 620.04 ft. MSL
Completion: 30.56 ft. BGS
Station: 15,204.30N
989.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		620	
							2			618	
							4	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand.		616	
							6	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		614	
							8	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		612	
							10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, soft, clayey SILT.		610	
							12			608	
							14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
							16			604	
							18			602	
							20				

NOTE(S): See G58S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G58a
Well ID: G58L
Surface Elev: 620.04 ft. MSL
Completion: 30.56 ft. BGS
Station: 15,204.30N
989.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Gray (10YR6/1) with 35% dark gray (10YR4/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
							24	Dark gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		596	
							26	Dark gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		594	
							28	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
							30	Greenish gray (5GY5/1) with 5% yellowish brown (10YR5/6) mottles, moist, soft, sandy CLAY with trace gravel.		590	

End of Boring = 30.56 ft bgs

NOTE(S): See G58S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G58~~
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-11 7-5 N=18	23			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		620	
2A	24/24 100%	ss	7-8 10-12 N=18	23			2			618	
3A	24/24 100%	ss	4-4 6-9 N=10	20			4	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand.		616	
4A	23/24 96%	ss	8-12 14-19 N=26	19			6	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		614	
5A	24/24 100%	ss	2-3 7-7 N=10	20			8	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		612	
6A	20/24 83%	ss	2-3 5-8 N=8	22			10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, soft, clayey SILT.		610	
7A	24/24 100%	ss	7-7 7-6 N=14	25			12			608	
8A	17/24 71%	ss	1-3 5-7 N=8	23			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
9A	19/24 79%	ss	3-3 5-5 N=8	24			16			604	
10A	22/24 92%	ss	1-3 3-4 N=6	33			18			602	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G58
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	17/24 71%	ss	2-2 5-5 N=7	24			22	Gray (10YR6/1) with 35% dark gray (10YR4/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
12A	24/24 100%	ss	5-5 6-8 N=11	22			24	Dark gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		596	
13A				20							
13B	24/24 100%	ss	2-3 5-5 N=8	26			26	Dark gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-9 6-7 N=15	30			28	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	23/24 96%	ss	woh-2 3-4 N=5	21			30	Greenish gray (5GY5/1) with 5% yellowish brown (10YR5/6) mottles, moist, soft, sandy CLAY with trace gravel.		590	
16A	24/24 100%	ss	6-8 11-7 N=19	18				Greenish gray (5GY5/1), very moist, dense, silty, fine-to coarse-grained SAND with trace gravel.			
16B				16				Gray (10YR6/1), wet, firm, SILT.			
16C				20			32	Greenish gray (5GY5/1), moist, firm, clayey SILT with sand and trace gravel.		588	
17A	20/24 83%	ss	3-6 10-3 N=16	13				Gray (N5/1), wet, medium dense, silty very fine- to coarse-grained SAND with trace gravel.			
18A				17				Greenish gray (5GY5/1), moist, firm, sandy CLAY with trace gravel.			
18B	23/24 96%	ss	3-6 8-12 N=14	14			▼ 34	Gray (N5/1), wet, medium dense, silty fine- to coarse-grained SAND with trace gravel.		586	
18C				14				Greenish gray (5GY5/1), very moist, firm, sandy CLAY with trace gravel.			
							36	Dark gray (N4/1), slightly moist, hard, clayey SILT with sand and slight trace gravel.		584	

End of Boring = 36.43 ft bgs

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G58~~
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-11 7-5 N=18	23			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		620	
2A	24/24 100%	ss	7-8 10-12 N=18	23			2			618	
3A	24/24 100%	ss	4-4 6-9 N=10	20			4	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand.		616	
4A	23/24 96%	ss	8-12 14-19 N=26	19			6	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		614	
5A	24/24 100%	ss	2-3 7-7 N=10	20			8	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		612	
6A	20/24 83%	ss	2-3 5-8 N=8	22			10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, soft, clayey SILT.		610	
7A	24/24 100%	ss	7-7 7-6 N=14	25			12			608	
8A	17/24 71%	ss	1-3 5-7 N=8	23			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
9A	19/24 79%	ss	3-3 5-5 N=8	24			16			604	
10A	22/24 92%	ss	1-3 3-4 N=6	33			18			602	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G58
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	17/24 71%	ss	2-2 5-5 N=7	24				Gray (10YR6/1) with 35% dark gray (10YR4/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							22			598	
12A	24/24 100%	ss	5-5 6-8 N=11	22				Dark gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
13A				20			24			596	
13B	24/24 100%	ss	2-3 5-5 N=8	26				Dark gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
14A	24/24 100%	ss	5-9 6-7 N=15	30			26			594	
15A	23/24 96%	ss	woh-2 3-4 N=5	21			28	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
16A	24/24 100%	ss	6-8 11-7 N=19	18			30	Greenish gray (5GY5/1) with 5% yellowish brown (10YR5/6) mottles, moist, soft, sandy CLAY with trace gravel.		590	
16B				16				Greenish gray (5GY5/1), very moist, dense, silty, fine-to coarse-grained SAND with trace gravel.			
16C				20			32	Gray (10YR6/1), wet, firm, SILT.		588	
17A	20/24 83%	ss	3-6 10-3 N=16	13				Greenish gray (5GY5/1), moist, firm, clayey SILT with sand and trace gravel.			
								Gray (N5/1), wet, medium dense, silty very fine- to coarse-grained SAND with trace gravel.			
								Greenish gray (5GY5/1), moist, firm, sandy CLAY with trace gravel.			
18A				17			▼ 34			586	
18B	23/24 96%	ss	3-6 8-12 N=14	14				Gray (N5/1), wet, medium dense, silty fine- to coarse-grained SAND with trace gravel.			
								Greenish gray (5GY5/1), very moist, firm, sandy CLAY with trace gravel.			
18C				14			36	Dark gray (N4/1), slightly moist, hard, clayey SILT with sand and slight trace gravel.		584	

End of Boring = 36.43 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G59a~~
Well ID: G59L
Surface Elev: 620.15 ft. MSL
Completion: 33.03 ft. BGS
Station: 15,343.87N
992.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Dark yellowish brown (10YR4/6) with 30% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
							4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel		616	
							8	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, silty CLAY, trace roots.		612	
							12	FILL - Dark grayish brown (10YR4/2), slightly moist, firm, clayey SILT with slight trace sand.		608	
							14	Very dark grayish brown (10YR3/2), slightly moist, firm, clayey SILT, trace roots.		606	
							16	Dark grayish brown (10YR4/2), moist, firm, silty CLAY, slight trace roots.		604	
							18	Dark grayish brown (10YR4/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY, slight trace roots.		602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S): See G59S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

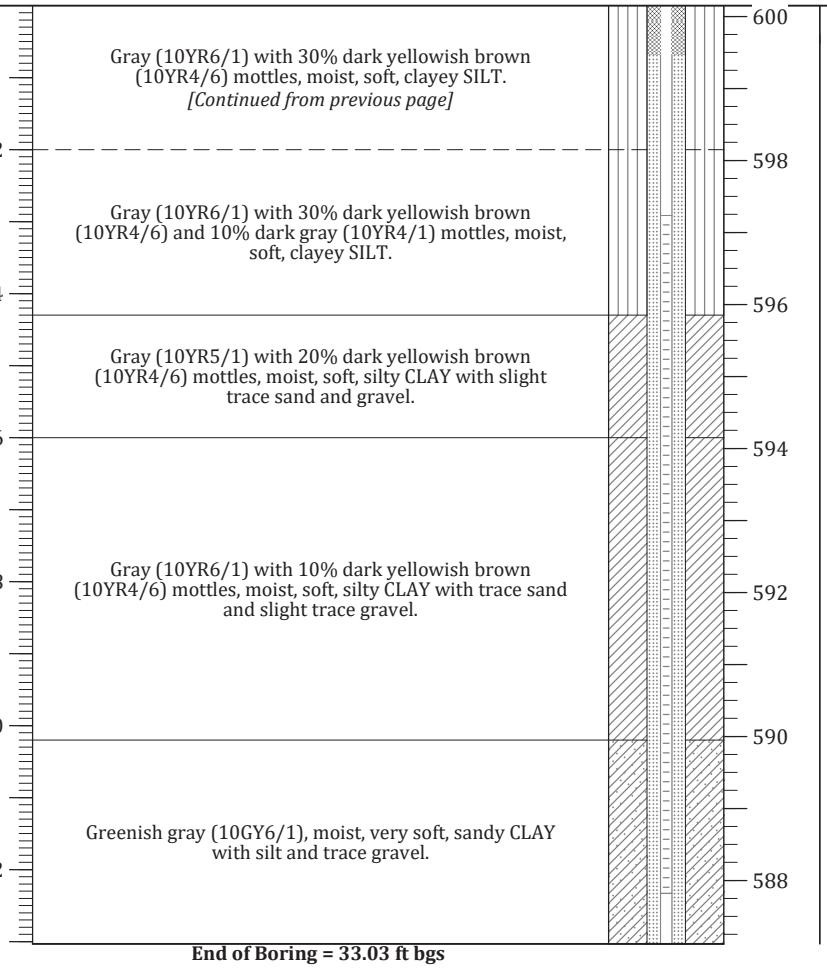
CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G59a
Well ID: G59L
Surface Elev: 620.15 ft. MSL
Completion: 33.03 ft. BGS
Station: 15,343.87N
992.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks



End of Boring = 33.03 ft bgs

NOTE(S): See G59S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-15 20-19 N=35	17			0	FILL - Dark yellowish brown (10YR4/6) with 30% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
2A	24/24 100%	ss	26-10 15-17 N=25	19			2			618	
3A	24/24 100%	ss	6-6 10-6 N=16	19			4			616	
4A	24/24 100%	ss	10-10 9-7 N=19	23			6	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel		614	
5A	23/24 96%	ss	3-5 5-5 N=10	20			8			612	
6A	20/24 83%	ss	2-3 5-8 N=8	20			10	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, silty CLAY, trace roots.		610	
7A	24/24 100%	ss	10-14 12-11 N=26	17			12	FILL - Dark grayish brown (10YR4/2), slightly moist, firm, clayey SILT with slight trace sand.		608	
7B				30			14	Very dark grayish brown (10YR3/2), slightly moist, firm, clayey SILT, trace roots.		606	
8A	20/24 83%	ss	3-4 8-9 N=12	22				Dark grayish brown (10YR4/2), moist, firm, silty CLAY, slight trace roots.			
9A	24/24 100%	ss	8-11 11-11 N=22	25			16			604	
10A	20/24 83%	ss	1-2 4-5 N=6	25			18	Dark grayish brown (10YR4/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY, slight trace roots.		602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	woh-2 2-4 N=4	29				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		600	
							22			598	
12A	16/24 67%	ss	4-7 5-6 N=12	31				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) and 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.			
							24			596	
13A	22/24 92%	ss	1-2 3-4 N=5	24				Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.			
							26			594	
14A	17/24 71%	ss	4-7 7-6 N=14	23				Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							28			592	
15A	16/24 67%	ss	1-2 4-6 N=6	21							
							30			590	
16A	16/24 67%	ss	woh-2 2-2 N=4	17							
							32	Greenish gray (10GY6/1), moist, very soft, sandy CLAY with silt and trace gravel.		588	
17A	16/24 67%	ss	2-3 2-3 N=5	20							
							34			586	
18A	21/24 88%	ss	1-3 4-6 N=7	15							
							36	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
19A	24/24 100%	ss	6-9 11-9 N=20	15							
							38			582	
20A	24/24 100%	ss	15-22 24-17 N=46	12			▼				
20B				16			40	Gray (N5/1), wet, dense, silty, very fine- to coarse-grained SAND.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE			TESTING				Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type					
21A 21B	24/24 *100%*	ss	*2-2* *4-5* N=6	16 30			42	Gray (10YR5/1) with 5% dark gray (10YR4/1), moist, soft, clayey SILT.		580 578	

End of Boring = 42.49 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-15 20-19 N=35	17			0	FILL - Dark yellowish brown (10YR4/6) with 30% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
2A	24/24 100%	ss	26-10 15-17 N=25	19			2			618	
3A	24/24 100%	ss	6-6 10-6 N=16	19			4			616	
4A	24/24 100%	ss	10-10 9-7 N=19	23			6	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel		614	
5A	23/24 96%	ss	3-5 5-5 N=10	20			8			612	
6A	20/24 83%	ss	2-3 5-8 N=8	20			10	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, silty CLAY, trace roots.		610	
7A	24/24 100%	ss	10-14 12-11 N=26	17			12	FILL - Dark grayish brown (10YR4/2), slightly moist, firm, clayey SILT with slight trace sand.		608	
7B				30			14	Very dark grayish brown (10YR3/2), slightly moist, firm, clayey SILT, trace roots.		606	
8A	20/24 83%	ss	3-4 8-9 N=12	22				Dark grayish brown (10YR4/2), moist, firm, silty CLAY, slight trace roots.			
9A	24/24 100%	ss	8-11 11-11 N=22	25			16			604	
10A	20/24 83%	ss	1-2 4-5 N=6	25			18	Dark grayish brown (10YR4/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY, slight trace roots.		602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	woh-2 2-4 N=4	29				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		600	
							22			598	
12A	16/24 67%	ss	4-7 5-6 N=12	31				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) and 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.			
							24			596	
13A	22/24 92%	ss	1-2 3-4 N=5	24				Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.			
							26			594	
14A	17/24 71%	ss	4-7 7-6 N=14	23				Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							28			592	
15A	16/24 67%	ss	1-2 4-6 N=6	21							
							30			590	
16A	16/24 67%	ss	woh-2 2-2 N=4	17							
							32	Greenish gray (10GY6/1), moist, very soft, sandy CLAY with silt and trace gravel.		588	
17A	16/24 67%	ss	2-3 2-3 N=5	20							
							34			586	
18A	21/24 88%	ss	1-3 4-6 N=7	15							
							36	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
19A	24/24 100%	ss	6-9 11-9 N=20	15							
							38			582	
20A	24/24 100%	ss	15-22 24-17 N=46	12			▼				
20B				16			40	Gray (N5/1), wet, dense, silty, very fine- to coarse-grained SAND.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE			TESTING				Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type					
21A 21B	24/24 *100%*	ss	*2-2* *4-5* N=6	16 30			42	Gray (10YR5/1) with 5% dark gray (10YR4/1), moist, soft, clayey SILT.		580 578	

End of Boring = 42.49 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/17/2008
Finish: 1/17/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG60
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG60b~~
Well ID: G60L
Surface Elev: 612.5 ft. MSL
Completion: 25.3 ft. BGS
Station: 15,474.74N
1,049.75E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ = 21.02 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellow brown (10YR3/4), slightly moist, silty CLAY, trace sand		612	
							1	Light gray (10YR7/2) with 40% brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand			
							2	Brown yellow (10YR6/8) with 40% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand		610	
							4	Yellow brown (10YR5/8), moist, clayey SILT, trace sand		608	
							6	Light yellow brown (10YR6/4) with 30% brown yellow (10YR6/8) mottles, moist, clayey SILT, trace sand		606	
							8	Yellow brown (10YR5/8) with 20% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		604	
							10	Light brown gray (10YR6/2) with 10% brown yellow (10YR6/8) mottles, very moist, clayey SILT, trace sand		602	
							12	Gray brown (10YR5/2) with 30% very dark gray brown (10YR3/2) mottles, moist, clayey SILT, trace sand		600	
							14	Dark gray (10YR4/1), moist, clayey SILT, trace sand		598	
							16	Dark gray (10YR4/1) with 10% very dark gray (10YR3/1) mottles, moist, clayey SILT, trace sand		596	
							17	Black (10YR2/1), moist, very silty CLAY, trace sand			
							18	Dark gray (10YR4/1), moist, silty CLAY, trace sand		594	
							18.5	Dark green gray (10Y4/1) with 5% very dark gray (10YR3/1) mottles, moist, silty CLAY, trace sand, trace organics			
							20	Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
CONTRACTOR: Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility
Rig mfg/model: CME-650 Track Rig
Location: Canton, Fulton Co., Illinois
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG60
Project: 03S5010
DATES: **Start:** 1/17/2008
Finish: 1/17/2008
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager
WEATHER: Overcast, windy, cold

BOREHOLE ID: BG60b
Well ID: G60L
Surface Elev: 612.5 ft. MSL
Completion: 25.3 ft. BGS
Station: 15,474.74N
1,049.75E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ = 21.02 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL
								Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel *[Continued from previous page]*	592
							22	Green gray (5GY5/1), very moist, silty CLAY, trace sand and gravel	590
							24	Green gray (5GY5/1) with 5% yellow brown (10YR5/4) mottles, wet, very silty CLAY, trace sand and gravel	588

End of Boring = 25.28 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG60~~
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellow brown (10YR3/4), slightly moist, silty CLAY, trace sand		612	
1A	19/24 79%	ss	4-6 6-7 N=12	24							
								Light gray (10YR7/2) with 40% brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand			
1B				19		4.27 Sh	2			610	
	21/24 88%	ss	4-4 5-6 N=9					Brown yellow (10YR6/8) with 40% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand			
2A				23		0.92 Sh	4				
3A				23						608	
								Yellow brown (10YR5/8), moist, clayey SILT, trace sand			
	24/24 100%	ss	2-3 4-4 N=7								
3B				25		1.40 Sh	6	Light yellow brown (10YR6/4) with 30% brown yellow (10YR6/8) mottles, moist, clayey SILT, trace sand		606	
	21/24 88%	ss	3-4 6-5 N=10								
4A				24			8			604	
	22/24 92%	ss	2-2 3-4 N=5					Yellow brown (10YR5/8) with 20% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand			
5A				27		0.78 Sh	10			602	
	19/24 79%	ss	2-2 3-3 N=5					Light brown gray (10YR6/2) with 10% brown yellow (10YR6/8) mottles, very moist, clayey SILT, trace sand			
6A				23		2.13 Sh	12			600	
	21/24 88%	ss	2-2 2-3 N=4					Gray brown (10YR5/2) with 30% very dark gray brown (10YR3/2) mottles, moist, clayey SILT, trace sand			
7A				27		2.33 Sh	14			598	
								Dark gray (10YR4/1), moist, clayey SILT, trace sand			
8A	23/24 96%	ss	2-2 3-4 N=5	29		1.71 B					
								Dark gray (10YR4/1) with 10% very dark gray (10YR3/1) mottles, moist, clayey SILT, trace sand			
8B				33		1.82	16			596	
9A				25		1.63 B					
	24/24 100%	ss	2-3 3-5 N=6					Black (10YR2/1), moist, very silty CLAY, trace sand			
9B				23		1.67					
9C				22		1.67	18	Dark gray (10YR4/1), moist, silty CLAY, trace sand			
10A				27		0.97 B				594	
	23/24 96%	ss	1-3 3-4 N=6					Dark green gray (10Y4/1) with 5% very dark gray (10YR3/1) mottles, moist, silty CLAY, trace sand, trace organics			
								Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel			
10B				23		0.74	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: **Start:** 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG60
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
								Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel *[Continued from previous page]*	592	
	24/24 100%	ss	*1-2* *4-5* N=6							
11A				18		1.32	22			
12A				18		0.47 *B*		Green gray (5GY5/1), very moist, silty CLAY, trace sand and gravel	590	
	24/24 100%	ss	*4-4* *4-4* N=8							
12B				20		0.04	24			
13A				19		*B* 0.93 *B*		Green gray (5GY5/1) with 5% yellow brown (10YR5/4) mottles, wet, very silty CLAY, trace sand and gravel	588	
	23/24 96%	ss	*2-2* *2-4* N=4							
13B				18		1.44 *BSh*	26	Green gray (5GY6/1), very moist, clayey SILT, trace sand	586	
14A				17		0.50 *B*		Green gray (5GY6/1), moist, very silty CLAY, trace sand and gravel		
	24/24 100%	ss	*3-1* *7-8* N=8							
14B				16		5.43 *Sh*	28	Dark gray (10YR4/1), moist, silty CLAY, trace sand and gravel	584	
	24/24 100%	ss	*3-6* *8-12* N=14							
15A				12		4.46 *Sh*	30	Dark gray (N4/1), very moist, sandy SILT	582	
16A				17			▼			
	24/24 100%	ss	*5-6* *6-7* N=12					Dark gray (N4/1), wet, fine to coarse SAND, trace gravel		
16B				16						
16C				20			32	Dark gray (N4/1), wet, fine to medium SAND	580	
	24/24 100%	ss	*3-3* *6-9* N=9					Gray (10YR5/1), very moist, clayey SILT, trace sand		
17A				35		1.44 *Sh*	34		578	
	22/24 92%	ss	*3-6* *14-17* N=20					Dark gray (N4/1), moist, clayey SILT, trace sand and gravel		
18A				16		3.93 *Sh*	36		576	
19A				12		4.46 *Sh*				
	24/24 100%	ss	*11-13* *14-13* N=27					Very dark green gray (10Y3/1), moist, silty CLAY, trace sand and gravel		
19B				18		6.21 *Sh*	38			

End of Boring = 38.0 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG60~~
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type
1A	19/24 79%	ss	4-6 6-7 N=12	24		
1B				19		4.27 Sh
	21/24 88%	ss	4-4 5-6 N=9			
2A				23		0.92 Sh
3A				23		
	24/24 100%	ss	2-3 4-4 N=7			
3B				25		1.40 Sh
	21/24 88%	ss	3-4 6-5 N=10			
4A				24		
	22/24 92%	ss	2-2 3-4 N=5			
5A				27		0.78 Sh
	19/24 79%	ss	2-2 3-3 N=5			
6A				23		2.13 Sh
	21/24 88%	ss	2-2 2-3 N=4			
7A				27		2.33 Sh
8A	23/24 96%	ss	2-2 3-4 N=5	29		1.71 B
8B				33		1.82
9A				25		1.63 B
	24/24 100%	ss	2-3 3-5 N=6			
9B				23		1.67
9C				22		1.67
10A				27		0.97 B
	23/24 96%	ss	1-3 3-4 N=6			
10B				23		0.74

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	Dark yellow brown (10YR3/4), slightly moist, silty CLAY, trace sand		612	
2	Light gray (10YR7/2) with 40% brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand		610	
4	Brown yellow (10YR6/8) with 40% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand		608	
	Yellow brown (10YR5/8), moist, clayey SILT, trace sand			
6	Light yellow brown (10YR6/4) with 30% brown yellow (10YR6/8) mottles, moist, clayey SILT, trace sand		606	
8	Yellow brown (10YR5/8) with 20% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		604	
10	Light brown gray (10YR6/2) with 10% brown yellow (10YR6/8) mottles, very moist, clayey SILT, trace sand		602	
12	Gray brown (10YR5/2) with 30% very dark gray brown (10YR3/2) mottles, moist, clayey SILT, trace sand		600	
14	Dark gray (10YR4/1), moist, clayey SILT, trace sand		598	
16	Dark gray (10YR4/1) with 10% very dark gray (10YR3/1) mottles, moist, clayey SILT, trace sand		596	
	Black (10YR2/1), moist, very silty CLAY, trace sand			
18	Dark gray (10YR4/1), moist, silty CLAY, trace sand		594	
	Dark green gray (10Y4/1) with 5% very dark gray (10YR3/1) mottles, moist, silty CLAY, trace sand, trace organics			
20	Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG60
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	1-2 4-5 N=6					Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		592	
11A				18		1.32	22				
12A				18		0.47 B		Green gray (5GY5/1), very moist, silty CLAY, trace sand and gravel		590	
	24/24 100%	ss	4-4 4-4 N=8								
12B				20		0.04	24				
13A				19		B		Green gray (5GY5/1) with 5% yellow brown (10YR5/4) mottles, wet, very silty CLAY, trace sand and gravel		588	
	23/24 96%	ss	2-2 2-4 N=4			0.93 B					
13B				18		1.44 BSh	26	Green gray (5GY6/1), very moist, clayey SILT, trace sand		586	
14A	24/24 100%	ss	3-1 7-8 N=8	17		0.50 B		Green gray (5GY6/1), moist, very silty CLAY, trace sand and gravel			
14B				16		5.43 Sh					
	24/24 100%	ss	3-6 8-12 N=14				28	Dark gray (10YR4/1), moist, silty CLAY, trace sand and gravel		584	
15A				12		4.46 Sh	30	Dark gray (N4/1), very moist, sandy SILT		582	
16A	24/24 100%	ss	5-6 6-7 N=12	17			▼	Dark gray (N4/1), wet, fine to coarse SAND, trace gravel			
16B				16							
16C				20			32	Dark gray (N4/1), wet, fine to medium SAND		580	
	24/24 100%	ss	3-3 6-9 N=9					Gray (10YR5/1), very moist, clayey SILT, trace sand			
17A				35		1.44 Sh	34			578	
	22/24 92%	ss	3-6 14-17 N=20					Dark gray (N4/1), moist, clayey SILT, trace sand and gravel			
18A				16		3.93 Sh	36			576	
19A	24/24 100%	ss	11-13 14-13 N=27	12		4.46 Sh		Very dark green gray (10Y3/1), moist, silty CLAY, trace sand and gravel			
19B				18		6.21 Sh	38	**End of Boring = 38.0 ft. BGS**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G61a~~
Well ID: G61L
Surface Elev: 620.00 ft. MSL
Completion: 19.90 ft. BGS
Station: 15,640.94N
994.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		618	
							4			616	
							6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		614	
							8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
								Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.			
							10			610	
							12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
							14			606	
							16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
								Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			
							18			602	
								Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							▼				
								Very dark gray (10YR3/1), slightly moist, friable, micaceous, clayey SILT.			
								End of Boring = 19.9 ft bgs			

NOTE(S): See G61S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G61~~
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	18-12 9-8 N=21				0	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		620	
2A	24/24 100%	ss	8-5 7-8 N=12	18			2			618	
3A	20/24 83%	ss	2-4 4-6 N=8	21			4	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		616	
4A	24/24 100%	ss	7-9 10-11 N=19	20			6			614	
4B				21			8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
5A	19/24 79%	ss	2-3 6-7 N=9	26				Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.			
6A	20/24 83%	ss	2-3 4-4 N=7	24			10			610	
7A	24/24 100%	ss	4-4 5-6 N=9	24			12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
8A	22/24 92%	ss	3-4 5-5 N=9	25			14			606	
							16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
9A	24/24 100%	ss	3-3 4-6 N=7	24				Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			
10A	22/24 92%	ss	2-3 3-4 N=6	25			18			602	
								Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
10B				28			20 ▼	Very dark gray (10YR3/1), slightly moist, friable,		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								micaceous, clayey SILT.			
11A	19/24 79%	ss	3-4 5-6 N=9	36							
11B				26			22	Dark gray (10YR4/1), moist, soft, clayey SILT.		598	
12A	24/24 100%	ss	4-3 6-9 N=9	25							
13A	20/24 83%	ss	woh-3 4-6 N=7	24			24			596	
14A	24/24 100%	ss	3-3 5-6 N=8	22			26	Greenish gray (5GY5/1), moist, soft, silty CLAY with slight trace sand.		594	
15A	22/24 92%	ss	woh-3 3-4 N=6	22			28			592	
16A	19/24 79%	ss	woh-1 3-3 N=4	17			30	Greenish gray (5GY5/1), very moist, very soft, sandy CLAY with slight trace gravel.		590	
17A	24/24 100%	ss	3-4 5-5 N=9	19			32			588	
17B				14			34	Greenish gray (10Y5/1), slightly moist, soft, clayey SILT with trace sand and slight trace gravel.		586	
18A	19/24 79%	ss	1-7 7-7 N=14	21			36	Medium light gray (N6/1), wet, firm, SILT with slight trace sand and gravel.		584	
19A	24/24 100%	ss	7-11 19-32 N=30	12			38	Greenish gray (10Y5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	

End of Boring = 38.0 ft bgs

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G61~~
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	18-12 9-8 N=21				0			620	
								FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.			
2A	24/24 100%	ss	8-5 7-8 N=12	18			2			618	
							4			616	
3A	20/24 83%	ss	2-4 4-6 N=8	21				FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.			
	24/24 100%	ss	7-9 10-11 N=19				6			614	
4A				20							
4B				21			8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
5A	19/24 79%	ss	2-3 6-7 N=9	26				Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.			
							10			610	
6A	20/24 83%	ss	2-3 4-4 N=7	24							
							12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
7A	24/24 100%	ss	4-4 5-6 N=9	24							
							14			606	
8A	22/24 92%	ss	3-4 5-5 N=9	25							
							16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
9A	24/24 100%	ss	3-3 4-6 N=7	24				Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			
							18			602	
10A	22/24 92%	ss	2-3 3-4 N=6	25				Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							▼				
10B				28			20	Very dark gray (10YR3/1), slightly moist, friable,		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								micaceous, clayey SILT.			
11A	19/24 79%	ss	3-4 5-6 N=9	36							
11B				26			22	Dark gray (10YR4/1), moist, soft, clayey SILT.		598	
12A	24/24 100%	ss	4-3 6-9 N=9	25							
13A	20/24 83%	ss	woh-3 4-6 N=7	24			24			596	
14A	24/24 100%	ss	3-3 5-6 N=8	22			26	Greenish gray (5GY5/1), moist, soft, silty CLAY with slight trace sand.		594	
15A	22/24 92%	ss	woh-3 3-4 N=6	22			28			592	
16A	19/24 79%	ss	woh-1 3-3 N=4	17			30	Greenish gray (5GY5/1), very moist, very soft, sandy CLAY with slight trace gravel.		590	
17A	24/24 100%	ss	3-4 5-5 N=9	19			32			588	
17B				14			34	Greenish gray (10Y5/1), slightly moist, soft, clayey SILT with trace sand and slight trace gravel.		586	
18A	19/24 79%	ss	1-7 7-7 N=14	21			36	Medium light gray (N6/1), wet, firm, SILT with slight trace sand and gravel.		584	
19A	24/24 100%	ss	7-11 19-32 N=30	12			38	Greenish gray (10Y5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	

End of Boring = 38.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/22/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G62~~
Well ID: G62L
Surface Elev: 620.02 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,785.21N
994.71E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	13-9 5-5 N=14	25.8			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		620	
2A	24/24 100%	SS	6-8 8-10 N=16	17.4			2			618	
3A	22/24 92%	SS	3-7 7-7 N=14	17.8			4	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		616	
4A	24/24 100%	SS	11-14 13-11 N=27	17.1			6			614	
5A	24/24 100%	SS	3-4 6-9 N=10	15.8			8	FILL - Yellowish brown (10YR5/4) with 5% medium dark gray (N4/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
6A	24/24 100%	SS	3-6 8-11 N=14	15.9			10			610	
7A	24/24 100%	SS	11-18 22-20 N=40	16.2			12	FILL - Yellowish brown (10YR5/4) with 5% medium dark gray (N4/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel and slight trace roots.		608	
8A	24/24 100%	SS	2-8 19-12 N=27	14.8			14	FILL - Yellowish brown (10YR5/4) with 5% medium dark gray (N4/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		606	
9A	24/24 100%	SS	12-13 18-15 N=31	23.1			16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		604	
10A	22/24 92%	SS	2-2 4-4 N=6	23.5			18			602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/22/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G62
Well ID: G62L
Surface Elev: 620.02 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,785.21N
994.71E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	22/24 92%	SS	1-2 4-4 N=6	20.6			22	Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
12A	24/24 100%	SS	2-3 3-4 N=6	23.5							
12B				21.8			24	Dark reddish gray (5YR4/2) with 5% dark reddish brown (5YR3/4) mottles, moist, soft, silty CLAY.		596	
13A	22/24 92%	SS	woh-2 3-3 N=5	20.9			26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	SS	4-5 5-8 N=10	20.3							
14B				22.0			28	Strong brown (7.5YR5/6), moist, hard, silty CLAY with trace sand and slight trace gravel.		592	
15A	24/24 100%	SS	1-2 3-3 N=5	18.7				Greenish gray (5GY5/1) with 10% dark yellowish brown (10YR4/6) and 5% olive gray (5Y4/2) mottles, moist, soft, silty CLAY with sand and trace gravel.			
16A	24/24 100%	SS	woh-1 2-4 N=3	18.2			30			590	
17A	17/24 71%	SS	4-3 5-7 N=8	19.4			32	Greenish gray (5GY5/1) with 5% olive gray (5Y4/2) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
18A	22/24 92%	SS	1-4 4-6 N=8	14.7			34			586	
19A	24/24 100%	SS	6-13 13-13 N=26	13.2			36	Dark gray (N4/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
							38	**End of Boring = 38.0 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G63a~~
Well ID: G63L
Surface Elev: 620.12 ft. MSL
Completion: 28.36 ft. BGS
Station: 15,928.37N
998.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		620	
							2			618	
							4			616	
							6			614	
							6	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.			
							8			612	
							8	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, soft, friable, clayey SILT with trace sand and slight trace gravel.			
							10			610	
							10	Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel, trace roots.			
							12			608	
							12	Gray (10YR5/1) with 10% yellowish brown (10YR5/4) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.			
							14			606	
							14	Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.			
							16			604	
							16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.			
							18			602	
							18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							20				

NOTE(S): See G63S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G63a
Well ID: G63L
Surface Elev: 620.12 ft. MSL
Completion: 28.36 ft. BGS
Station: 15,928.37N
998.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL	Remarks
							22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.	600	
							24	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.	598	
							26		596	
							28		594	
									592	

End of Boring = 28.36 ft bgs

NOTE(S): See G63S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G63~~
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	3-3 3-6 N=6	21			0	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		620	
2A	24/24 100%	ss	2-3 4-5 N=7	22			2			618	
3A	22/24 92%	ss	3-3 4-6 N=7	18			4			616	
4A	24/24 100%	ss	9-9 10-11 N=19	17			6	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		614	
5A	24/24 100%	ss	1-3 4-5 N=7	13			8	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, soft, friable, clayey SILT with trace sand and slight trace gravel.		612	
6A	23/24 96%	ss	1-3 3-6 N=6	15			10			610	
7A	24/24 100%	ss	8-9 12-12 N=21	15			12	Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		608	
8A	23/24 96%	ss	1-2 5-6 N=7	13			14	Gray (10YR5/1) with 10% yellowish brown (10YR5/4) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		606	
8B				18			16	Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		604	
9A	24/24 100%	ss	7-10 14-13 N=24	19							
9B				19			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		602	
10A	20/24 83%	ss	1-3 3-3 N=6	26				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
11A	22/24		1-4	21			20	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G63
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	92%	ss	4-3 N=8					Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							22	*[Continued from previous page]*		598	
12A	24/24 100%	ss	4-5 5-6 N=10	22							
							24			596	
13A	19/24 79%	ss	1-2 4-5 N=6	21							
							26	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 7-7 N=14	20							
							28			592	
15A	24/24 100%	ss	1-2 3-4 N=5	20							
							30			590	
16A	20/24 83%	ss	woh-1 2-3 N=3	22				Yellowish brown (10YR5/4) with 15% gray (10YR5/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							32			588	
17A	20/24 83%	ss	3-4 6-6 N=10	17							
17B				16				Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
							34			586	
18A	23/24 96%	ss	3-8 17-15 N=25	11				Dark gray (N4/1), slightly moist, hard, clayey SILT with trace sand and gravel.			
							36			584	
19A	23/24 96%	ss	10-18 25-9 N=43	11				Dark gray (N4/1), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.			
19B				26							
							38	Dark gray (N4/1), very moist, firm, SILT, trace organic material.		582	
20A	16/24 67%	ss	9-10 13-15 N=23	19				Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.			
							40	**End of Boring = 40.0 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G63~~
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	3-3 3-6 N=6	21			0			620	
2A	24/24 100%	ss	2-3 4-5 N=7	22			2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		618	
3A	22/24 92%	ss	3-3 4-6 N=7	18			4			616	
4A	24/24 100%	ss	9-9 10-11 N=19	17			6			614	
5A	24/24 100%	ss	1-3 4-5 N=7	13			8	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		612	
6A	23/24 96%	ss	1-3 3-6 N=6	15			10	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, soft, friable, clayey SILT with trace sand and slight trace gravel.		610	
7A	24/24 100%	ss	8-9 12-12 N=21	15			12	Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		608	
8A	23/24 96%	ss	1-2 5-6 N=7	13			14	Gray (10YR5/1) with 10% yellowish brown (10YR5/4) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		606	
8B				18			16	Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		604	
9A	24/24 100%	ss	7-10 14-13 N=24	19							
9B				19			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		602	
10A	20/24 83%	ss	1-3 3-3 N=6	26				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
11A	22/24		1-4	21			20	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G63
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	92%	ss	4-3 N=8					Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							22	*[Continued from previous page]*		598	
12A	24/24 100%	ss	4-5 5-6 N=10	22							
							24			596	
13A	19/24 79%	ss	1-2 4-5 N=6	21							
							26	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 7-7 N=14	20							
							28			592	
15A	24/24 100%	ss	1-2 3-4 N=5	20							
							30			590	
16A	20/24 83%	ss	woh-1 2-3 N=3	22				Yellowish brown (10YR5/4) with 15% gray (10YR5/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							32			588	
17A	20/24 83%	ss	3-4 6-6 N=10	17							
17B				16				Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
							34			586	
18A	23/24 96%	ss	3-8 17-15 N=25	11				Dark gray (N4/1), slightly moist, hard, clayey SILT with trace sand and gravel.			
							36			584	
19A	23/24 96%	ss	10-18 25-9 N=43	11				Dark gray (N4/1), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.			
19B				26							
							38	Dark gray (N4/1), very moist, firm, SILT, trace organic material.		582	
20A	16/24 67%	ss	9-10 13-15 N=23	19				Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.			
							40	**End of Boring = 40.0 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G64a~~
Well ID: G64L
Surface Elev: 620.02 ft. MSL
Completion: 27.95 ft. BGS
Station: 16,069.29N
995.70E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
							6	Gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		614	
							8	Yellowish brown (10YR5/4) with 10% gray (10YR6/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		612	
							12	Yellowish brown (10YR5/4) with 10% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		608	
							14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
							18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
							20	Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	

NOTE(S): See G64S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G64a
Well ID: G64L
Surface Elev: 620.02 ft. MSL
Completion: 27.95 ft. BGS
Station: 16,069.29N
995.70E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*			
							22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		598	
							24	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		596	
							26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with sand and slight trace gravel.		594	
								End of Boring = 27.95 ft bgs			

NOTE(S): See G64S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G64~~
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	24-14 10-6 N=24	24			2	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	4-6 8-9 N=14	17			4			616	
3A	23/24 96%	ss	5-7 5-7 N=12	15			6			614	
4A	22/24 92%	ss	7-8 10-13 N=18	13			8	Gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		612	
5A	24/24 100%	ss	3-5 7-7 N=12	19			10	Yellowish brown (10YR5/4) with 10% gray (10YR6/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
6A	22/24 92%	ss	3-3 5-8 N=8	24			12	Yellowish brown (10YR5/4) with 10% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		608	
7A 7B	22/24 92%	ss	8-8 6-7 N=14	25 25			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
8A	22/24 92%	ss	1-5 4-5 N=9	22			16			604	
9A	24/24 100%	ss	8-5 4-5 N=9	25			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	20/24 83%	ss	1-1 3-4 N=4	24			20	Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
11A	22/24		0-2	24							

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G64
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	92%	ss	4-4 N=6	25			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		598	
12A	24/24 100%	ss	5-6 6-6 N=12	21			24			596	
13A	22/24 92%	ss	1-1 4-7 N=5	23			26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 8-6 N=15	20			28	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with sand and slight trace gravel.		592	
15A	24/24 100%	ss	1-2 2-3 N=4	18			30	Greenish gray (10GY6/1) with 10% olive (5Y5/3) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		590	
16A	17/24 71%	ss	woh-2 4-6 N=6	17			32			588	
17A				17							
17B	24/24 100%	ss	6-8 12-13 N=20	13			34	Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		586	
18A	19/24 79%	ss	7-8 9-13 N=17	14							
19A				13			36			584	
19B	24/24 100%	ss	7-10 12-13 N=22	22				Gray (N5/1), wet, medium dense, silty, very fine- to fine-grained SAND.			
19C				33			38	Gray (N5/1), very moist, firm, clayey SILT.		582	
20A	20/24 83%	ss	3-6 10-14 N=16	14				Gray (N5/1), wet, dense, silty, fine- to coarse-grained SAND with slight trace gravel.			
								Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.			
							40	**End of Boring = 40.0 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G64~~
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	24-14 10-6 N=24	24			2	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	4-6 8-9 N=14	17			4			616	
3A	23/24 96%	ss	5-7 5-7 N=12	15			6			614	
4A	22/24 92%	ss	7-8 10-13 N=18	13			8	Gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		612	
5A	24/24 100%	ss	3-5 7-7 N=12	19			10	Yellowish brown (10YR5/4) with 10% gray (10YR6/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
6A	22/24 92%	ss	3-3 5-8 N=8	24			12	Yellowish brown (10YR5/4) with 10% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		608	
7A 7B	22/24 92%	ss	8-8 6-7 N=14	25 25			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
8A	22/24 92%	ss	1-5 4-5 N=9	22			16			604	
9A	24/24 100%	ss	8-5 4-5 N=9	25			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	20/24 83%	ss	1-1 3-4 N=4	24			20	Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
11A	22/24		0-2	24							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G64
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	92%	ss	4-4 N=6	25			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		598	
12A	24/24 100%	ss	5-6 6-6 N=12	21			24	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		596	
13A	22/24 92%	ss	1-1 4-7 N=5	23			26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 8-6 N=15	20			28	Greenish gray (10GY6/1) with 10% olive (5Y5/3) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	24/24 100%	ss	1-2 2-3 N=4	18			30	Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		590	
16A	17/24 71%	ss	woh-2 4-6 N=6	17			32	Gray (N5/1), wet, medium dense, silty, very fine- to fine-grained SAND.		588	
17A				17			34	Gray (N5/1), very moist, firm, clayey SILT.		586	
17B	24/24 100%	ss	6-8 12-13 N=20	13			36	Gray (N5/1), wet, dense, silty, fine- to coarse-grained SAND with slight trace gravel.		584	
18A	19/24 79%	ss	7-8 9-13 N=17	14			38	Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		582	
19A				13			40	**End of Boring = 40.0 ft bgs**			
19B	24/24 100%	ss	7-10 12-13 N=22	22							
19C				33							
20A	20/24 83%	ss	3-6 10-14 N=16	14							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger - blind drilled within 10 ft of BG65
Project: 03S5010
DATES: **Start:** 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG65b~~
Well ID: G65L
Surface Elev: 610.1 ft. MSL
Completion: 22.5 ft. BGS
Station: 13,986.12N
919.86E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 22.31 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
							1	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand			
							2	Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand		608	
							4	Brown yellow (10YR6/6), moist, clayey SILT, trace sand		606	
							6	Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT		604	
							8	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand		602	
							10	Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand		600	
							12	Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel		598	
							14	Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel		596	
							16			594	
							18			592	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger - blind drilled within 10 ft of BG65
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65b
Well ID: G65L
Surface Elev: 610.1 ft. MSL
Completion: 22.5 ft. BGS
Station: 13,986.12N
919.86E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 22.31 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
								Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
								Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND			
							▼ 22	Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel		588	
								Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
								End of Boring = 22.45 ft. BGS			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	4-4 6-6 N=10	23			0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
1B				22		2.72 BSh	2	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand		608	
	24/24 100%	ss	6-6 8-10 N=14					Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
2A				19		4.15 Sh	4			606	
	20/24 83%	ss	4-4 7-7 N=11					Brown yellow (10YR6/6), moist, clayey SILT, trace sand			
3A				17		2.62 Sh	6			604	
	22/24 92%	ss	4-8 6-8 N=14								
4A											
4B				11			8			602	
	17/24 71%	ss	3-5 6-8 N=11					Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT			
5A				9			10			600	
	24/24 100%	ss	3-5 7-6 N=12								
6A				11						598	
7A				13			12				
	24/24 100%	ss	6-9 9-10 N=18								
7B				17			14	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand		596	
	17/24 71%	ss	2-3 5-6 N=8								
8A				18			16			594	
9A	21/24 88%	ss	5-8 10-10 N=18	17				Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand			
9B				17			18			592	
10A				20				Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
10B	19/24 79%	ss	1-3 4-7 N=7	18				Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel			
10C				22		1.44	20			590	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N 909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A				21		*Sh* 1.16 *BSh*		Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
	20/24 *83%*	ss	*4-4* *3-3* N=7					Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
11B											
11C				16			22	Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND		588	
								Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel			
12A	19/24 *79%*	ss	*3-5* *4-43* N=9	26				Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
12B				26			24			586	
	24/24 *100%*	ss	*1-3* *5-10* N=8					Yellow brown (10YR5/6) with 50% light brown gray (10YR6/2) mottles, moist, very silty CLAY, trace sand and gravel			
13A				19			26			584	
								Gray (10YR6/1) with 5% yellow brown (10YR5/4) mottles, moist, clayey SILT, trace sand and gravel			
14A	20/24 *83%*	ss	*10-8* *7-6* N=15	19			▼	Gray (10YR6/1) with 25% yellow brown (10YR5/4) mottles, wet, sandy SILT, trace gravel			
14B				14							
14C				22		1.09	28	Gray brown (10YR5/2), very moist, clayey SILT, trace sand		582	
15A				25		*B*					
								Yellow brown (10YR5/8), very moist to wet, fine to coarse SAND, trace gravel			
15B	24/24 *100%*	ss	*7-12* *11-17* N=23	21				Dark yellow brown (10YR4/6) with 40% yellow brown (10YR5/6) mottles, wet, sandy SILT, trace gravel			
15C				13							
15D				11			30	Gray brown (10YR5/2) with 40% yellow brown (10YR5/6) mottles, moist, very silty CLAY, trace sand and gravel		580	
16A				13							
								Dark yellow brown (10YR4/6) with 15% pale brown (10YR6/3) mottles, moist, very silty CLAY, little sand, trace gravel			
	20/24 *83%*	ss	*2-10* *9-14* N=19								
16B				12		5.82 *BSh*		Green gray (10Y5/1), moist, silty CLAY, trace sand and gravel		578	
	24/24 *100%*	ss	*11-15* *16-20* N=31				32				
17A				12		6.40 *Bh*				576	
	24/24 *100%*	ss	*7-16* *24-35* N=40				34	Gray (N5/1) with 30% gray brown (10YR5/2) mottles, moist, silty CLAY, little sand and gravel			
18A				11		7.62 *Sh*				574	
	24/24 *100%*	ss	*43-72* *75-97* N=147				36				
19A				10						572	
19B				11			38	Gray (N5), wet, fine to medium SAND			
	22/24 *92%*	ss	*11-27* *25-25* N=52					Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
20A				13		5.24	40			570	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh		Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*			
	24/24 *100%*	ss	*4-14* *17-24* N=31								
21A				10		10.86 *BSh*					
21B				11		6.98 *Sh*	42	Very dark green (10Y3/1) with 25% gray brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand and gravel		568	
22A				24		2.33 *Sh*		Green (5GY) with 10% gray brown (10YR4/3) mottles, moist, silty CLAY, trace sand and gravel			
22B	24/24 *100%*	ss	*27-41* *77-109* N=118	18				Dark green gray (10GY4/1), moist, silty CLAY, trace sand			
22C				14				Green (10Y5/1), wet, fine to medium SAND		566	
22D				11			44	CHERT			

End of Boring = 44.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger - blind drilled within 5 ft of BG65
Project: 03S5010
DATES: **Start:** 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG65a~~
Well ID: G65S
Surface Elev: 609.9 ft. MSL
Completion: 32.7 ft. BGS
Station: 13,985.08N
914.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 25.28 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
							1	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand			
							2			608	
							3	Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
							4			606	
							5	Brown yellow (10YR6/6), moist, clayey SILT, trace sand			
							6			604	
							7	Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT			
							8			602	
							9				
							10			600	
							11				
							12			598	
							13	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand			
							14			596	
							15				
							16			594	
							17	Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand			
							18			592	
							19	Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
							20	Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel		590	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger - blind drilled within 5 ft of BG65
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65a
Well ID: G65S
Surface Elev: 609.9 ft. MSL
Completion: 32.7 ft. BGS
Station: 13,985.08N
914.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 25.28 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
								Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
								Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND			
							22	Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel		588	
								Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
							24	Yellow brown (10YR5/6) with 50% light brown gray (10YR6/2) mottles, moist, very silty CLAY, trace sand and gravel		586	
								▼			
							26	Gray (10YR6/1) with 5% yellow brown (10YR5/4) mottles, moist, clayey SILT, trace sand and gravel		584	
								▼ Gray (10YR6/1) with 25% yellow brown (10YR5/4) mottles, wet, sandy SILT, trace gravel			
							28	Gray brown (10YR5/2), very moist, clayey SILT, trace sand		582	
								Yellow brown (10YR5/8), very moist to wet, fine to coarse SAND, trace gravel			
								Dark yellow brown (10YR4/6) with 40% yellow brown (10YR5/6) mottles, wet, sandy SILT, trace gravel			
							30	Gray brown (10YR5/2) with 40% yellow brown (10YR5/6) mottles, moist, very silty CLAY, trace sand and gravel		580	
								Dark yellow brown (10YR4/6) with 15% pale brown (10YR6/3) mottles, moist, very silty CLAY, little sand, trace gravel			
								Green gray (10Y5/1), moist, silty CLAY, trace sand and gravel			
							32	Gray (N5/1) with 30% gray brown (10YR5/2) mottles, moist, silty CLAY, little sand and gravel		578	
								End of Boring = 32.70 ft. BGS			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/14/2008 **FIELD STAFF: Driller:** B. Williamson
Finish: 1/14/2008 **Helper:** R. Keedy
WEATHER: Overcast, windy, cold **Eng/Geo:** R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N 909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	4-4 6-6 N=10	23			0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
1B				22		2.72 BSh	2	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand		608	
	24/24 100%	ss	6-6 8-10 N=14					Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
2A				19		4.15 Sh	4			606	
	20/24 83%	ss	4-4 7-7 N=11					Brown yellow (10YR6/6), moist, clayey SILT, trace sand			
3A				17		2.62 Sh	6			604	
	22/24 92%	ss	4-8 6-8 N=14								
4A											
4B				11			8			602	
	17/24 71%	ss	3-5 6-8 N=11					Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT			
5A				9			10			600	
	24/24 100%	ss	3-5 7-6 N=12								
6A				11						598	
7A				13			12				
	24/24 100%	ss	6-9 9-10 N=18								
7B				17			14	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand		596	
	17/24 71%	ss	2-3 5-6 N=8								
8A				18			16			594	
9A	21/24 88%	ss	5-8 10-10 N=18	17				Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand			
9B				17			18			592	
10A				20				Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
10B	19/24 79%	ss	1-3 4-7 N=7	18				Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel			
10C				22		1.44	20			590	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
CONTRACTOR: Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility
Rig mfg/model: CME-650 Track Rig
BOREHOLE ID: BG65
Location: Canton, Fulton Co., Illinois
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
Well ID: hole abandoned
Project: 03S5010
Surface Elev: 609.7 ft. MSL
DATES: **Start:** 1/14/2008
FIELD STAFF: **Driller:** B. Williamson
Completion: 44.0 ft. BGS
Finish: 1/14/2008
Helper: R. Keedy
Station: 13,982.80N
WEATHER: Overcast, windy, cold
Eng/Geo: R. Hasenyager
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A				21		*Sh* 1.16		Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
	20/24 *83%*	ss	*4-4* *3-3* N=7			*BSh*		Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
11B											
11C				16			22	Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND		588	
								Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel			
12A	19/24 *79%*	ss	*3-5* *4-43* N=9	26				Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
12B				26			24			586	
	24/24 *100%*	ss	*1-3* *5-10* N=8					Yellow brown (10YR5/6) with 50% light brown gray (10YR6/2) mottles, moist, very silty CLAY, trace sand and gravel			
13A				19			26			584	
								Gray (10YR6/1) with 5% yellow brown (10YR5/4) mottles, moist, clayey SILT, trace sand and gravel			
14A	20/24 *83%*	ss	*10-8* *7-6* N=15	19			▼	Gray (10YR6/1) with 25% yellow brown (10YR5/4) mottles, wet, sandy SILT, trace gravel			
14B				14							
14C				22		1.09	28	Gray brown (10YR5/2), very moist, clayey SILT, trace sand		582	
15A				25		*B*					
								Yellow brown (10YR5/8), very moist to wet, fine to coarse SAND, trace gravel			
15B	24/24 *100%*	ss	*7-12* *11-17* N=23	21				Dark yellow brown (10YR4/6) with 40% yellow brown (10YR5/6) mottles, wet, sandy SILT, trace gravel			
15C				13							
15D				11			30	Gray brown (10YR5/2) with 40% yellow brown (10YR5/6) mottles, moist, very silty CLAY, trace sand and gravel		580	
16A				13							
								Dark yellow brown (10YR4/6) with 15% pale brown (10YR6/3) mottles, moist, very silty CLAY, little sand, trace gravel			
	20/24 *83%*	ss	*2-10* *9-14* N=19								
16B				12		5.82 *BSh*		Green gray (10Y5/1), moist, silty CLAY, trace sand and gravel		578	
	24/24 *100%*	ss	*11-15* *16-20* N=31				32				
17A				12		6.40 *Bh*				576	
	24/24 *100%*	ss	*7-16* *24-35* N=40				34	Gray (N5/1) with 30% gray brown (10YR5/2) mottles, moist, silty CLAY, little sand and gravel			
18A				11		7.62 *Sh*				574	
	24/24 *100%*	ss	*43-72* *75-97* N=147				36				
19A				10						572	
19B				11			38	Gray (N5), wet, fine to medium SAND			
	22/24 *92%*	ss	*11-27* *25-25* N=52					Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
20A				13		5.24	40			570	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh		Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*			
	24/24 *100%*	ss	*4-14* *17-24* N=31								
21A				10		10.86 *BSh*					
21B				11		6.98 *Sh*	42	Very dark green (10Y3/1) with 25% gray brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand and gravel		568	
22A				24		2.33 *Sh*		Green (5GY) with 10% gray brown (10YR4/3) mottles, moist, silty CLAY, trace sand and gravel			
22B	24/24 *100%*	ss	*27-41* *77-109* N=118	18				Dark green gray (10GY4/1), moist, silty CLAY, trace sand			
22C				14				Green (10Y5/1), wet, fine to medium SAND		566	
22D				11			44	CHERT			

End of Boring = 44.0 ft. BGS

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G66a~~
Well ID: G66L
Surface Elev: 614.86 ft. MSL
Completion: 19.74 ft. BGS
Station: 14,240.49N
965.72E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		614	
							2	FILL - Grayish brown (10YR5/2) with 10% dark yellowish brown (10YR4/6) and 10% yellowish brown (10YR5/4) mottles, slightly moist, hard, clayey SILT with slight trace sand.		612	
							4	FILL - Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT, slight trace roots.		610	
							6	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		608	
							8	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, firm, clayey SILT.		606	
							10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT.		604	
							12	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		602	
							14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		600	
							16			598	
							18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		596	

End of Boring = 19.74 ft bgs

NOTE(S): See G66S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G66~~
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	30-30 20-10 N=50	18.4			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		614	
2A				20.5			2	FILL - Grayish brown (10YR5/2) with 10% dark yellowish brown (10YR4/6) and 10% yellowish brown (10YR5/4) mottles, slightly moist, hard, clayey SILT with slight trace sand.			
2B	24/24 100%	SS	10-13 15-22 N=28	16.3			4	FILL - Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT, slight trace roots.		612	
3A	20/24 83%	SS	4-8 8-7 N=16	17.7			6	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		610	
4A	24/24 100%	SS	10-12 12-9 N=24	19.5			8	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, firm, clayey SILT.		608	
5A	19/24 79%	SS	3-6 8-10 N=14	22.8			10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT.		606	
6A	19/24 79%	SS	1-3 3-5 N=6	26.1			12	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		604	
7A	22/24 92%	SS	3-4 3-4 N=7	28.4			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 4-4 N=6	23.4			16			600	
9A	20/24 83%	SS	3-4 5-6 N=9	23.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		598	
10A	19/24 79%	SS	1-3 4-3 N=7	24.6			20			596	
11A	19/24		2-2	25.9						594	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G66
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	79%	SS	3-4 N=5	23.9			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		592	
12A	23/24 96%	SS	3-3 4-5 N=7	25.2			24				
13A	22/24 92%	SS	woh-2 2-3 N=4	22.7			26	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		590	
14A	23/24 96%	SS	4-7 7-8 N=14	18.8			28	Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		588	
15A	18/24 75%	SS	1-1 3-4 N=4	21.3				Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand.		586	
16A	19/24 79%	SS	1-3 4-5 N=7	17.2			30	Greenish gray (5GY6/1), moist, soft, clayey SILT with slight trace sand and gravel.		584	
17A	24/24 100%	SS	6-8 9-9 N=17	13.9			32	Dark gray (N4/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
17B				32.2				Dark gray (N4/1), very moist, firm, clayey SILT with slight trace sand.			
18A	22/24 92%	SS	4-10 16-13 N=26	15.6			▼ 34	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand.		580	
19A	24/24 100%	SS	12-12 13-22 N=25	11.8			36	Dark gray (N4/1), moist, firm, clayey SILT with sand and slight trace gravel.		578	
20A	19/24 79%	SS	18-28 36-48 N=64	11.2			38	Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	Thin(<0.1'), wet, fine- to medium-grained sand seams near 36.0', 38.0', and 39.5'.
							40				

End of Boring = 40.09 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G66~~
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	30-30 20-10 N=50	18.4			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		614	
2A				20.5			2	FILL - Grayish brown (10YR5/2) with 10% dark yellowish brown (10YR4/6) and 10% yellowish brown (10YR5/4) mottles, slightly moist, hard, clayey SILT with slight trace sand.			
2B	24/24 100%	SS	10-13 15-22 N=28	16.3			4	FILL - Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT, slight trace roots.		612	
3A	20/24 83%	SS	4-8 8-7 N=16	17.7			6	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		610	
4A	24/24 100%	SS	10-12 12-9 N=24	19.5			8	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, firm, clayey SILT.		608	
5A	19/24 79%	SS	3-6 8-10 N=14	22.8			10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT.		606	
6A	19/24 79%	SS	1-3 3-5 N=6	26.1			12	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		604	
7A	22/24 92%	SS	3-4 3-4 N=7	28.4			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 4-4 N=6	23.4			16			600	
9A	20/24 83%	SS	3-4 5-6 N=9	23.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		598	
10A	19/24 79%	SS	1-3 4-3 N=7	24.6			20			596	
11A	19/24		2-2	25.9						594	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G66
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	79%	SS	3-4 N=5	23.9			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		592	
12A	23/24 96%	SS	3-3 4-5 N=7	25.2			24				
13A	22/24 92%	SS	woh-2 2-3 N=4	22.7			26	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		590	
14A	23/24 96%	SS	4-7 7-8 N=14	18.8			28	Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		588	
15A	18/24 75%	SS	1-1 3-4 N=4	21.3				Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand.		586	
16A	19/24 79%	SS	1-3 4-5 N=7	17.2			30	Greenish gray (5GY6/1), moist, soft, clayey SILT with slight trace sand and gravel.		584	
17A	24/24 100%	SS	6-8 9-9 N=17	13.9			32	Dark gray (N4/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
17B				32.2			▼ 34	Dark gray (N4/1), very moist, firm, clayey SILT with slight trace sand.			
18A	22/24 92%	SS	4-10 16-13 N=26	15.6				Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand.		580	
19A	24/24 100%	SS	12-12 13-22 N=25	11.8			36	Dark gray (N4/1), moist, firm, clayey SILT with sand and slight trace gravel.		578	
20A	19/24 79%	SS	18-28 36-48 N=64	11.2			38	Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	Thin(<0.1'), wet, fine- to medium-grained sand seams near 36.0', 38.0', and 39.5'.
							40	**End of Boring = 40.09 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G67a~~
Well ID: G67L
Surface Elev: 614.64 ft. MSL
Completion: 17.18 ft. BGS
Station: 14,527.50N
928.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
							2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
							4	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		610	
							6	Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.		608	
							8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
							10	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
							12	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		602	
							14	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
							16			598	

End of Boring = 17.18 ft bgs

NOTE(S): See G67S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G67~~
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	24-18 14-18 N=32	18.7			0	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	8-13 11-14 N=24	16.6			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
3A	24/24 100%	SS	4-4 7-8 N=11	18.0			4	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		610	
4A	24/24 100%	SS	8-8 14-15 N=22	25.8			6	Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.		608	
5A	19/24 79%	SS	1-3 3-3 N=6	25.5			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
6A	22/24 92%	SS	1-2 4-4 N=6	21.9			10			604	
7A	22/24 92%	SS	6-6 6-5 N=12	21.2			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 2-2 N=4	22.2			14	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		600	
9A	24/24 100%	SS	3-3 4-3 N=7	22.9			16	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
9B				25.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		596	
10A	19/24 79%	SS	1-2 1-2 N=3	25.4			20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G67
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	SS	1-2 2-2 N=4	25.5			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY. *[Continued from previous page]*		594	
12A	22/24 92%	SS	2-3 3-4 N=6	27.8			24	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.		592	
13A	24/24 100%	SS	woh-1 2-2 N=3	23.5			26	Grayish brown (10YR5/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, very soft, silty CLAY with trace sand.		590	
14A	16/24 67%	SS	2-2 3-3 N=5	19.2			28	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		588	
15A	17/24 71%	SS	woh-1 1-3 N=2	15.8			30			586	
16A	18/24 75%	SS	3-4 7-15 N=11	17.6			32	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
16B				12.3							
17A	24/24 100%	SS	14-21 25-22 N=46	11.6			34	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		582	
17B				13.6				Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.			
18A	18/24 75%	SS	1-8 12-11 N=20	11.9			36	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		580	
19A	22/24 92%	SS	14-22 23-25 N=45	12.5			38	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		578	

End of Boring = 38.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G67~~
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	24-18 14-18 N=32	18.7			0	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	8-13 11-14 N=24	16.6			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
3A	24/24 100%	SS	4-4 7-8 N=11	18.0			4	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		610	
4A	24/24 100%	SS	8-8 14-15 N=22	25.8			6	Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.		608	
5A	19/24 79%	SS	1-3 3-3 N=6	25.5			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
6A	22/24 92%	SS	1-2 4-4 N=6	21.9			10			604	
7A	22/24 92%	SS	6-6 6-5 N=12	21.2			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 2-2 N=4	22.2			14	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		600	
9A	24/24 100%	SS	3-3 4-3 N=7	22.9			16	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
9B				25.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		596	
10A	19/24 79%	SS	1-2 1-2 N=3	25.4			20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G67
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	SS	1-2 2-2 N=4	25.5			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY. *[Continued from previous page]*		594	
12A	22/24 92%	SS	2-3 3-4 N=6	27.8			24	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.		592	
13A	24/24 100%	SS	woh-1 2-2 N=3	23.5			26	Grayish brown (10YR5/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, very soft, silty CLAY with trace sand.		590	
14A	16/24 67%	SS	2-2 3-3 N=5	19.2			28	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		588	
15A	17/24 71%	SS	woh-1 1-3 N=2	15.8			30			586	
16A	18/24 75%	SS	3-4 7-15 N=11	17.6			32	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
16B				12.3							
17A	24/24 100%	SS	14-21 25-22 N=46	11.6			34	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		582	
17B				13.6				Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.			
18A	18/24 75%	SS	1-8 12-11 N=20	11.9			36	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		580	
19A	22/24 92%	SS	14-22 23-25 N=45	12.5			38	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		578	

End of Boring = 38.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/18/2008
Finish: 11/18/2008
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G70a~~
Well ID: G70L
Surface Elev: 614.97 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,371.22N
156.88E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 27.00 - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4), dry, firm, clayey SILT.		614	
							2				
							4	FILL - Brown (10YR5/3), dry, firm, silty CLAY.		612	
							6	FILL - Dark grayish brown (10YR4/2), slightly moist, firm, silty CLAY.		610	
							8	FILL - Brown (10YR5/3), slightly moist, firm, silty CLAY.		608	
							10	FILL - Yellowish brown (10YR5/6), moist, hard, silty CLAY, trace roots.		606	
							12	FILL - Yellowish brown (10YR5/6), very moist, hard, silty CLAY.		604	
							14			602	
							16	FILL - Dark yellowish brown (10YR3/6), very moist, hard, silty CLAY.		600	
							18	FILL - Yellowish brown (10YR5/6), very moist, hard, silty CLAY.		598	
							20	Brown (7.5YR4/4) with 50% strong brown (7.5YR4/6) mottles, moist, hard, silty CLAY.		596	

NOTE(S): See G70S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/18/2008
Finish: 11/18/2008
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G70a
Well ID: G70L
Surface Elev: 614.97 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,371.22N
156.88E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 27.00 - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) *% Recovery*	SAMPLE Type	TESTING *Blows / 6 in* N - Value **RQD**	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Brown (7.5YR4/4) with 50% strong brown (7.5YR4/6) mottles, moist, hard, silty CLAY. *[Continued from previous page]*		594	
							22	Brown (7.5YR4/3), moist, hard, silty CLAY with trace sand.		592	
							24	Brown (10YR5/3) with 50% dark yellowish brown (10YR4/6) mottles, moist, hard, silty CLAY with trace sand and slight trace gravel.		590	
							26	Dark yellowish brown (10YR4/4) with 30% grayish brown (10YR5/2) very moist to wet, soft, clayey SILT with trace sand and slight trace gravel.		588	
							28	Yellowish brown (10YR5/4) with 50% pale brown (10YR6/3) mottles, very moist to wet, soft, clayey SILT with slight trace sand and gravel. *Silt content increases with depth.*		586	
							30	Yellowish brown (10YR5/4) with 20% light yellowish brown (10YR6/4) mottles, very moist, hard, clayey SILT with slight trace gravel.			
								End of Boring = 30.00 ft bgs			

NOTE(S): See G70S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G71a~~
Well ID: G71L
Surface Elev: 614.94 ft. MSL
Completion: 30.20 ft. BGS
Station: 14,106.39N
278.83E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/8), slightly moist, firm, clayey SILT with slight trace sand and gravel.		614	
							4	FILL - Yellowish brown (10YR5/8) with 20% gray (10YR6/1) mottles, moist, firm, silty CLAY with slight trace sand and gravel, trace roots.		610	
							8	Light yellowish brown (10YR6/4) with 30% brownish yellow (10YR6/8) mottles, moist, soft to friable, clayey SILT with slight trace sand.		606	
							12	Light gray (10YR7/1) with 20% yellowish brown (10YR5/8) mottles, slightly moist, friable, clayey SILT with slight trace sand.		602	
							16	Dark yellowish brown (10YR4/6), moist, friable, clayey SILT with slight trace sand.		598	
							18	Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		596	
							20				

NOTE(S): See G71S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G71a
Well ID: G71L
Surface Elev: 614.94 ft. MSL
Completion: 30.20 ft. BGS
Station: 14,106.39N
278.83E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, firm, clayey SILT with slight trace sand.		594	
							22	Yellowish brown (10YR5/8) with 25% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, moist, firm, silty CLAY with sand and slight trace gravel.		592	
							24	Brownish yellow (10YR6/6) with 20% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with trace sand and slight trace gravel.		590	
							26	Gray (10YR5/1) with 50% brownish yellow (10YR6/6) mottles, moist, soft, silty CLAY with sand and trace gravel.		588	
							28	Brownish yellow (10YR6/6) with 25% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.			
								Brownish yellow (10YR6/6), slightly moist, loose, silty, very fine- to medium-grained SAND with slight trace gravel.		586	
							30	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, friable, clayey SILT.			
								End of Boring = 30.20 ft bgs			

NOTE(S): See G71S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G71~~
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	6-9 9-5 N=18	15.5			2	FILL - Yellowish brown (10YR5/8), slightly moist, firm, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	4-6 9-11 N=15	18.2			4			612	
3A	24/24 100%	SS	3-6 9-12 N=15	18.9			6	FILL - Yellowish brown (10YR5/8) with 20% gray (10YR6/1) mottles, moist, firm, silty CLAY with slight trace sand and gravel, trace roots.		610	
4A	24/24 100%	SS	10-15 17-13 N=32	18.4			8			608	
5A	24/24 100%	SS	2-4 6-7 N=10	17.0			10	Light yellowish brown (10YR6/4) with 30% brownish yellow (10YR6/8) mottles, moist, soft to friable, clayey SILT with slight trace sand.		606	
6A	20/24 83%	SS	1-4 5-6 N=9	9.0			12			604	
7A	24/24 100%	SS	7-10 12-12 N=22	8.0			14	Light gray (10YR7/1) with 20% yellowish brown (10YR5/8) mottles, slightly moist, friable, clayey SILT with slight trace sand.		602	
8A	24/24 100%	SS	3-5 6-7 N=11	10.3			16			600	
9A	24/24 100%	SS	6-8 10-9 N=18	15.4			18	Dark yellowish brown (10YR4/6), moist, friable, clayey SILT with slight trace sand.		598	
10A	24/24 100%	SS	2-4 6-6 N=10	15.8			20	Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		596	
	24/24		3-4					Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, firm, clayey SILT with slight		594	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G71
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	100%	SS	6-9					trace sand.			
11A			N=10	18.0							
							22	Yellowish brown (10YR5/8) with 25% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, moist, firm, silty CLAY with sand and slight trace gravel.		592	
	24/24 100%	SS	6-13 15-14								
12A			N=28	20.6			24	Brownish yellow (10YR6/6) with 20% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with trace sand and slight trace gravel.			
	24/24 100%	SS	woh-2 4-6							590	
13A			N=6	18.0				Gray (10YR5/1) with 50% brownish yellow (10YR6/6) mottles, moist, soft, silty CLAY with sand and trace gravel.			
14A				17.8			26				
	24/24 100%	SS	6-16 14-16							588	
			N=30								
14B				11.5			28	Brownish yellow (10YR6/6) with 25% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.			
15A	24/24 100%	SS	2-12 14-50/5"	12.6				Brownish yellow (10YR6/6), slightly moist, loose, silty, very fine- to medium-grained SAND with slight trace gravel.		586	
			N=26								
16A				13.5			30	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, friable, clayey SILT.			
	24/24 100%	SS	3-14 10-11							584	
16B			N=24	13.3							
							32	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.			
	24/24 100%	SS	8-13 15-11							582	
17A			N=28	14.0			34				
										580	
18A	23/24 96%	SS	2-11 9-7	13.0			▼				
			N=20								
18B				28.0			36	Dark gray (10YR4/1), wet, soft, clayey SILT, trace wood fragments.			
										578	
19A	22/24 92%	SS	4-6 7-10	28.5							
			N=13				38	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.			
	24/24 100%	SS	10-13 15-26							576	
20A			N=28	12.0							
							40	**End of Boring = 40.00 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G71~~
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	6-9 9-5 N=18	15.5			2	FILL - Yellowish brown (10YR5/8), slightly moist, firm, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	4-6 9-11 N=15	18.2			4			612	
3A	24/24 100%	SS	3-6 9-12 N=15	18.9			6	FILL - Yellowish brown (10YR5/8) with 20% gray (10YR6/1) mottles, moist, firm, silty CLAY with slight trace sand and gravel, trace roots.		610	
4A	24/24 100%	SS	10-15 17-13 N=32	18.4			8			608	
5A	24/24 100%	SS	2-4 6-7 N=10	17.0			10	Light yellowish brown (10YR6/4) with 30% brownish yellow (10YR6/8) mottles, moist, soft to friable, clayey SILT with slight trace sand.		606	
6A	20/24 83%	SS	1-4 5-6 N=9	9.0			12			604	
7A	24/24 100%	SS	7-10 12-12 N=22	8.0			14	Light gray (10YR7/1) with 20% yellowish brown (10YR5/8) mottles, slightly moist, friable, clayey SILT with slight trace sand.		602	
8A	24/24 100%	SS	3-5 6-7 N=11	10.3			16			600	
9A	24/24 100%	SS	6-8 10-9 N=18	15.4			18	Dark yellowish brown (10YR4/6), moist, friable, clayey SILT with slight trace sand.		598	
10A	24/24 100%	SS	2-4 6-6 N=10	15.8			20	Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		596	
	24/24		3-4					Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, firm, clayey SILT with slight		594	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G71
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	100%	SS	6-9					trace sand.			
11A			N=10	18.0			22	Yellowish brown (10YR5/8) with 25% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, moist, firm, silty CLAY with sand and slight trace gravel.		592	
	24/24 100%	SS	6-13 15-14								
12A			N=28	20.6			24	Brownish yellow (10YR6/6) with 20% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with trace sand and slight trace gravel.		590	
	24/24 100%	SS	woh-2 4-6								
13A			N=6	18.0			26	Gray (10YR5/1) with 50% brownish yellow (10YR6/6) mottles, moist, soft, silty CLAY with sand and trace gravel.		588	
14A				17.8							
	24/24 100%	SS	6-16 14-16								
14B			N=30	11.5			28	Brownish yellow (10YR6/6) with 25% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.			
15A	24/24 100%	SS	2-12 14-50/5"	12.6				Brownish yellow (10YR6/6), slightly moist, loose, silty, very fine- to medium-grained SAND with slight trace gravel.		586	
			N=26				30	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, friable, clayey SILT.			
16A				13.5						584	
	24/24 100%	SS	3-14 10-11								
16B			N=24	13.3			32	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.		582	
	24/24 100%	SS	8-13 15-11								
17A			N=28	14.0			34				
18A	23/24 96%	SS	2-11 9-7	13.0			▼			580	
			N=20				36	Dark gray (10YR4/1), wet, soft, clayey SILT, trace wood fragments.			
18B				28.0						578	
19A	22/24 92%	SS	4-6 7-10	28.5			38	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.			
			N=13							576	
	24/24 100%	SS	10-13 15-26								
20A			N=28	12.0			40	**End of Boring = 40.00 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72a~~
Well ID: G72L
Surface Elev: 615.01 ft. MSL
Completion: 24.79 ft. BGS
Station: 13,904.84N
509.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.		615	
							5	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.		610	
							10	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.		605	
							15	Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		600	
							20	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.		595	
							25	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.		590	

NOTE(S): See G72S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72a
Well ID: G72L
Surface Elev: 615.01 ft. MSL
Completion: 24.79 ft. BGS
Station: 13,904.84N
509.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks
								Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.	594
							22	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.	592
							24	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.	

End of Boring = 24.79 ft bgs

NOTE(S): See G72S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72~~
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	3-3 6-6 N=9	20.4			0	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	3-5 6-6 N=11	18.3			2			612	
3A	24/24 100%	SS	3-5 6-9 N=11	15.7			4			610	
4A	24/24 100%	SS	10-14 16-16 N=30	21.3			6	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.		608	
5A	24/24 100%	SS	3-4 6-7 N=10	19.3			8			606	
6A	24/24 100%	SS	2-3 6-8 N=9	18.2			10	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.		604	
7A	20/24 83%	SS	5-7 12-13 N=19	9.2			12			602	
8A	24/24 100%	SS	1-3 4-6 N=7	11.1			14	Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		600	
9A	24/24 100%	SS	5-7 10-9 N=17	12.3			16	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.		598	
10A	24/24 100%	SS	1-3 4-7 N=7	17.5			18	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.		596	
	24/24		1-3				20	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	100%	SS	4-8 N=7	16.6			22	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand. *[Continued from previous page]*			
12A	24/24 100%	SS	4-8 12-13 N=20	19.1			24	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		592	
13A	24/24 100%	SS	1-3 5-8 N=8	17.4			26	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.		590	
14A	24/24 100%	SS	5-6 8-8 N=14	21.2			28	Yellowish brown (10YR5/8) with 10% gray (10YR6/1) mottles, very moist, soft, silty CLAY with trace sand.		588	
15A	24/24 100%	SS	woh-1 2-3 N=3	26.5			30	Gray (10YR6/1) with 20% yellowish brown (10YR5/8) mottles, very moist to wet, very soft, silty CLAY with trace sand and slight trace gravel.		586	
16A	24/24 100%	SS	1-3 6-10 N=9	19.3				Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, wet, very soft, clayey SILT with some very fine-grained sand and slight trace gravel.		584	
16B				15.9			32	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
17A	20/24 83%	SS	5-10 13-11 N=23	24.9				Brownish yellow (10YR6/6), wet, soft, clayey SILT with trace very fine-grained sand.		582	
18A				27.8			34	Dark gray (10YR4/1), moist, firm, very silty CLAY with slight trace sand.			
18B	24/24 100%	SS	2-6 7-9 N=13	11.1				Dark gray (10YR4/1), moist, loose, SILT and very fine-grained SAND.		580	
19A	24/24 100%	SS	7-9 12-14 N=21	11.1			36	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		578	
20A	17/17 100%	SS	26-45 50/5"	9.4			38			576	

End of Boring = 39.40 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72~~
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	3-3 6-6 N=9	20.4			0			614	
							2	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.			
2A	24/24 100%	SS	3-5 6-6 N=11	18.3						612	
							4				
3A	24/24 100%	SS	3-5 6-9 N=11	15.7						610	
							6	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.			
4A	24/24 100%	SS	10-14 16-16 N=30	21.3						608	
							8				
5A	24/24 100%	SS	3-4 6-7 N=10	19.3						606	
							10	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.			
6A	24/24 100%	SS	2-3 6-8 N=9	18.2						604	
							12				
7A	20/24 83%	SS	5-7 12-13 N=19	9.2				Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		602	
							14				
8A	24/24 100%	SS	1-3 4-6 N=7	11.1						600	
							16	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.			
9A	24/24 100%	SS	5-7 10-9 N=17	12.3						598	
							18	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.			
10A	24/24 100%	SS	1-3 4-7 N=7	17.5						596	
							20	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.			
	24/24		1-3								

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	100%	SS	4-8 N=7	16.6			22	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand. *[Continued from previous page]*			
12A	24/24 100%	SS	4-8 12-13 N=20	19.1			24	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		592	
13A	24/24 100%	SS	1-3 5-8 N=8	17.4			26	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.		590	
14A	24/24 100%	SS	5-6 8-8 N=14	21.2			28	Yellowish brown (10YR5/8) with 10% gray (10YR6/1) mottles, very moist, soft, silty CLAY with trace sand.		588	
15A	24/24 100%	SS	woh-1 2-3 N=3	26.5			30	Gray (10YR6/1) with 20% yellowish brown (10YR5/8) mottles, very moist to wet, very soft, silty CLAY with trace sand and slight trace gravel.		586	
16A	24/24 100%	SS	1-3 6-10 N=9	19.3				Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, wet, very soft, clayey SILT with some very fine-grained sand and slight trace gravel.		584	
16B				15.9			32	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
17A	20/24 83%	SS	5-10 13-11 N=23	24.9				Brownish yellow (10YR6/6), wet, soft, clayey SILT with trace very fine-grained sand.		582	
18A				27.8			34	Dark gray (10YR4/1), moist, firm, very silty CLAY with slight trace sand.			
18B	24/24 100%	SS	2-6 7-9 N=13	11.1				Dark gray (10YR4/1), moist, loose, SILT and very fine-grained SAND.		580	
19A	24/24 100%	SS	7-9 12-14 N=21	11.1			36	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		578	
20A	17/17 100%	SS	26-45 50/5"	9.4			38			576	

End of Boring = 39.40 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/6/2009
Finish: 2/6/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G73a~~
Well ID: G73L
Surface Elev: 614.64 ft. MSL
Completion: 34.76 ft. BGS
Station: 13,924.52N
799.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
							2	FILL - Dark yellowish brown (10YR4/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
							4	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		610	
							6	FILL - Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		608	
							8	FILL - Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		606	
							10	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		604	
							12	FILL - Strong brown (7.5YR4/6), moist, firm, silty CLAY with slight trace sand, trace roots.		602	
							14	Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.		600	
							16	Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) and 5% (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		598	
							18	Brown (10YR4/3) with 5% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		596	
							20				

NOTE(S): See G73S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/6/2009
Finish: 2/6/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G73a
Well ID: G73L
Surface Elev: 614.64 ft. MSL
Completion: 34.76 ft. BGS
Station: 13,924.52N
799.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Brown (10YR4/3) with 5% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel. *[Continued from previous page]*		594	
							24			592	
							26	Dark yellowish brown (10YR4/4) with 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		590	
								Dark gray (10YR4/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		588	
							28	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		586	
							30	Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		584	
							32	Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		582	
								Dark yellowish brown (10YR4/4) with 30% gray (10YR6/1) mottles, very moist, soft, clayey SILT.			
							34	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		580	
								Dark yellowish brown (10YR4/6) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand and gravel.			

End of Boring = 34.76 ft bgs

NOTE(S): See G73S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01b~~
Well ID: P01L
Surface Elev: 622.00 ft. MSL
Completion: 20.35 ft. BGS
Station: 16,744.77N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 8.63 - 01/08/09
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.			
							2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
							4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
							6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
							8			614	
							▼				
							10	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		612	
							12			610	
							14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
							16			606	
							18	Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.		604	
							▼				
							20	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		602	
								Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.			
								End of Boring = 20.35 ft bgs			

NOTE(S): See P01I Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01~~
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	4-4 5-10 N=9	17.2			0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.		622	
1B				30.5							
2A	24/24 100%	SS	2-2 3-4 N=5	30.3			2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
2B				24.9							
3A	23/24 96%	SS	2-2 3-4 N=5	24.9			4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
4A	24/24 100%	SS	2-3 4-4 N=7	22.9			6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
5A	20/24 83%	SS	2-2 3-3 N=5	22.1			8			614	
6A	12/24 50%	SS	1-1 2-3 N=3	26.9			▼ 10	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		612	
7A	18/24 75%	SS	2-4 5-6 N=9	24.5			12			610	
7B				27.7							
8A	24/24 100%	SS	2-2 3-4 N=5	25.2			14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
8B				25.1			16			606	
9A	7/24 29%	SS	woh-woh woh-woh	24.9			▼ 18	Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.		604	
10A	24/24 100%	SS	2-3 4-5 N=7	22.5			20	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		602	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	23/24 96%	SS	2-2 3-6 N=5	28.0			0	Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.			
11B				21.9				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
12A	24/24 100%	SS	0-0 3-5 N=3	24.5			22	Dark gray (10YR4/1), wet, soft, silty CLAY with little sand.		600	
12B				21.8				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
13A	24/24 100%	SS	1-2 2-4 N=4	20.3			24	Greenish gray (5GY6/1), wet, loose, clayey fine- to coarse-grained SAND with trace gravel.		598	
14A	24/24 100%	SS	0-3 3-3 N=6	19.9			26	Olive (5Y5/3), moist, soft, clayey SILT with slight trace sand.		596	
14B				16.4			28	Gray (N5/1), moist, firm, clayey SILT with slight trace sand and gravel.		594	
15A	24/24 100%	SS	4-5 7-10 N=12	16.5							
16A	24/24 100%	SS	2-3 4-5 N=7	16.4			30			592	
17A	18/24 75%	SS	3-3 4-5 N=7	30.6			32			590	
18A	24/24 100%	SS	7-9 14-21 N=23	23.5			34	Dark gray (10YR4/1), moist, firm, clayey SILT.		588	
18B				12.5			36	Greenish gray (5G5/1) with 30% reddish brown (5YR5/3) mottles, slightly moist, hard, clayey SILT with little sand and gravel.		586	
19A	24/24 100%	SS	8-10 15-20 N=25	12.4				Gray (N5/1), wet, silty fine- to coarse-grained SAND with trace gravel.			
19B				11.4			38	Gray (10YR5/1) slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
20A	12/16 75%	SS	16-26 50/4"	12.5			40			582	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	24/24 100%	SS	7-15 18-21 N=33	11.5				Dark greenish gray (10Y4/1), wet, silty fine- to coarse-grained SAND with trace gravel.			
21B				15.2				Dark gray (N4/1), moist, very hard, silty CLAY with some sand and gravel.			
22A	24/24 100%	SS	8-6 17-21 N=23	14.3			42	Dark greenish gray (10Y4/1), wet, silty fine- to coarse-grained SAND with trace gravel.		580	
22B				13.0			44	Dark gray (N4/1), slightly moist, very hard, clayey SILT with little sand and trace gravel.		578	
23A	13/24 54%	SS	24-22 20-22 N=42	13.7			46			576	

End of Boring = 46.00 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01a~~
Well ID: P01S
Surface Elev: 622.00 ft. MSL
Completion: 27.74 ft. BGS
Station: 16,754.60N
-194.67E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 8.46 - 01/08/09
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.			
							2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
							4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
							6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
							8 ▼	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		614	
							10			612	
							12			610	
							14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
							16	Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.		606	
							18 ▼	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		604	
							20			602	

NOTE(S): See P01I Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01a
Well ID: P01S
Surface Elev: 622.00 ft. MSL
Completion: 27.74 ft. BGS
Station: 16,754.60N
-194.67E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 8.46 - 01/08/09
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.			
								Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
							22	Dark gray (10YR4/1), wet, soft, silty CLAY with little sand.		600	
								Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
							24			598	
								Greenish gray (5GY6/1), wet, loose, clayey fine- to coarse-grained SAND with trace gravel.			
							26			596	
								Olive (5Y5/3), moist, soft, clayey SILT with slight trace sand.			
								Gray (N5/1), moist, firm, clayey SILT with slight trace sand and gravel.			
								End of Boring = 27.74 ft bgs			

NOTE(S): See P01I Boring log for sample and testing data.

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01~~
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	4-4 5-10 N=9	17.2			0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.		622	
1B				30.5							
2A	24/24 100%	SS	2-2 3-4 N=5	30.3			2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
2B				24.9							
3A	23/24 96%	SS	2-2 3-4 N=5	24.9			4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
4A	24/24 100%	SS	2-3 4-4 N=7	22.9			6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
5A	20/24 83%	SS	2-2 3-3 N=5	22.1			8			614	
							▼ 10	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		612	
6A	12/24 50%	SS	1-1 2-3 N=3	26.9			12			610	
7A	18/24 75%	SS	2-4 5-6 N=9	24.5			14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
7B				27.7							
8A	24/24 100%	SS	2-2 3-4 N=5	25.2			16			606	
8B				25.1				Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.			
9A	7/24 29%	SS	woh-woh woh-woh	24.9			▼ 18			604	
10A	24/24 100%	SS	2-3 4-5 N=7	22.5			20	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		602	

NOTE(S):

FIELD BORING LOG

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HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	23/24 96%	SS	2-2 3-6 N=5	28.0			0	Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.			
11B				21.9				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
12A	24/24 100%	SS	0-0 3-5 N=3	24.5			22	Dark gray (10YR4/1), wet, soft, silty CLAY with little sand.		600	
12B				21.8				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
13A	24/24 100%	SS	1-2 2-4 N=4	20.3			24	Greenish gray (5GY6/1), wet, loose, clayey fine- to coarse-grained SAND with trace gravel.		598	
14A	24/24 100%	SS	0-3 3-3 N=6	19.9			26	Olive (5Y5/3), moist, soft, clayey SILT with slight trace sand.		596	
14B				16.4			28			594	
15A	24/24 100%	SS	4-5 7-10 N=12	16.5							
16A	24/24 100%	SS	2-3 4-5 N=7	16.4			30	Gray (N5/1), moist, firm, clayey SILT with slight trace sand and gravel.		592	
17A	18/24 75%	SS	3-3 4-5 N=7	30.6			32			590	
18A	24/24 100%	SS	7-9 14-21 N=23	23.5			34	Dark gray (10YR4/1), moist, firm, clayey SILT.		588	
18B				12.5			36	Greenish gray (5G5/1) with 30% reddish brown (5YR5/3) mottles, slightly moist, hard, clayey SILT with little sand and gravel.		586	
19A	24/24 100%	SS	8-10 15-20 N=25	12.4				Gray (N5/1), wet, silty fine- to coarse-grained SAND with trace gravel.			
19B				11.4			38			584	
20A	12/16 75%	SS	16-26 50/4"	12.5				Gray (10YR5/1) slightly moist, hard, clayey SILT with trace sand and slight trace gravel.			
							40			582	

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

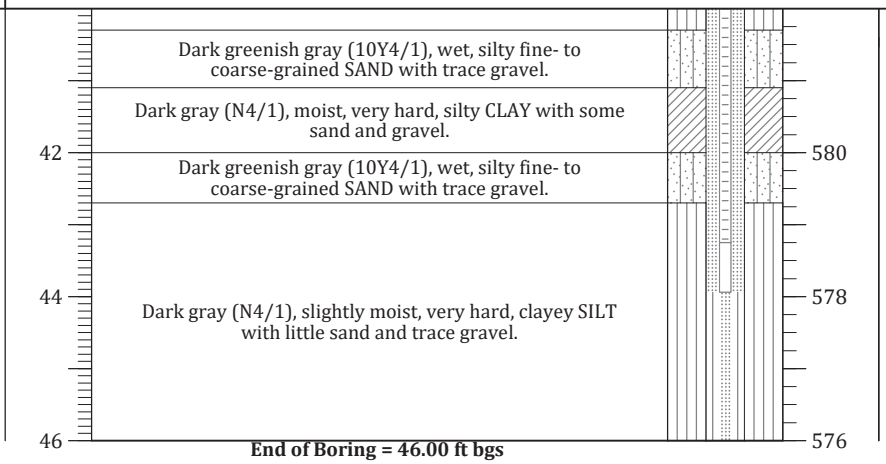
CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
21A	24/24 100%	SS	7-15 18-21 N=33	11.5		
21B				15.2		
22A				14.3		
	24/24 100%	SS	8-6 17-21 N=23			
22B				13.0		
23A	13/24 54%	SS	24-22 20-22 N=42	13.7		



End of Boring = 46.00 ft bgs

NOTE(S):

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HANSON

P41D (MW-5D)

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	~~B-14/MW-5~~
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	610.3
Foreman	Randy Howard CME 850	Drilling Method	HSA/ 2-3/4" Mud Rotary
Engineer/Geologist	ASY	Sampling Method	SS/Core
Weather & Temp.	82°, Sunny, Breezy	Hammer Type	Auto
Date: Start	9/17/2003 1250	Water Depth: DD	18'
Finish	9/19/2003 1255	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brn. silt loam, moist, topsoil.	SS-1	1.5	3.5	3-5-5-5 Rec = 18" Qp = 2.5
0.5	4.5	Lt. brn.-gray to yellow-brn. silt, tr.-so. clay, moist, mottled, iron staining, roots (loess).	SS-2	4.0	6.0	3-4-4-4 Rec = 20" Qp = 1.7
4.5	7.8	Gray silt, so. iron staining, v. moist @ 6' 7", occ. roots, moist (loess).	SS-3	6.5	8.5	2-2-3-3 Rec = 24" Qp = 1.6
7.8	9.0	Brn. and gray mottled silt, tr. clay, moist (loess).	SS-4	9.0	11.0	1-2-3-4 Rec = 20" Qp = 1.3
9.0	11.0	Yel.-brn. silt, tr. clay, moist (loess).	SS-5	11.5	13.5	1-2-3-3 Rec = 24" Qp = 1.3
11.0	14.5	Red-brn. and gray clayey silt, tr. f. sand, moist (till).	SS-6	14.0	16.0	2-3-3-3 Rec = 22" Qp = 1.4 to 2.4
14.5	18.0	As above, so. f.-m. sand, tr. coal frags and gravel (till).	SS-7	16.5	18.5	2-2-2-2 Rec = 24" Qp = -
18.0	20.8	Yellow-brn. sa. silt, so. clay, tr. gravel, v. moist to wet.	SS-8	19.0	21.0	1-1-2-2 Rec = 24" Qp = -
20.8	23.3	Red-brn and gray clayey silt, tr.-so. f. sand, tr. gravel and coal frags., moist (till).	SS-9	21.5	23.5	2-4-3-5 Rec = 19" Qp = 2.2
23.3	24.0	Brn-gray silty v.f. sand, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 19" Qp = -
24.0	26.0	Lt. gray to yellow-gray silt, v. moist-wet, laminated, so. dark gray laminae, occ. wood frags.	SS-11	26.5	28.5	4-9-17-25 Rec = 23" Qp = 3.2 (till)

General Remarks:

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Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.0	27.5	Gray cl. silt, so. sand (f.-m.), stiff, moist, occ. f. gravel (till).	SS-12	29.0	31.0	6-11-18-24 Rec = 24" Qp = 4.5+
27.5	28.4	Red brown to brn. f.-m. sand, wet.	SS-13	31.5	33.5	5-13-25-40 Rec = 21" Qp = 4.5+ to -
28.4	33.0	Gray sa. silt, so. clay, tr. gravel, moist, v. stiff (till).	SS-14	34.0	36.0	13-29-33-44 Rec = 19" Qp = -
33.0	38.4	Gray f.-m. sand, wet, tr. crs. sand (gravel @ base), dense.	SS-15	36.5	38.5	3-17-28-22 Rec = 18" Qp = -
38.4	46.0	Gray silty clay, tr.-so. gravel (f.-m.), tr. v.f.-f. sand, occ. coal fragments, dry to mst. v. stiff (till).	SS-16	39.0	41.0	5-11-16-23 Rec = 22" Qp = 4.5+
46.0	48.6	Brown to brn.-gray f.-m. sandy silt, so. clay, tr. gravel, stiff, moist (till).	SS-17	41.5	43.5	5-12-17-24 Rec = 24" Qp = 4.5+
48.6	50.0	Gray f.-crs. sand, dry, v. dense, tr.-so. gravel, v. moist @ base, methane production.	SS-18	44.0	46.0	6-10-17-21 Rec = 23" Qp = 4.5+
50.0	51.5	Lt. gray to yel-gray silt, v. moist-wet, iron staining, methane production.	SS-19	46.5	48.0	5-20-50/5" Rec = 15" Qp = 4.3 to 4.5+
51.5	55.8	Gray-brn. v.f. sa. silt, so. clay, tr. f. gravel, moist, v. stiff (till).	SS-20	49.0	51.0	35-40-47-50/5" Rec = 24" Qp = 1.0 (silt)
55.8	65.5	Gray f.-crs. sand, tr. f. gravel and silt, wet, partially cemented (calcareous), v. dense, more gravel 61.5' - 65.5'.	SS-21	51.5	53.0	14-34-50/4" (overpacked w/sand) Rec = 12" silt Qp = 1.0 (silt)
65.5	66.5	Gray silty v.f.-m. sand, tr. gravel, partially cemented, v. dense.	SS-22	54.0	55.0	14-50 Rec = 12" Qp = 4.5+
66.5	71.7	Gray clayey silt, so. v.f.-f. sand, tr. gravel (f.-m.), calcareous, sl. moist, v. stiff (till), so. shale frags.	SS-23	56.5	58.5	18-31-31-37 Rec = 21" Qp = -
71.7	80.8	Gray v.f.-f. sa. silt, tr.-so. clay, tr. f.-m. gravel, occ. coal frags., v. stiff, sl. moist, calcareous (till).	SS-24	59.0	61.0	16-27-32-41 Rec = 18" Qp = -
80.8	84.0	Gray to dk. gray silt, tr.-so. clay, tr. v.f.-f. sand and f.-m. gravel, occ. varves, wood frags., stiff, sl. calcareous (till).	SS-25	61.5	63.5	16-26-29-30 Rec = 19" Qp = -
84.0	89.6	Dk. gray silt, tr. clay, tr. v.f. sand, occ. zones of diss. carbonaceous material (m. sand sized), occ. coal frags., occ. varved zones, v. stiff.	SS-26	64.0	65.5	12-30-50/4" Rec = 14" Qp = -

General Remarks:

1640 Switch to mud rotary @ 55'.
1748 Begin mud rotary w/polymer.
1905 end drilling for today at 64.0'.
Methane produced from 49' - 53' inside borehole.

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Project Name Ameren Duck Creek - Phase II Site Invest.

Boring # B-14/MW-5

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
89.6	93.0	Gray wthrd. siltstone, thinly bedded, tr. clay.	SS-27	66.5	68.5	18-34-45-50/5" Rec = 24" Qp = 4.5++
			SS-28	69.0	71.0	15-29-32-45 Rec = 24" Qp = 4.5++
			SS-29	71.5	73.0	23-45-50/4" Rec = 15" Qp = 4.5+
			SS-30	74.0	75.5	24-36-37 Rec = 17" Qp = 4.5++
			SS-31	76.5	78.0	26-37-44 Rec = 18" Qp = 4.5+
			SS-32	79.0	81.0	Drop Rod-27-39-50 Rec = 22" Qp = 4.5+
			SS-33	81.5	83.5	13-23-33-44 Rec = 24" Qp = 4.5+
			SS-34	84.0	86.0	7-13-21-27 Rec = 24" Qp = 4.5+
			SS-35	87.5	89.5	8-16-32-50/3" Rec = 17" Qp = 4.5+
			SS-36	90.0	90.5	50/5-1/2" Rec = 6" Qp = 4.5+
		End SS @ 93.0'. Begin coring @ 93.7'.	SS-37	92.5	93.0	50/4"

General Remarks:

* 9-18-03 Resume B-14 @ 0800 @ 64.0'.
* Drilled much harder @ 89.6'.
* 9-18-03 1240 Stopped drilling @ 92.5'.

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 1 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time 8:35	DWR %	DWRC	Down Pressure	Depth In Feet
93.0	Start core 93.7'	1	Run 9.3'	1		100%	Gray	250#	
94.0	Loss		Rec 8.15'		1:53				
	94.8'		88%						
95.0	Gray silty shale, thinly bedded.				1:35				
	95.6' High angle		RQD 7.95'/ 9.3'						
96.0	96.0' fracture				2:07				
			85%				Lt. gray		
97.0					1:47				
						4'4" added 5.0'			
98.0					1:54				
	98.3'								
99.0	Gray shale, so. silt, thinly bedded.				1:35				
							Dk. gray		
100.0					1:12				
101.0					1:03				
102.0					0:53				
103.0									

Core barrel 13.0' - End Run 1 - 103.0

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 2 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
103.0	Dark gray shale, fissil.	2	Run 10.0'	1	1:45	100	Gray	450#	
104.0			Rec 8.6'	104.8'					
105.0				2	1:52				
106.0			RQD 7.5'/ 10.0'		1:58				
107.0					2:30				
108.0	108.0'				1:53				
	108.3' Gray shaley limestone.					sl. drop			
109.0	Loss 109.1'				1:50				
	Dark gray limey shale, fractured, near vert., open, clean. 109.7'					sl. drop			
110.0	Loss 110.1'				2:23				
	Gray shaley limestone, tr. fossils.								
111.0	Dark gray shale, fissil.				-			250#	
112.0					3:30				
	112.65'								
	112.75' Gray shaley limestone.								
113.0					3:02				

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 3 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
113.0	Dark gray limey shale.	2		2		100	Gray	250#	
	113.85'								
114.0	104.05' Dark gray shaley, limestone, fossiliferous.								
	Dk. gray to black shale, so. lime, scattered fossils.								
115.0									
	115.9'			115.9'					
116.0				3					
	Black shale, so. lime.								
	116.5'								
117.0	Dk. gray shaley limestone to limey shale, fossiliferous.								
	117.3'								
	Loss (in hole)								
118.0	118.0'								
	EOB @ 118.0'								

9-19-03 Coring completed 1255

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HANSON

RECORD OF SOIL EXPLORATION

P41I1 (MW-5I1)

Project Name	Ameren Duck Creek	Sheet	1 of 1
Job #	03S5010	Boring #	~~B-14A/P-5I1~~
Location	CCB Landfill - Phase III Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	609.9
Foreman	Randy Howard	Drilling Method	HSA CME 850 ATV
Engineer/Geologist	ASY	Sampling Method	SS
Weather & Temp.	35°, Sunny, Windy	Hammer Type	Auto
Date: Start	12/15/2003 1330	Water Depth: DD	-
Finish	12/15/2003 1600	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
		No sampling to 29' (see B-14)				
29.0	30.5	Brown-red f.-m. sand, wet.	SS-1	29.0	31.0	16-26-25-23 sand: - Rec = 24" Qp = till: 4.5+
30.5	32.5	Gray sandy clay, so. silt, tr. gravel, v. stiff, moist (till).	SS-2	31.5	33.5	8-18-26-46 sand: - Rec = 24" Qp = till: 4.5+
32.5	37.0	Gray f.-m. sand, wet.	SS-3	34.0	36.0	No sample. Sand blown-in inside auger. Rec = Qp =
37.0	38.5	Gray silty clay, tr. sand and gravel, tr.-so. coal frags., v. stiff, moist (till).	SS-4	36.5	38.5	14-10-11-14 Rec = 20" Qp = 4.5+
		EOB @ 38.5'				

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-14/MW-5
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	610.3
Foreman	Randy Howard CME 850	Drilling Method	HSA/ 2-3/4" Mud Rotary
Engineer/Geologist	ASY	Sampling Method	SS/Core
Weather & Temp.	82°, Sunny, Breezy	Hammer Type	Auto
Date: Start	9/17/2003 1250	Water Depth: DD	18'
Finish	9/19/2003 1255	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brn. silt loam, moist, topsoil.	SS-1	1.5	3.5	3-5-5-5 Rec = 18" Qp = 2.5
0.5	4.5	Lt. brn.-gray to yellow-brn. silt, tr.-so. clay, moist, mottled, iron staining, roots (loess).	SS-2	4.0	6.0	3-4-4-4 Rec = 20" Qp = 1.7
4.5	7.8	Gray silt, so. iron staining, v. moist @ 6' 7", occ. roots, moist (loess).	SS-3	6.5	8.5	2-2-3-3 Rec = 24" Qp = 1.6
7.8	9.0	Brn. and gray mottled silt, tr. clay, moist (loess).	SS-4	9.0	11.0	1-2-3-4 Rec = 20" Qp = 1.3
9.0	11.0	Yel.-brn. silt, tr. clay, moist (loess).	SS-5	11.5	13.5	1-2-3-3 Rec = 24" Qp = 1.3
11.0	14.5	Red-brn. and gray clayey silt, tr. f. sand, moist (till).	SS-6	14.0	16.0	2-3-3-3 Rec = 22" Qp = 1.4 to 2.4
14.5	18.0	As above, so. f.-m. sand, tr. coal frags and gravel (till).	SS-7	16.5	18.5	2-2-2-2 Rec = 24" Qp = -
18.0	20.8	Yellow-brn. sa. silt, so. clay, tr. gravel, v. moist to wet.	SS-8	19.0	21.0	1-1-2-2 Rec = 24" Qp = -
20.8	23.3	Red-brn and gray clayey silt, tr.-so. f. sand, tr. gravel and coal frags., moist (till).	SS-9	21.5	23.5	2-4-3-5 Rec = 19" Qp = 2.2
23.3	24.0	Brn-gray silty v.f. sand, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 19" Qp = -
24.0	26.0	Lt. gray to yellow-gray silt, v. moist-wet, laminated, so. dark gray laminae, occ. wood frags.	SS-11	26.5	28.5	4-9-17-25 Rec = 23" Qp = 3.2 (till)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.0	27.5	Gray cl. silt, so. sand (f.-m.), stiff, moist, occ. f. gravel (till).	SS-12	29.0	31.0	6-11-18-24 Rec = 24" Qp = 4.5+
27.5	28.4	Red brown to brn. f.-m. sand, wet.	SS-13	31.5	33.5	5-13-25-40 Rec = 21" Qp = 4.5+ to -
28.4	33.0	Gray sa. silt, so. clay, tr. gravel, moist, v. stiff (till).	SS-14	34.0	36.0	13-29-33-44 Rec = 19" Qp = -
33.0	38.4	Gray f.-m. sand, wet, tr. crs. sand (gravel @ base), dense.	SS-15	36.5	38.5	3-17-28-22 Rec = 18" Qp = -
38.4	46.0	Gray silty clay, tr.-so. gravel (f.-m.), tr. v.f.-f. sand, occ. coal fragments, dry to mst. v. stiff (till).	SS-16	39.0	41.0	5-11-16-23 Rec = 22" Qp = 4.5+
46.0	48.6	Brown to brn.-gray f.-m. sandy silt, so. clay, tr. gravel, stiff, moist (till).	SS-17	41.5	43.5	5-12-17-24 Rec = 24" Qp = 4.5+
48.6	50.0	Gray f.-crs. sand, dry, v. dense, tr.-so. gravel, v. moist @ base, methane production.	SS-18	44.0	46.0	6-10-17-21 Rec = 23" Qp = 4.5+
50.0	51.5	Lt. gray to yel-gray silt, v. moist-wet, iron staining, methane production.	SS-19	46.5	48.0	5-20-50/5" Rec = 15" Qp = 4.3 to 4.5+
51.5	55.8	Gray-brn. v.f. sa. silt, so. clay, tr. f. gravel, moist, v. stiff (till).	SS-20	49.0	51.0	35-40-47-50/5" Rec = 24" Qp = 1.0 (silt)
55.8	65.5	Gray f.-crs. sand, tr. f. gravel and silt, wet, partially cemented (calcareous), v. dense, more gravel 61.5' - 65.5'.	SS-21	51.5	53.0	14-34-50/4" (overpacked w/sand) Rec = 12" silt Qp = 1.0 (silt)
65.5	66.5	Gray silty v.f.-m. sand, tr. gravel, partially cemented, v. dense.	SS-22	54.0	55.0	14-50 Rec = 12" Qp = 4.5+
66.5	71.7	Gray clayey silt, so. v.f.-f. sand, tr. gravel (f.-m.), calcareous, sl. moist, v. stiff (till), so. shale frags.	SS-23	56.5	58.5	18-31-31-37 Rec = 21" Qp = -
71.7	80.8	Gray v.f.-f. sa. silt, tr.-so. clay, tr. f.-m. gravel, occ. coal frags., v. stiff, sl. moist, calcareous (till).	SS-24	59.0	61.0	16-27-32-41 Rec = 18" Qp = -
80.8	84.0	Gray to dk. gray silt, tr.-so. clay, tr. v.f.-f. sand and f.-m. gravel, occ. varves, wood frags., stiff, sl. calcareous (till).	SS-25	61.5	63.5	16-26-29-30 Rec = 19" Qp = -
84.0	89.6	Dk. gray silt, tr. clay, tr. v.f. sand, occ. zones of diss. carbonaceous material (m. sand sized), occ. coal frags., occ. varved zones, v. stiff.	SS-26	64.0	65.5	12-30-50/4" Rec = 14" Qp = -

General Remarks:

1640 Switch to mud rotary @ 55'.
1748 Begin mud rotary w/polymer.
1905 end drilling for today at 64.0'.
Methane produced from 49' - 53' inside borehole.

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest.

Boring # B-14/MW-5

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
89.6	93.0	Gray wthrd. siltstone, thinly bedded, tr. clay.	SS-27	66.5	68.5	18-34-45-50/5" Rec = 24" Qp = 4.5++
			SS-28	69.0	71.0	15-29-32-45 Rec = 24" Qp = 4.5++
			SS-29	71.5	73.0	23-45-50/4" Rec = 15" Qp = 4.5+
			SS-30	74.0	75.5	24-36-37 Rec = 17" Qp = 4.5++
			SS-31	76.5	78.0	26-37-44 Rec = 18" Qp = 4.5+
			SS-32	79.0	81.0	Drop Rod-27-39-50 Rec = 22" Qp = 4.5+
			SS-33	81.5	83.5	13-23-33-44 Rec = 24" Qp = 4.5+
			SS-34	84.0	86.0	7-13-21-27 Rec = 24" Qp = 4.5+
			SS-35	87.5	89.5	8-16-32-50/3" Rec = 17" Qp = 4.5+
			SS-36	90.0	90.5	50/5-1/2" Rec = 6" Qp = 4.5+
		End SS @ 93.0'. Begin coring @ 93.7'.	SS-37	92.5	93.0	50/4"

General Remarks:

* 9-18-03 Resume B-14 @ 0800 @ 64.0'.
* Drilled much harder @ 89.6'.
* 9-18-03 1240 Stopped drilling @ 92.5'.

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 1 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time 8:35	DWR %	DWRC	Down Pressure	Depth In Feet
93.0	Start core 93.7'	1	Run 9.3'	1		100%	Gray	250#	
94.0	Loss		Rec 8.15'		1:53				
	94.8'		88%						
95.0	Gray silty shale, thinly bedded.				1:35				
	95.6' High angle fracture		RQD 7.95'/ 9.3'						
96.0	96.0'				2:07				
			85%				Lt. gray		
97.0					1:47				
						4'4" added 5.0'			
98.0					1:54				
	98.3'								
99.0	Gray shale, so. silt, thinly bedded.				1:35				
							Dk. gray		
100.0					1:12				
101.0					1:03				
102.0					0:53				
103.0									

Core barrel 13.0' - End Run 1 - 103.0

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 2 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
103.0	Dark gray shale, fissil.	2	Run 10.0'	1		100	Gray	450#	
104.0			Rec 8.6'		1:45				
				104.8'					
105.0				2	1:52				
106.0			RQD 7.5'/ 10.0'		1:58				
107.0					2:30				
108.0	108.0'				1:53				
	108.3' Gray shaley limestone.					sl. drop			
109.0	Loss 109.1'				1:50				
	Dark gray limey shale, fractured, near vert., open, clean. 109.7'					sl. drop			
110.0	Loss 110.1'				2:23				
	Gray shaley limestone, tr. fossils.								
111.0	Dark gray shale, fissil.				-			250#	
112.0					3:30				
	112.65'								
	112.75' Gray shaley limestone.								
113.0					3:02				

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 3 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
113.0	Dark gray limey shale.	2		2		100	Gray	250#	
	113.85'								
114.0	104.05' Dark gray shaley, limestone, fossiliferous.								
	Dk. gray to black shale, so. lime, scattered fossils.								
115.0									
	115.9'			115.9'					
116.0				3					
	Black shale, so. lime.								
	116.5'								
117.0	Dk. gray shaley limestone to limey shale, fossiliferous.								
	117.3'								
	Loss (in hole)								
118.0	118.0'								
	EOB @ 118.0'								

9-19-03 Coring completed 1255

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P41I2 (MW-5I2)

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 1
Job #	03S5010	Boring #	~~B-14B/P-5I2~~
Location	CCB Landfill - Phase III Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	609.8
Foreman	Randy Howard	Drilling Method	HSA CME 850 ATV
Engineer/Geologist	ASY	Sampling Method	SS
Weather & Temp.		Hammer Type	Auto
Date: Start	12/16/2003 0805	Water Depth: DD	-
Finish	12/16/2003 1230	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
		No sampling to 44' (see B-14)				
44.0	47.0	Gray to brown-gray silty clay, tr. sand and gravel, occ. coal frags., v. stiff, sl. moist (till).	SS-1	44.0	46.0	5-10-15-24 Rec = 24" Qp = 4.5+
47.0	49.0	Gray f.-crs. sand, so. gravel, partially cemented, wet, methane production.	SS-2	46.5	47.3	12-50/4" till: 4.5+ Rec = 10" Qp = sand: -
49.0	50.3	Gray-brown silt, partially cemented, wet, methane production.	SS-3	49.0	51.0	8-18-28-32 silt: - to 0.5 Rec = 10" Qp = till: 4.5+
50.3	51.0	Gray-brown clayey silt, so. v.f. sand, tr. gravel, v. stiff, moist (till).				
		EOB @ 51.0'				

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-14/MW-5
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	610.3
Foreman	Randy Howard CME 850	Drilling Method	HSA/ 2-3/4" Mud Rotary
Engineer/Geologist	ASY	Sampling Method	SS/Core
Weather & Temp.	82°, Sunny, Breezy	Hammer Type	Auto
Date: Start	9/17/2003 1250	Water Depth: DD	18'
Finish	9/19/2003 1255	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brn. silt loam, moist, topsoil.	SS-1	1.5	3.5	3-5-5-5 Rec = 18" Qp = 2.5
0.5	4.5	Lt. brn.-gray to yellow-brn. silt, tr.-so. clay, moist, mottled, iron staining, roots (loess).	SS-2	4.0	6.0	3-4-4-4 Rec = 20" Qp = 1.7
4.5	7.8	Gray silt, so. iron staining, v. moist @ 6' 7", occ. roots, moist (loess).	SS-3	6.5	8.5	2-2-3-3 Rec = 24" Qp = 1.6
7.8	9.0	Brn. and gray mottled silt, tr. clay, moist (loess).	SS-4	9.0	11.0	1-2-3-4 Rec = 20" Qp = 1.3
9.0	11.0	Yel.-brn. silt, tr. clay, moist (loess).	SS-5	11.5	13.5	1-2-3-3 Rec = 24" Qp = 1.3
11.0	14.5	Red-brn. and gray clayey silt, tr. f. sand, moist (till).	SS-6	14.0	16.0	2-3-3-3 Rec = 22" Qp = 1.4 to 2.4
14.5	18.0	As above, so. f.-m. sand, tr. coal frags and gravel (till).	SS-7	16.5	18.5	2-2-2-2 Rec = 24" Qp = -
18.0	20.8	Yellow-brn. sa. silt, so. clay, tr. gravel, v. moist to wet.	SS-8	19.0	21.0	1-1-2-2 Rec = 24" Qp = -
20.8	23.3	Red-brn and gray clayey silt, tr.-so. f. sand, tr. gravel and coal frags., moist (till).	SS-9	21.5	23.5	2-4-3-5 Rec = 19" Qp = 2.2
23.3	24.0	Brn-gray silty v.f. sand, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 19" Qp = -
24.0	26.0	Lt. gray to yellow-gray silt, v. moist-wet, laminated, so. dark gray laminae, occ. wood frags.	SS-11	26.5	28.5	4-9-17-25 Rec = 23" Qp = 3.2 (till)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.0	27.5	Gray cl. silt, so. sand (f.-m.), stiff, moist, occ. f. gravel (till).	SS-12	29.0	31.0	6-11-18-24 Rec = 24" Qp = 4.5+
27.5	28.4	Red brown to brn. f.-m. sand, wet.	SS-13	31.5	33.5	5-13-25-40 Rec = 21" Qp = 4.5+ to -
28.4	33.0	Gray sa. silt, so. clay, tr. gravel, moist, v. stiff (till).	SS-14	34.0	36.0	13-29-33-44 Rec = 19" Qp = -
33.0	38.4	Gray f.-m. sand, wet, tr. crs. sand (gravel @ base), dense.	SS-15	36.5	38.5	3-17-28-22 Rec = 18" Qp = -
38.4	46.0	Gray silty clay, tr.-so. gravel (f.-m.), tr. v.f.-f. sand, occ. coal fragments, dry to mst. v. stiff (till).	SS-16	39.0	41.0	5-11-16-23 Rec = 22" Qp = 4.5+
46.0	48.6	Brown to brn.-gray f.-m. sandy silt, so. clay, tr. gravel, stiff, moist (till).	SS-17	41.5	43.5	5-12-17-24 Rec = 24" Qp = 4.5+
48.6	50.0	Gray f.-crs. sand, dry, v. dense, tr.-so. gravel, v. moist @ base, methane production.	SS-18	44.0	46.0	6-10-17-21 Rec = 23" Qp = 4.5+
50.0	51.5	Lt. gray to yel-gray silt, v. moist-wet, iron staining, methane production.	SS-19	46.5	48.0	5-20-50/5" Rec = 15" Qp = 4.3 to 4.5+
51.5	55.8	Gray-brn. v.f. sa. silt, so. clay, tr. f. gravel, moist, v. stiff (till).	SS-20	49.0	51.0	35-40-47-50/5" Rec = 24" Qp = 1.0 (silt)
55.8	65.5	Gray f.-crs. sand, tr. f. gravel and silt, wet, partially cemented (calcareous), v. dense, more gravel 61.5' - 65.5'.	SS-21	51.5	53.0	14-34-50/4" (overpacked w/sand) Rec = 12" silt Qp = 1.0 (silt)
65.5	66.5	Gray silty v.f.-m. sand, tr. gravel, partially cemented, v. dense.	SS-22	54.0	55.0	14-50 Rec = 12" Qp = 4.5+
66.5	71.7	Gray clayey silt, so. v.f.-f. sand, tr. gravel (f.-m.), calcareous, sl. moist, v. stiff (till), so. shale frags.	SS-23	56.5	58.5	18-31-31-37 Rec = 21" Qp = -
71.7	80.8	Gray v.f.-f. sa. silt, tr.-so. clay, tr. f.-m. gravel, occ. coal frags., v. stiff, sl. moist, calcareous (till).	SS-24	59.0	61.0	16-27-32-41 Rec = 18" Qp = -
80.8	84.0	Gray to dk. gray silt, tr.-so. clay, tr. v.f.-f. sand and f.-m. gravel, occ. varves, wood frags., stiff, sl. calcareous (till).	SS-25	61.5	63.5	16-26-29-30 Rec = 19" Qp = -
84.0	89.6	Dk. gray silt, tr. clay, tr. v.f. sand, occ. zones of diss. carbonaceous material (m. sand sized), occ. coal frags., occ. varved zones, v. stiff.	SS-26	64.0	65.5	12-30-50/4" Rec = 14" Qp = -

General Remarks:

1640 Switch to mud rotary @ 55'.
1748 Begin mud rotary w/polymer.
1905 end drilling for today at 64.0'.
Methane produced from 49' - 53' inside borehole.

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest.

Boring # B-14/MW-5

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
89.6	93.0	Gray wthrd. siltstone, thinly bedded, tr. clay.	SS-27	66.5	68.5	18-34-45-50/5" Rec = 24" Qp = 4.5++
			SS-28	69.0	71.0	15-29-32-45 Rec = 24" Qp = 4.5++
			SS-29	71.5	73.0	23-45-50/4" Rec = 15" Qp = 4.5+
			SS-30	74.0	75.5	24-36-37 Rec = 17" Qp = 4.5++
			SS-31	76.5	78.0	26-37-44 Rec = 18" Qp = 4.5+
			SS-32	79.0	81.0	Drop Rod-27-39-50 Rec = 22" Qp = 4.5+
			SS-33	81.5	83.5	13-23-33-44 Rec = 24" Qp = 4.5+
			SS-34	84.0	86.0	7-13-21-27 Rec = 24" Qp = 4.5+
			SS-35	87.5	89.5	8-16-32-50/3" Rec = 17" Qp = 4.5+
			SS-36	90.0	90.5	50/5-1/2" Rec = 6" Qp = 4.5+
		End SS @ 93.0'. Begin coring @ 93.7'.	SS-37	92.5	93.0	50/4"

General Remarks:

* 9-18-03 Resume B-14 @ 0800 @ 64.0'.
* Drilled much harder @ 89.6'.
* 9-18-03 1240 Stopped drilling @ 92.5'.

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 1 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time 8:35	DWR %	DWRC	Down Pressure	Depth In Feet
93.0	Start core 93.7'	1	Run 9.3'	1		100%	Gray	250#	
94.0	Loss		Rec 8.15'		1:53				
	94.8'		88%						
95.0	Gray silty shale, thinly bedded.				1:35				
	95.6' High angle		RQD 7.95'/ 9.3'						
96.0	96.0' fracture				2:07				
			85%				Lt. gray		
97.0					1:47				
						4'4" added 5.0'			
98.0					1:54				
	98.3'								
99.0	Gray shale, so. silt, thinly bedded.				1:35				
							Dk. gray		
100.0					1:12				
101.0					1:03				
102.0					0:53				
103.0									

Core barrel 13.0' - End Run 1 - 103.0

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 2 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
103.0	Dark gray shale, fissil.	2	Run 10.0'	1		100	Gray	450#	
104.0			Rec 8.6'		1:45				
105.0				104.8'	1:52				
106.0			RQD 7.5'/ 10.0'	2	1:58				
107.0					2:30				
108.0	108.0'				1:53				
	108.3' Gray shaley limestone.					sl. drop			
109.0	Loss 109.1'				1:50				
	Dark gray limey shale, fractured, near vert., open, clean. 109.7'					sl. drop			
110.0	Loss 110.1'				2:23				
	Gray shaley limestone, tr. fossils.								
111.0	Dark gray shale, fissil.				-			250#	
112.0					3:30				
	112.65'								
	112.75' Gray shaley limestone.								
113.0					3:02				

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 3 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
113.0	Dark gray limey shale.	2		2		100	Gray	250#	
	113.85'								
114.0	104.05' Dark gray shaley, limestone, fossiliferous.								
	Dk. gray to black shale, so. lime, scattered fossils.								
115.0									
	115.9'			115.9'					
116.0				3					
	Black shale, so. lime.								
	116.5'								
117.0	Dk. gray shaley limestone to limey shale, fossiliferous.								
	117.3'								
	Loss (in hole)								
118.0	118.0'								
	EOB @ 118.0'								

9-19-03 Coring completed 1255

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HANSON

P42D (MW-9D)

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 2
Job #	03S5010	Boring #	~~B-22 / MW-9~~
Location	CCB Landfill - Phase IV Site Invest.	Station	-
Driller	Testing Service Corporation	Surface Elevation	615.7
Foreman	Bruno Williamson	Drilling Method	HSA 3 1/4" I.D.
Engineer/Geologist	Scott Yankey	Sampling Method	SB/SS
Weather & Temp.	32°, Sunny, Calm	Hammer Type	Auto
Date: Start	12/8/2004	Water Depth: DD	8.5'
Finish	12/8/2004	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brown silt loam (topsoil).	SB-1	0.0	4.5	Rec = 4' Qp = 0.6
0.5	8.0	Yellow-brown silt, so. gray mottling, so. clay, iron staining, concretions, soft, moist (loess).	SB-2	4.5	9.5	Rec = 4' Qp = 0.8
8.0	11.2	Gray silt, tr. clay and v.f. sand, so. brown mottling, iron staining, concretions, moist, wet at 8.5' (loess).	SB-3	9.5	14.5	Rec = 5' Qp = 2.4
11.2	17.0	Dark gray and brown mottled clayey silt, so. v.f. sand, iron staining, stiff, moist (paleosol?).	SB-4	14.5	19.5	Rec = 5' Qp = 2.0
17.0	23.0	Brown and gray mottled silty clay, tr. v.f. sand and f. gravel, stiff, moist (till).	SB-5	19.5	24.5	Rec = 5' Qp = 2.0
23.0	24.5	Gray silt, so. v.f.-f. sand, soft v. moist.	SB-6	24.5	29.5	Rec = 2.0' Qp = -
24.5	29.5	Brown-gray f.-med. sand, wet.	SB-7	29.5	34.5	Rec = 5' Qp = 1.5-4.0
29.5	30.5	Gray clayey silt, so. sand and gravel, stiff, moist (till).	SB-8	34.5	39.5	Rec = 3' Qp = 1.7-4.5+
30.5	31.7	Gray silt, so. v.f.-f. sand, tr. gravel, wet.	SB-9	39.5	44.5	Rec = 5' Qp = 4.5+
31.7	32.2	Brown med. sand, wet.	SB-10	44.5	49.5	Rec = 5' Qp = 4.5+
32.2	35.0	Brown clayey silt, so. sand, tr.-so. gravel, v. stiff, moist (till).	SB-11	49.5	54.5	Rec = 1.0' Qp = -

General Remarks:

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Project Name Ameren Duck Creek - Phase IV Site Invest. **Boring #** B-22 / MW-9

Sheet 2 of 2

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
35.0	39.0	Gray silt, with some sand seams, wet.	SB-12	54.5	59.5	Rec = 5' Qp = 4.5+
39.0	47.0	Gray silty clay, so. v.f.-f. sand, tr.-so. gravel, occ. coal and wood fragments, v. stiff (till).	SB-13	59.5	64.5	Rec = 5' Qp = 4.5+
47.0	48.0	Gray clayey sand. so. silt and gravel, so. thin sand partings.	SB-14	64.5	69.5	Rec = 5' Qp = 4.5+
48.0	49.5	Gray silty clay, so. v.f.-f. sand, tr.-so. gravel, occ. coal and wood fragments, v. stiff, organic zone 49.1-49.2' (till).	SB-15	69.5	74.5	Rec = 2.5' Qp = -
49.5	54.5	Gray f.-v.crs. sand, partially cemented, calcareous, wet.	SB-16	74.5	79.5	Rec = 5' Qp = 4.5+
54.5	67.0	Gray clayey silt, so. v.f.-f. sand, tr.-so. gravel, calcareous (till).	SB-17	79.5	84.5	Rec = 5' Qp = 4.5+
67.0	67.5	Gray silt, wet.	SB-18	84.5	85.5	Refusal Rec = 1' Qp = 4.5+
67.5	69.5	Gray sandy silt, partially cemented, wet.	SS-1	85.5	87.0	28-50-100/3" Rec = 16" Qp = 4.5+
69.5	73.8	Gray f.-v.crs. sand, partially cemented, calcareous, wet.	SS-2	89.5	89.7	100/3" Rec = 2.5" Qp = 4.5+
73.8	74.5	Gray silt, so. v.f. sand, partially cemented, calcareous.				
74.5	79.5	Gray clayey silt, so. v.f. sand, tr.-so. gravel, occ. coal and wood fragments, v. stiff, abund. wood frags. and organics 79-79.5' (till).				
79.5	83.0	Darh gray clayey silt, so. v.f. sand, tr. gravel, v. stiff (till).				
83.0	85.5	Gray silty sand, so. silt and clay, cemented, calcareous, so. v. thin sand partings.				
85.5	89.5	Dark gray-brown sandy silt, tr. clay and gravel, cemented, calcareous.				
89.5	89.7	Dark gray weathered shale.				

General Remarks:

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	14/24 58%	SS	2-3 3-4 N=6				0		620	
							2		618	
2A	18/24 75%	SS	3-6 8-11 N=14	17.5			4	FILL - Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.	616	
3A	15/24 63%	SS	3-4 6-7 N=10	19.6			6		614	
4A	20/24 83%	SS	6-8 11-14 N=19	18.5			8		612	
5A	22/24 92%	SS	3-5 6-7 N=11	26.8			10	Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.	610	
6A	21/24 88%	SS	2-4 5-5 N=9	23.8			12	Yellowish brown (10YR5/8) with 30% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.	608	
7A	20/24 83%	SS	4-4 6-7 N=10	22.8			14		606	
8A	21/24 88%	SS	5-6 7-7 N=13	22.1			16	Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, moist, medium, SILT with few clay and trace sand.	604	
9A	21/24 88%	SS	5-5 6-6 N=11	21.0			18	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, medium, SILT with few clay and trace sand.	602	
10A	24/24 100%	SS	2-3 4-7 N=7	28.1				Dark yellowish brown (10YR3/4), moist, medium, SILT with few clay and trace sand, trace organics.		
10B				61.7			20	Dark brown (10YR3/3), moist, medium, PEAT.		

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark brown (10YR3/3), moist, medium, PEAT. *[Continued from previous page]*		600	
11A	20/24 *83%*	SS	*2-5* *6-7* N=11	31.4			22	Very dark gray (10YR3/1), moist, medium, SILT with some clay and trace sand, trace organics.		598	
12A	24/24 *100%*	SS	*9-8* *7-6* N=15	33.7			24	Very dark gray (10YR3/1), wet, medium, SILT with some clay and trace sand, trace organics. Dark brown (10YR3/3), moist, medium, PEAT.		596	
13A	20/24 *83%*	SS	*4-3* *4-4* N=7	23.0			26	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand and gravel.		594	
14A	22/24 *92%*	SS	*4-5* *6-6* N=11	20.6			28			592	
15A	24/24 *100%*	SS	*3-3* *4-5* N=7	17.5			30	Greenish gray (5G6/1), moist, medium, CLAY with some silt and trace sand and gravel.		590	
16A	24/24 *100%*	SS	*1-3* *3-3* N=6	20.2			32			588	
17A	24/24 *100%*	SS	*5-6* *6-7* N=12	15.9			34	Greenish gray (5G6/1), wet, soft, SILT with few clay, little sand, and trace gravel.		586	
	0/7 *0%*	BD						**End of Boring = 34.62 ft bgs**			

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P61
Well ID: P61
Surface Elev: 611.09 ft. MSL
Completion: 20.00 ft. BGS
Station: 1,398,670.81N
2,346,779.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	ss	--- ---					Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		610	
							2				
2A	19/24 79%	ss	1-3 3-3 N=6					Yellowish brown (10YR5/6) with 5% gray (10YR5/1) mottles, moist, medium CLAY with some silt and trace sand.		608	
							4				
3A	21/24 88%	ss	2-4 4-5 N=8					Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		606	
							6				
4A	19/24 79%	ss	woh-2 4-4 N=6					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, soft, SILT with few clay and trace sand.		604	
							▼ 8				
5A	10/24 42%	ss	1-2 2-3 N=4					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.		602	
							10	Yellowish brown (10YR5/8), moist, soft, SILT with few clay and trace sand.			
6A	17/24 71%	ss	2-2 3-3 N=5					Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, soft, SILT with few clay and trace sand.		600	
							12				
7A	24/24 100%	ss	woh-1 2-2 N=3					Brown (10YR4/3), wet, soft, SILT with few clay and trace sand.		598	
							14				
8A	24/24 100%	ss	1-2 3-3 N=5					Black (10YR2/1), moist, medium, CLAY with few silt and trace sand.		596	
							16				
9A	24/24 100%	ss	1-3 3-4 N=6					Gray (10YR5/1), moist, medium CLAY with some silt and trace sand.		594	
							18				
10A	24/24 100%	ss	1-1 3-3 N=4							592	
							20	**End of boring = 20 ft.**			

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P62
Well ID: P62
Surface Elev: 610.81 ft. MSL
Completion: 16.30 ft. BGS
Station: 1,398,887.32N
2,346,602.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---					Yellowish brown (10YR5/6), moist, medium, SILT with some clay and trace sand.		610	
							2	Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.			
2A	23/24 96%	SS	1-7 9-9 N=16					Yellowish brown (10YR5/6), moist, hard, SILT with few clay, trace sand, and trace gravel.		608	
							4				
3A	24/24 100%	SS	2-5 5-6 N=10					Gray (10YR5/1), moist, medium, SILT with few clay, trace sand, and trace gravel.		606	
							6				
4A	24/24 100%	SS	4-4 7-8 N=11					Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.		604	
							8				
5A	24/24 100%	SS	2-5 5-6 N=10							602	
							10	Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.			
6A	24/24 100%	SS	3-4 6-10 N=10							600	
							12	Dark yellowish brown (10YR4/6), moist, medium, SILT with few clay and trace sand.			
7A	23/24 96%	SS	2-3 5-6 N=8							598	
							14	Gray (10YR5/1) with 5% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand, and trace gravel			
8A	24/24 100%	SS	1-2 3-4 N=5							596	
	0/4 0%	BD					16				

End of boring = 16.3 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P63
Well ID: P63
Surface Elev: 612.33 ft. MSL
Completion: 18.25 ft. BGS
Station: 1,399,026.62N
2,346,605.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---				0			612	
								Grayish brown (10R5/2), moist, medium, CLAY with some silt, trace sand, and trace gravel.			
							2			610	
2A	24/24 100%	SS	3-7 7-10 N=14					Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.			
							4			608	
3A	24/24 100%	SS	2-4 4-4 N=8					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.			
							6			606	
4A	22/24 92%	SS	1-1 4-5 N=5					Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, moist, soft, SILT with few clay and trace sand.			
							▼ 8			604	
5A	21/24 88%	SS	2-2 3-4 N=5								
							10	Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, wet, soft, SILT with few clay and trace sand.		602	
6A	23/24 96%	SS	2-3 3-5 N=6								
							12			600	
7A	20/24 83%	SS	2-2 3-4 N=5					Dark yellowish brown (10YR3/4), moist, medium SILT with few clay and trace sand.			
							14			598	
8A	24/24 100%	SS	2-2 3-3 N=5					Gray (10YR5/1) with 35% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.			
							16			596	
9A	24/24 100%	SS	1-2 3-3 N=5					Yellowish brown(10YR5/6), moist, soft, CLAY with some silt, trace sand, and trace gravel.			
	0/4 0%	BD					18				

End of boring = 18.25 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/25/2021
Finish: 2/25/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P64
Well ID: P64
Surface Elev: 614.04 ft. MSL
Completion: 16.47 ft. BGS
Station: 1,399,305.91N
2,346,597.96E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 6.70 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---					Yellowish brown (10YR5/6), medium CLAY with some silt and trace sand.			
							2			612	
2A	23/24 96%	SS	2-4 4-5 N=8					Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace sand.			
							4			610	
3A	23/24 96%	SS	2-2 2-3 N=4					Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, soft, SILT with few clay, trace sand, and trace wood fragments.			
							6			608	
4A	20/24 83%	SS	1-2 4-4 N=6				▼				
							8			606	
5A	15/24 63%	SS	1-2 2-3 N=4					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.			
							10			604	
6A	19/24 79%	SS	1-2 2-3 N=4								
							12			602	
7A	24/24 100%	SS	1-1 2-3 N=3					Yellowish brown (10YR5/6), moist, soft, SILT with some clay and trace sand.			
							14			600	
8A	24/24 100%	SS	1-2 2-3 N=4					Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, soft, CLAY with some silt and trace sand.			
	0/6 0%	BD					16			598	

End of boring = 16.5 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/14/2017
Finish: 3/14/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: R61L
Well ID: R61L
Surface Elev: 619.96 ft. MSL
Completion: 28.67 ft. BGS
Station: 15,649.93N
994.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - At completion
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks
							0	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, moist, firm, clayey SILT.	618
							4	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, moist, firm, clayey SILT.	616
							6		614
							8	Grayish brown (10YR5/2), moist, hard, clayey SILT.	612
							10	Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.	610
							12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	608
							14		606
							16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	604
							18	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	602
							20	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	600
								Very dark gray (10YR3/1), moist, friable, micaceous,	

NOTE(S): R61L installed in blind drilled boring approximately 10 ft. west of G61L. Lithologies from boring G61L, except as indicated.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/14/2017
Finish: 3/14/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: R61L
Well ID: R61L
Surface Elev: 619.96 ft. MSL
Completion: 28.67 ft. BGS
Station: 15,649.93N
994.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - At completion
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								clayey SILT.			
1A	13/24 54%	SS	2-2 2-3 N=4	23.1				Very dark grayish brown (10YR3/2), moist, soft, CLAY with some silt and trace sand and gravel.			
							22			598	
2A	24/24 100%	SS	5-5 6-6 N=11	23.9				Very dark grayish brown (10YR3/2), moist, medium, CLAY with some silt and trace sand.			
							24			596	
3A	20/24 83%	SS	2-3 4-5 N=7	22.5				Dark gray (10YR4/1), moist, medium, CLAY with some silt and trace sand.			
							26			594	
4A	24/24 100%	SS	5-5 6-6 N=11	22.1							
							28			592	
	0/8 0%	BD									

End of Boring = 28.67 ft bgs

NOTE(S): R61L installed in blind drilled boring approximately 10 ft. west of G61L. Lithologies from boring G61L, except as indicated.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	18-12 9-8 N=21				0				
							2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		618	
2A	24/24 100%	SS	8-5 7-8 N=12	18.4							
							4			616	
3A	20/24 83%	SS	2-4 4-6 N=8	20.9							
							6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		614	
4A	24/24 100%	SS	7-9 10-11 N=19	20.1							
4B				20.5			8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
5A	19/24 79%	SS	2-3 6-7 N=9	26.5				Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.			
							10			610	
6A	20/24 83%	SS	2-3 4-4 N=7	24.4							
							12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
7A	24/24 100%	SS	4-4 5-6 N=9	24.0							
							14			606	
8A	22/24 92%	SS	3-4 5-5 N=9	25.0							
							16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
9A	24/24 100%	SS	3-3 4-6 N=7	23.9				Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			
							18			602	
10A	22/24 92%	SS	2-3 3-4 N=6	25.0				Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							20 ▼	Very dark gray (10YR3/1), slightly moist, friable,		600	
10B				28.2							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								micaceous, clayey SILT.			
11A	19/24 *79%*	SS	*3-4* *5-6* N=9	35.8							
11B				26.0			22	Dark gray (10YR4/1), moist, soft, clayey SILT.		598	
12A	24/24 *100%*	SS	*4-3* *6-9* N=9	25.3							
13A	20/24 *83%*	SS	*woh-3* *4-6* N=7	24.4			24			596	
14A	24/24 *100%*	SS	*3-3* *5-6* N=8	22.4			26	Greenish gray (5GY5/1), moist, soft, silty CLAY with slight trace sand.		594	
15A	22/24 *92%*	SS	*woh-3* *3-4* N=6	21.5			28			592	
16A	19/24 *79%*	SS	*woh-1* *3-3* N=4	16.7			30	Greenish gray (5GY5/1), very moist, very soft, sandy CLAY with slight trace gravel.		590	
17A	24/24 *100%*	SS	*3-4* *5-5* N=9	18.8			32			588	
17B				13.6				Greenish gray (10Y5/1), slightly moist, soft, clayey SILT with trace sand and slight trace gravel.			
18A	19/24 *79%*	SS	*1-7* *7-7* N=14	20.7			34			586	
								Medium light gray (N6/1), wet, firm, SILT with slight trace sand and gravel.			
19A	24/24 *100%*	SS	*7-11* *19-32* N=30	12.4			36			584	
								Greenish gray (10Y5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.			
							38	**End of Boring = 38.0 ft bgs**		582	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G61a
Well ID: G61L
Surface Elev: 620.00 ft. MSL
Completion: 19.90 ft. BGS
Station: 15,640.94N
994.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.	618
4		616
6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.	614
8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.	612
	Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.	
10		610
12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	608
14		606
16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.	604
	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.	
18		602
	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	
▼	Very dark gray (10YR3/1), slightly moist, friable, micaceous, clayey SILT.	

End of Boring = 19.9 ft bgs

NOTE(S): See G61S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

~~R72S~~

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72~~
Well ID: ~~G72S~~
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	3-3 6-6 N=9	20.4			0	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	3-5 6-6 N=11	18.3			2				
3A	24/24 100%	SS	3-5 6-9 N=11	15.7			4			612	
4A	24/24 100%	SS	10-14 16-16 N=30	21.3			6	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.		610	
5A	24/24 100%	SS	3-4 6-7 N=10	19.3			8			608	
6A	24/24 100%	SS	2-3 6-8 N=9	18.2			10	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.		606	
7A	20/24 83%	SS	5-7 12-13 N=19	9.2			12			604	
8A	24/24 100%	SS	1-3 4-6 N=7	11.1			14	Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		602	
9A	24/24 100%	SS	5-7 10-9 N=17	12.3			16			600	
10A	24/24 100%	SS	1-3 4-7 N=7	17.5			18	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.		598	
	24/24		1-3				20	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.		596	
								Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	100%	SS	4-8 N=7	16.6			22	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand. *[Continued from previous page]*			
12A	24/24 100%	SS	4-8 12-13 N=20	19.1			24	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		592	
13A	24/24 100%	SS	1-3 5-8 N=8	17.4			26	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.		590	
14A	24/24 100%	SS	5-6 8-8 N=14	21.2			28	Yellowish brown (10YR5/8) with 10% gray (10YR6/1) mottles, very moist, soft, silty CLAY with trace sand.		588	
15A	24/24 100%	SS	woh-1 2-3 N=3	26.5			30	Gray (10YR6/1) with 20% yellowish brown (10YR5/8) mottles, very moist to wet, very soft, silty CLAY with trace sand and slight trace gravel.		586	
16A	24/24 100%	SS	1-3 6-10 N=9	19.3				Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, wet, very soft, clayey SILT with some very fine-grained sand and slight trace gravel.		584	
16B				15.9			32	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
17A	20/24 83%	SS	5-10 13-11 N=23	24.9				Brownish yellow (10YR6/6), wet, soft, clayey SILT with trace very fine-grained sand.		582	
18A				27.8			34	Dark gray (10YR4/1), moist, firm, very silty CLAY with slight trace sand.			
18B	24/24 100%	SS	2-6 7-9 N=13	11.1				Dark gray (10YR4/1), moist, loose, SILT and very fine-grained SAND.		580	
19A	24/24 100%	SS	7-9 12-14 N=21	11.1			36	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		578	
20A	17/17 100%	SS	26-45 50/5"	9.4			38			576	

End of Boring = 39.40 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

WELL CONSTRUCTION LOGS

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: G54C

Site Name: Duck Creek Part 845 Groundwater Borehole #: G54C

State Plane Coordinate: X 2,348,250.1 Y 1,384,885.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Tad A. Gass Date Started: 2/3/2021 Date Finished: 2/5/2021

Report Form Completed By: Tad A. Gass Date: 2/23/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: tremie

Setting Time: 45 min.

Type of Bentonite Seal -- Granular (Pellet) Slurry (choose one)

Installation Method: gravity

Setting Time: 25 min.

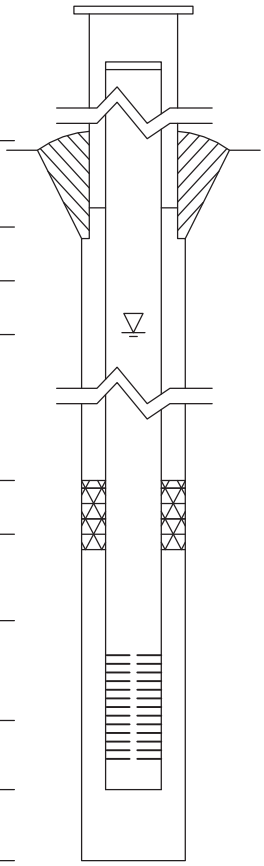
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
623.03	-3.43	Top of Protective Casing
622.72	-3.13	Top of Riser Pipe
619.59	0.00	Ground Surface
615.59	4.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
530.00	89.59	Top of Sand Pack
528.00	91.59	Top of Screen
518.09	101.50	Bottom of Screen
517.59	102.00	Bottom of Well
517.59	102.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	95.56
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.07
Total Length of Casing	(feet)	105.13
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P61

Site Name: Duck Creek Part 845 Groundwater Borehole #: P61

State Plane Coordinate: X 2,346,779.3 Y 1,398,670.8 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

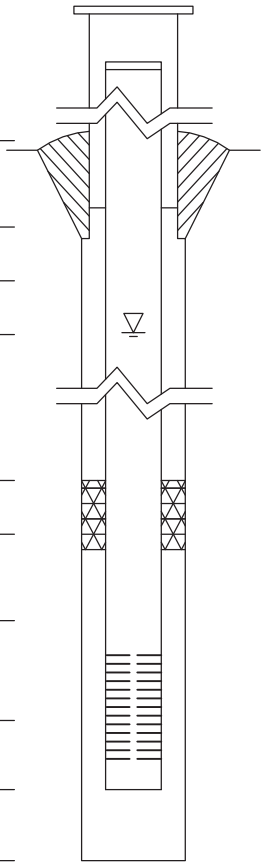
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.31	-3.21	Top of Protective Casing
613.96	-2.87	Top of Riser Pipe
611.09	0.00	Ground Surface
607.58	3.51	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
603.54	7.55	Top of Sand Pack
602.38	8.71	Top of Screen
592.72	18.37	Bottom of Screen
592.33	18.76	Bottom of Well
591.09	20.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	11.58
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	9.66
Total Length of Casing	(feet)	21.63
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P62

Site Name: Duck Creek Part 845 Groundwater Borehole #: P62

State Plane Coordinate: X 2,346,602.3 Y 1,398,887.3 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

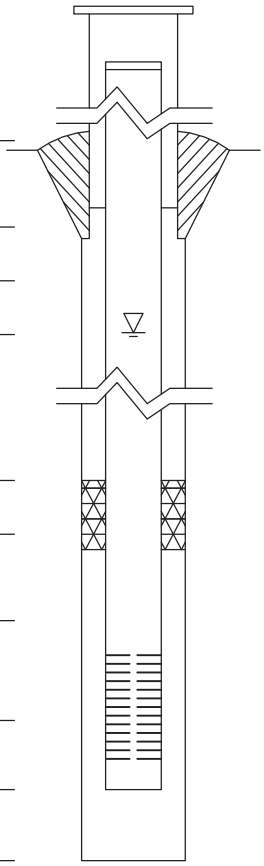
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.96	-3.15	Top of Protective Casing
613.54	-2.73	Top of Riser Pipe
610.81	0.00	Ground Surface
607.89	2.92	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
601.33	9.48	Top of Sand Pack
599.63	11.18	Top of Screen
595.03	15.78	Bottom of Screen
594.51	16.30	Bottom of Well
594.51	16.30	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	16.30
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	4.60
Total Length of Casing	(feet)	21.42
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P63

Site Name: Duck Creek Part 845 Groundwater Borehole #: P63

State Plane Coordinate: X 2,346,605.9 Y 1,399,026.6 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

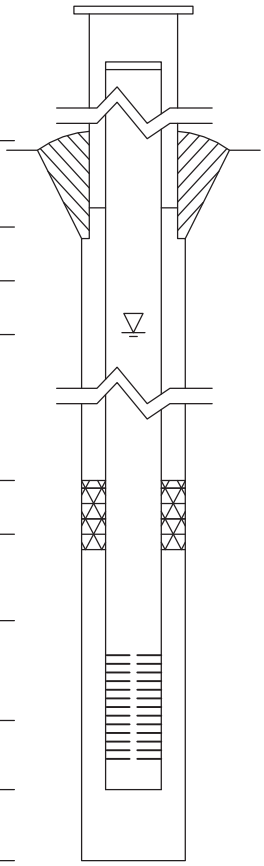
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.85	-2.52	Top of Protective Casing
614.47	-2.15	Top of Riser Pipe
612.33	0.00	Ground Surface
609.23	3.10	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
600.98	11.35	Top of Sand Pack
599.29	13.04	Top of Screen
594.70	17.63	Bottom of Screen
594.08	18.25	Bottom of Well
594.08	18.25	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.19
Bottom of Screen to End Cap	(feet)	0.62
Screen Length (1st slot to last slot)	(feet)	4.59
Total Length of Casing	(feet)	20.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P64

Site Name: Duck Creek Part 845 Groundwater Borehole #: P64

State Plane Coordinate: X 2,346,598.0 Y 1,399,305.9 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/25/2021 Date Finished: 2/25/2021

Report Form Completed By: Tad A. Gass Date: 2/25/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

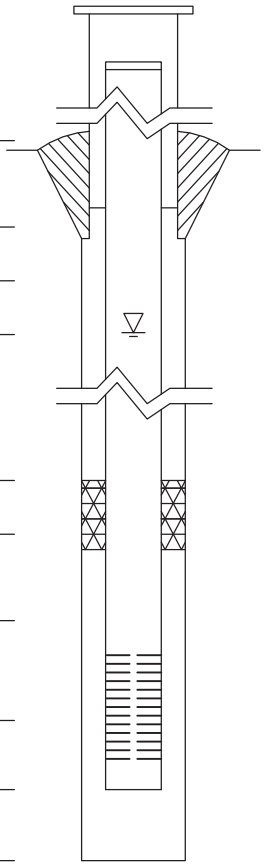
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
616.83	-2.78	Top of Protective Casing
616.47	-2.43	Top of Riser Pipe
614.04	0.00	Ground Surface
611.04	3.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
608.96	5.08	Top of Sand Pack
607.87	6.17	Top of Screen
598.08	15.96	Bottom of Screen
597.57	16.47	Bottom of Well
597.57	16.47	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

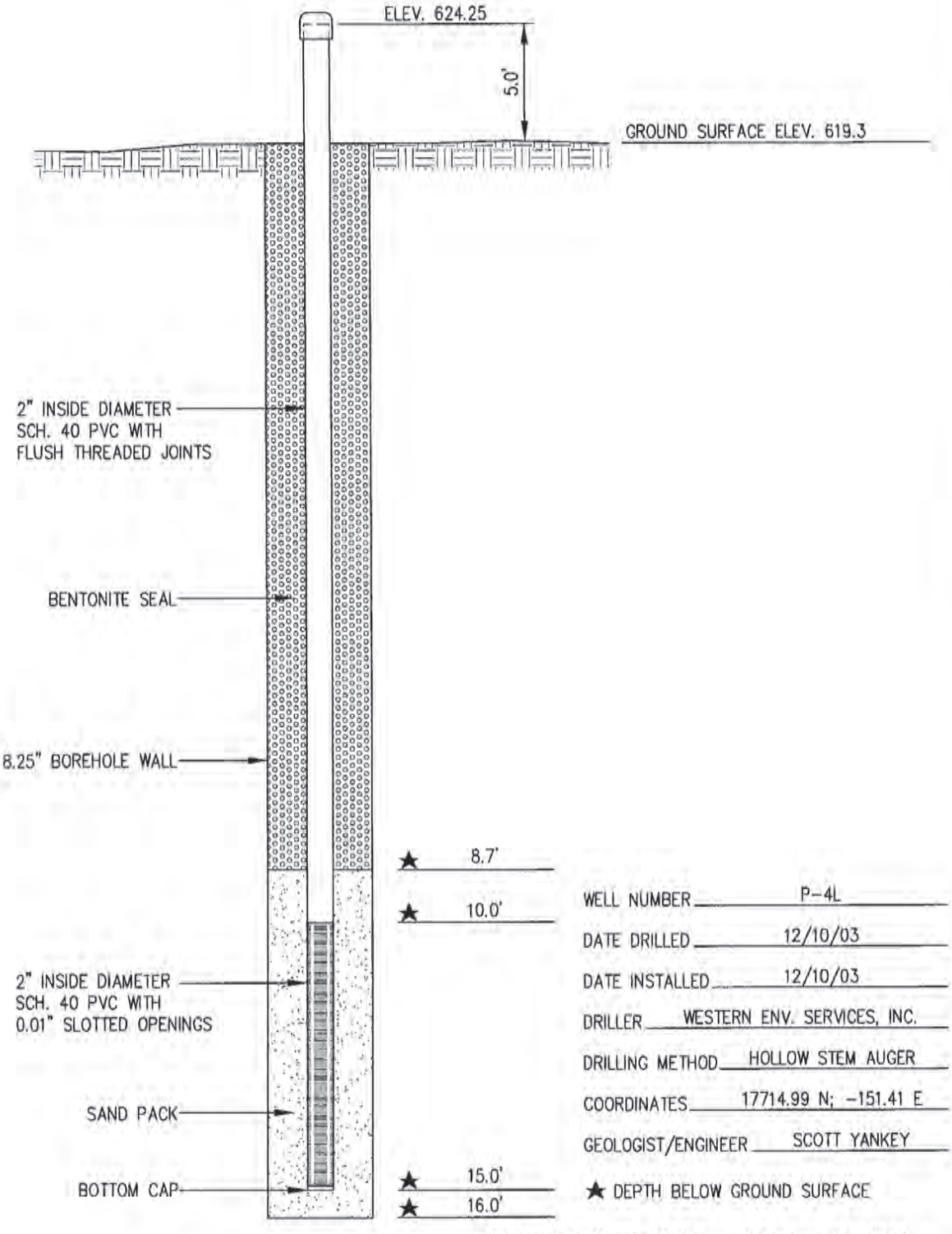
CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	9.19
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	9.19
Total Length of Casing	(feet)	18.90
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

G02L (MW-4L)



WELL NUMBER P-4L

DATE DRILLED 12/10/03

DATE INSTALLED 12/10/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 17714.99 N; -151.41 E

GEOLOGIST/ENGINEER SCOTT YANKEY

★ DEPTH BELOW GROUND SURFACE

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PIEZOMETER P-4L CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 24, 2004 3:13 PM KDE
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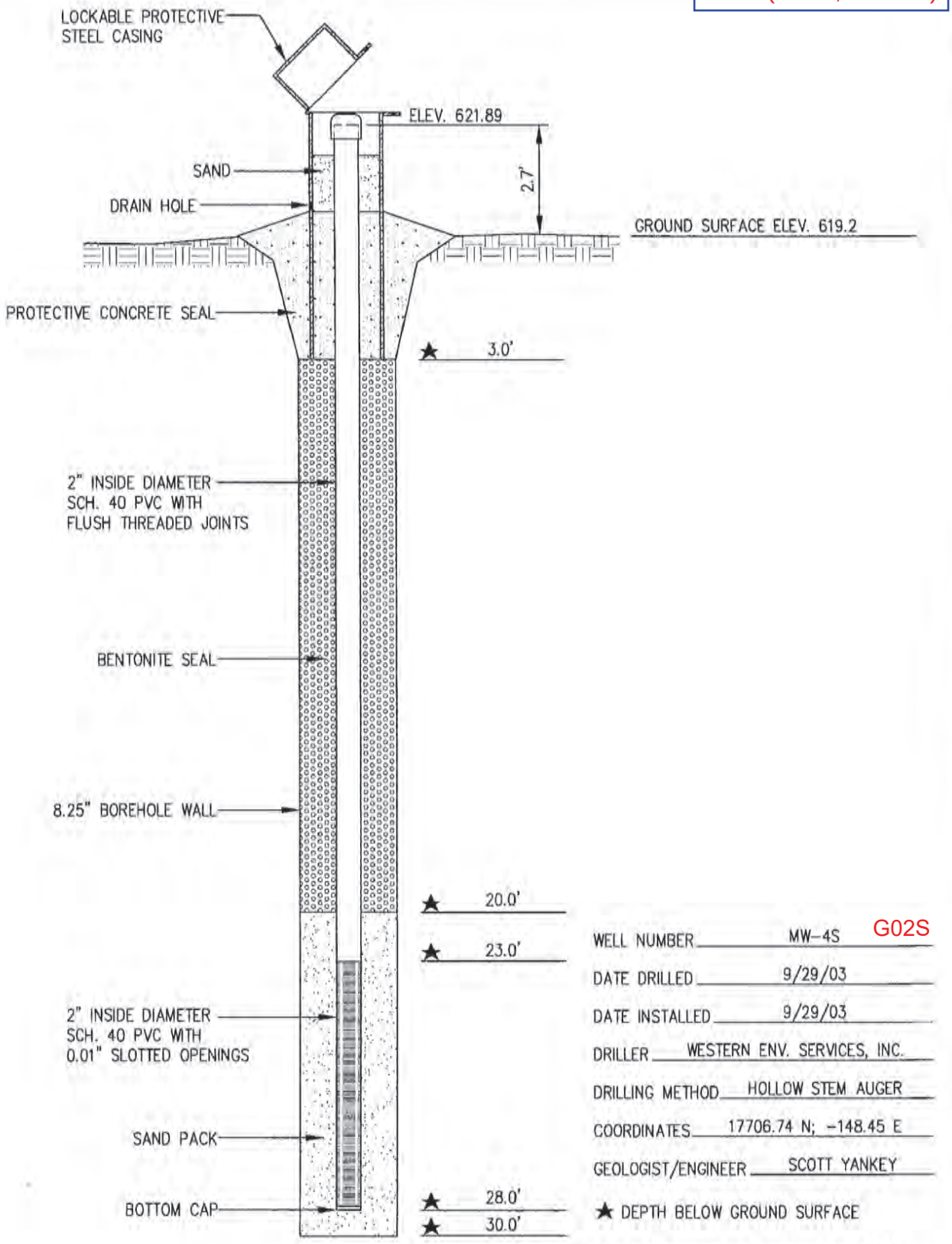
Electronic Filing: Received, Clerk's Office 06/20/2024

G02S (P02S, MW-4S)



G02S

WELL NUMBER MW-4S

DATE DRILLED 9/29/03

DATE INSTALLED 9/29/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 17706.74 N; -148.45 E

GEOLOGIST/ENGINEER SCOTT YANKEY

★ DEPTH BELOW GROUND SURFACE

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MONITORING WELL MW-4S CONSTRUCTION DETAIL

PHASE II HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 23, 2004 1:50 PM KDE
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Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50L (MW51L)

Site #: _____ County: Fulton Well #: ~~MW51L~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51a~~

State Plane Coordinate: X 16,174.9 Y -5.3 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: gravity

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hr

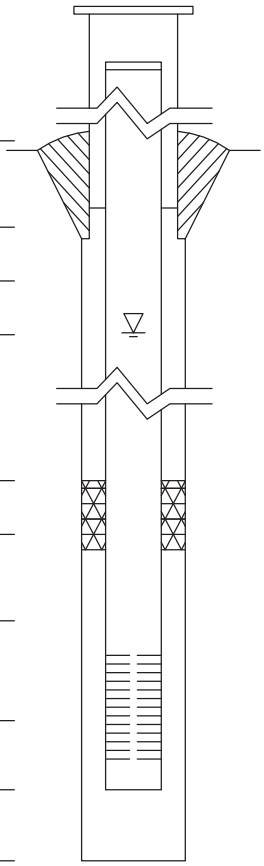
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.31	-3.47	Top of Protective Casing
623.83	-2.99	Top of Riser Pipe
620.84	0.00	Ground Surface
620.54	0.30	Top of Annular Sealant
615.27	5.57	Static Water Level (After Completion) 3/29/2007
620.54	0.30	Top of Seal
610.81	10.03	Top of Sand Pack
609.23	11.61	Top of Screen
604.52	16.32	Bottom of Screen
604.13	16.71	Bottom of Well
604.13	16.71	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	14.60
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	19.70
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50S (MW51S)

Site #: _____ County: Fulton Well #: ~~MW51S~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51b~~

State Plane Coordinate: X 16,180.8 Y -5.1 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

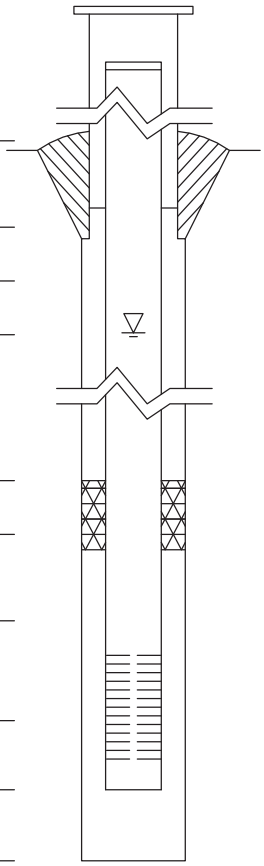
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.22	-3.38	Top of Protective Casing
623.82	-2.98	Top of Riser Pipe
620.84	0.00	Ground Surface
620.54	0.30	Top of Annular Sealant
614.98	5.86	Static Water Level (After Completion) 3/29/2007
597.42	23.42	Top of Seal
593.80	27.04	Top of Sand Pack
591.67	29.17	Top of Screen
586.86	33.98	Bottom of Screen
586.52	34.32	Bottom of Well
586.52	34.32	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.25
Bottom of Screen to End Cap	(feet)	0.34
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	37.30
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.7 Y 15,409.7 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time:

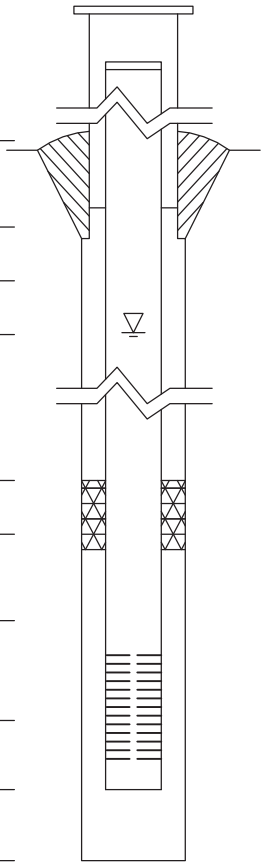
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand
(if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.35	-3.44	Top of Protective Casing
619.91	-3.00	Top of Riser Pipe
616.91	0.00	Ground Surface
614.81	2.10	Top of Annular Sealant
606.34	10.57	Static Water Level (After Completion) 1/30/2008
614.81	2.10	Top of Seal
606.77	10.14	Top of Sand Pack
604.87	12.04	Top of Screen
600.08	16.83	Bottom of Screen
599.70	17.21	Bottom of Well
599.19	17.72	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.15
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	20.32
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51a~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.3 Y 15,405.4 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

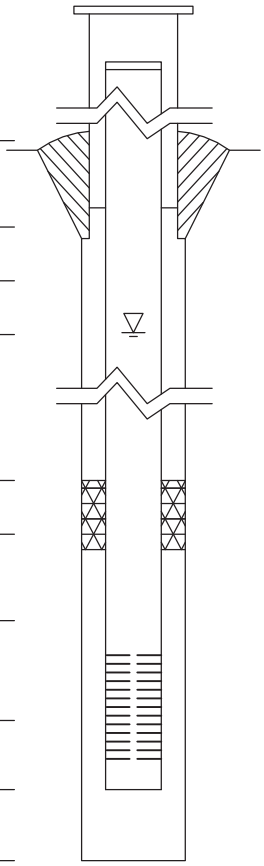
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.32	-3.52	Top of Protective Casing
619.81	-3.01	Top of Riser Pipe
616.80	0.00	Ground Surface
614.50	2.30	Top of Annular Sealant
606.39	10.41	Static Water Level (After Completion) 1/30/2008
597.05	19.75	Top of Seal
594.58	22.22	Top of Sand Pack
592.79	24.01	Top of Screen
588.01	28.79	Bottom of Screen
587.64	29.16	Bottom of Well
587.64	29.16	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	27.02
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	32.17
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.5 Y 14,660.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/22/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time: 12 hrs

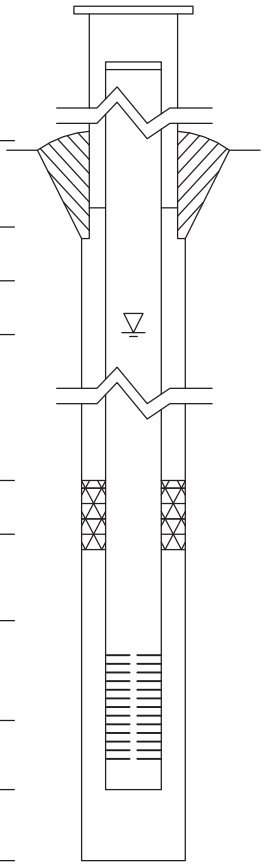
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material:
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.10	-3.40	Top of Protective Casing
619.64	-2.94	Top of Riser Pipe
616.70	0.00	Ground Surface
614.50	2.20	Top of Annular Sealant
587.92	28.78	Static Water Level (After Completion) 1/30/2008
591.25	25.45	Top of Seal
588.79	27.91	Top of Sand Pack
587.49	29.21	Top of Screen
582.90	33.80	Bottom of Screen
582.53	34.17	Bottom of Well
582.53	34.17	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.15
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	37.31
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.1 Y 14,655.3 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/21/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 min

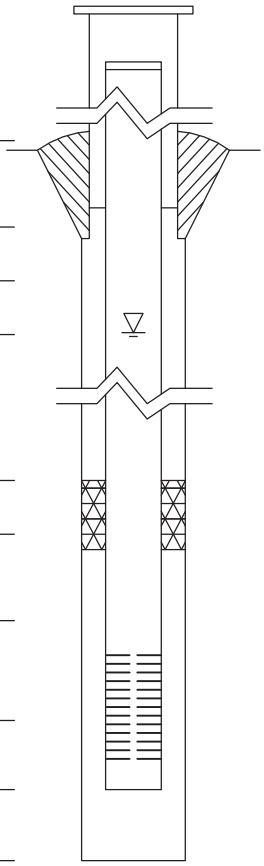
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.19	-3.66	Top of Protective Casing
619.64	-3.11	Top of Riser Pipe
616.53	0.00	Ground Surface
613.33	3.20	Top of Annular Sealant
584.08	32.45	Static Water Level (After Completion) 1/30/2008
582.26	34.27	Top of Seal
579.31	37.22	Top of Sand Pack
577.38	39.15	Top of Screen
572.60	43.93	Bottom of Screen
572.33	44.20	Bottom of Well
570.53	46.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	42.29
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	47.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53L

Site Name: Gypsum Management Facility Borehole #: ~~G53a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 506.3 Y 16,200.0 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 25 minutes

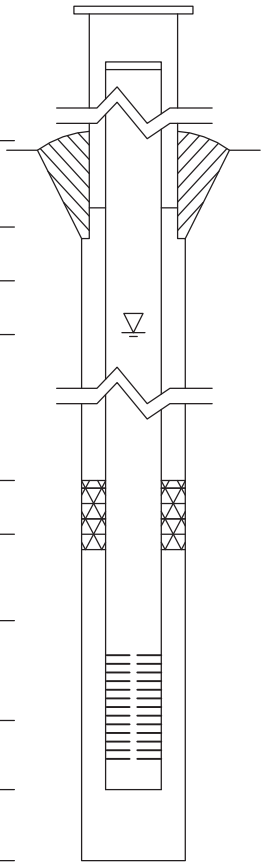
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.61	-3.32	Top of Protective Casing
623.28	-2.99	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
600.45	19.84	Static Water Level (After Completion) 3/4/2009
607.79	12.50	Top of Seal
605.67	14.62	Top of Sand Pack
603.32	16.97	Top of Screen
593.97	26.32	Bottom of Screen
593.50	26.79	Bottom of Well
593.50	26.79	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.96
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	29.78
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53S

Site Name: Gypsum Management Facility Borehole #: ~~G53~~

~~State~~ Plant ~~Plane~~ Coordinate: X 510.5 Y 16,199.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

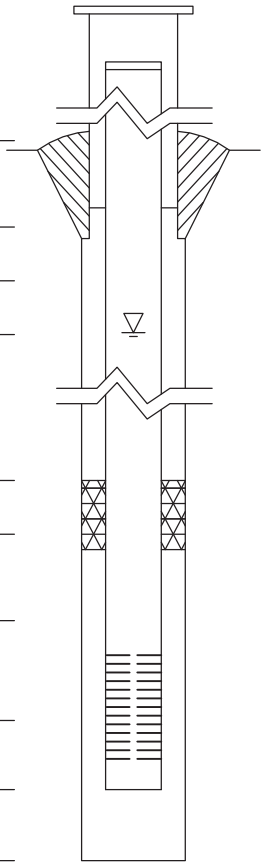
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.33	-3.04	Top of Protective Casing
623.17	-2.88	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
599.63	20.66	Static Water Level (After Completion) 3/4/2009
595.29	25.00	Top of Seal
592.29	28.00	Top of Sand Pack
589.65	30.64	Top of Screen
585.16	35.13	Bottom of Screen
584.73	35.56	Bottom of Well
584.25	36.04	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	33.52
Bottom of Screen to End Cap	(feet)	0.43
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	38.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: G54C

Site Name: Duck Creek Part 845 Groundwater Borehole #: G54C

State Plane Coordinate: X 2,348,250.1 Y 1,384,885.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Tad A. Gass Date Started: 2/3/2021 Date Finished: 2/5/2021

Report Form Completed By: Tad A. Gass Date: 2/23/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: tremie

Setting Time: 45 min.

Type of Bentonite Seal -- Granular (Pellet) Slurry (choose one)

Installation Method: gravity

Setting Time: 25 min.

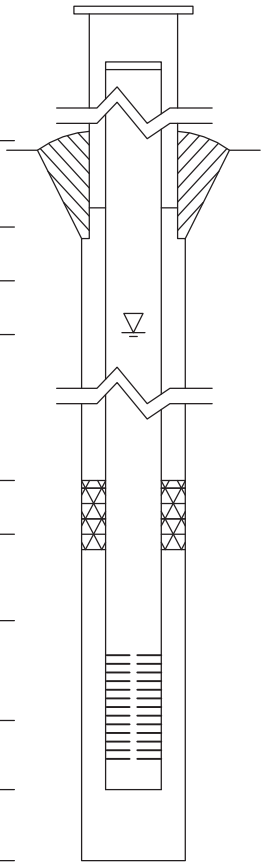
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.03	-3.43	Top of Protective Casing
622.72	-3.13	Top of Riser Pipe
619.59	0.00	Ground Surface
615.59	4.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
530.00	89.59	Top of Sand Pack
528.00	91.59	Top of Screen
518.09	101.50	Bottom of Screen
517.59	102.00	Bottom of Well
517.59	102.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	95.56
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.07
Total Length of Casing	(feet)	105.13
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54L

Site Name: Gypsum Management Facility Borehole #: ~~G54a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 463.8 Y 14,664.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

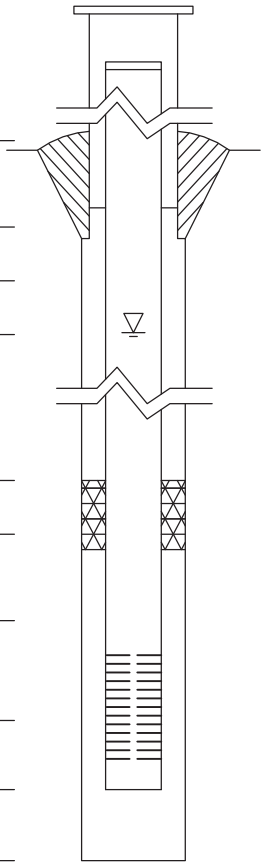
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.37	-3.09	Top of Protective Casing
623.00	-2.72	Top of Riser Pipe
620.28	0.00	Ground Surface
618.48	1.80	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
597.78	22.50	Top of Seal
595.28	25.00	Top of Sand Pack
592.96	27.32	Top of Screen
583.53	36.75	Bottom of Screen
583.06	37.22	Bottom of Well
583.06	37.22	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.04
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.43
Total Length of Casing	(feet)	39.94
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54S

Site Name: Gypsum Management Facility Borehole #: ~~G54~~

~~State~~ Plant ~~Plane~~ Coordinate: X 460.5 Y 14,664.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 60 minutes

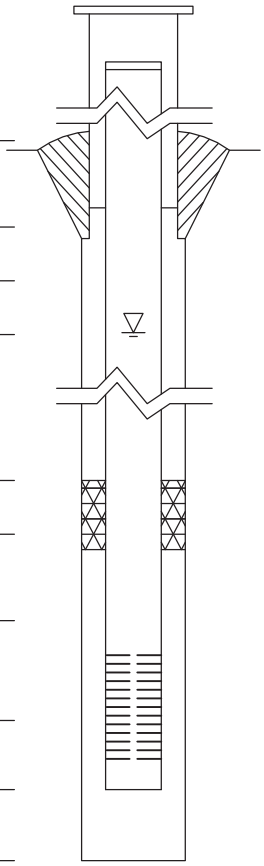
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.54	-3.26	Top of Protective Casing
623.13	-2.85	Top of Riser Pipe
620.28	0.00	Ground Surface
618.38	1.90	Top of Annular Sealant
580.98	39.30	Static Water Level (After Completion) 3/4/2009
580.78	39.50	Top of Seal
578.61	41.67	Top of Sand Pack
576.78	43.50	Top of Screen
572.31	47.97	Bottom of Screen
571.87	48.41	Bottom of Well
571.87	48.41	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	46.50
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.47
Total Length of Casing	(feet)	51.41
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55L

Site Name: Gypsum Management Facility Borehole #: ~~G55a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.1 Y 14,667.7 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 22 minutes

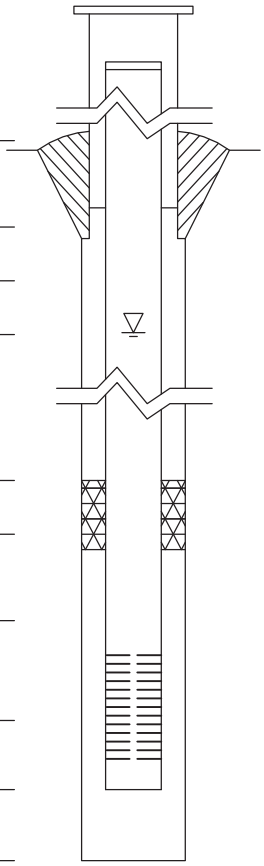
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.47	-3.69	Top of Protective Casing
623.28	-3.50	Top of Riser Pipe
619.78	0.00	Ground Surface
617.78	2.00	Top of Annular Sealant
585.79	33.99	Static Water Level (After Completion) 3/4/2009
597.95	21.83	Top of Seal
596.28	23.50	Top of Sand Pack
593.02	26.76	Top of Screen
583.66	36.12	Bottom of Screen
583.18	36.60	Bottom of Well
583.18	36.60	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.26
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	40.10
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55S

Site Name: Gypsum Management Facility Borehole #: ~~G55~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.0 Y 14,663.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 55 minutes

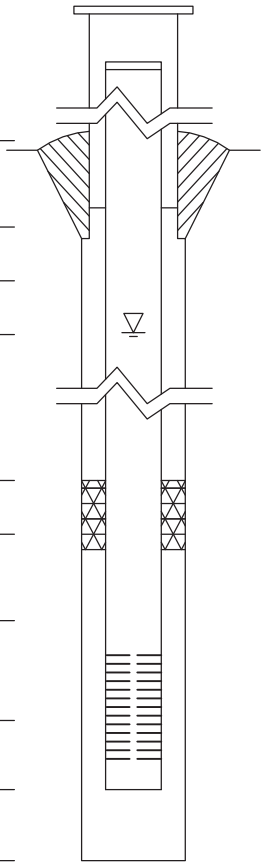
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.21	-3.43	Top of Protective Casing
622.91	-3.13	Top of Riser Pipe
619.78	0.00	Ground Surface
617.95	1.83	Top of Annular Sealant
586.49	33.29	Static Water Level (After Completion) 3/4/2009
582.78	37.00	Top of Seal
580.95	38.83	Top of Sand Pack
578.74	41.04	Top of Screen
574.29	45.49	Bottom of Screen
573.82	45.96	Bottom of Well
573.82	45.96	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

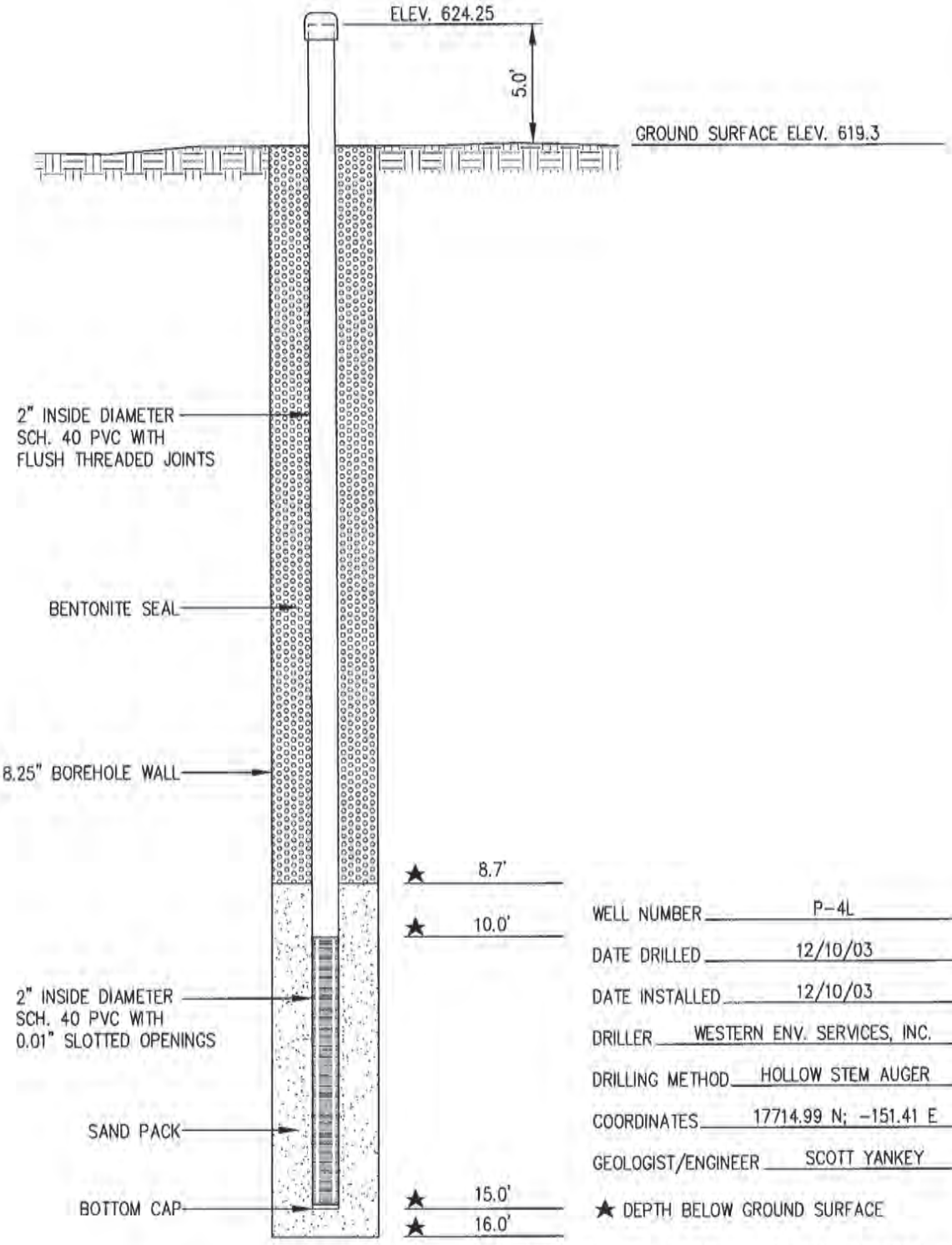
CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	44.17
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	4.45
Total Length of Casing	(feet)	49.09
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

G02L (MW-4L)



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PIEZOMETER P-4L CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 24, 2004 3:13 PM KDE
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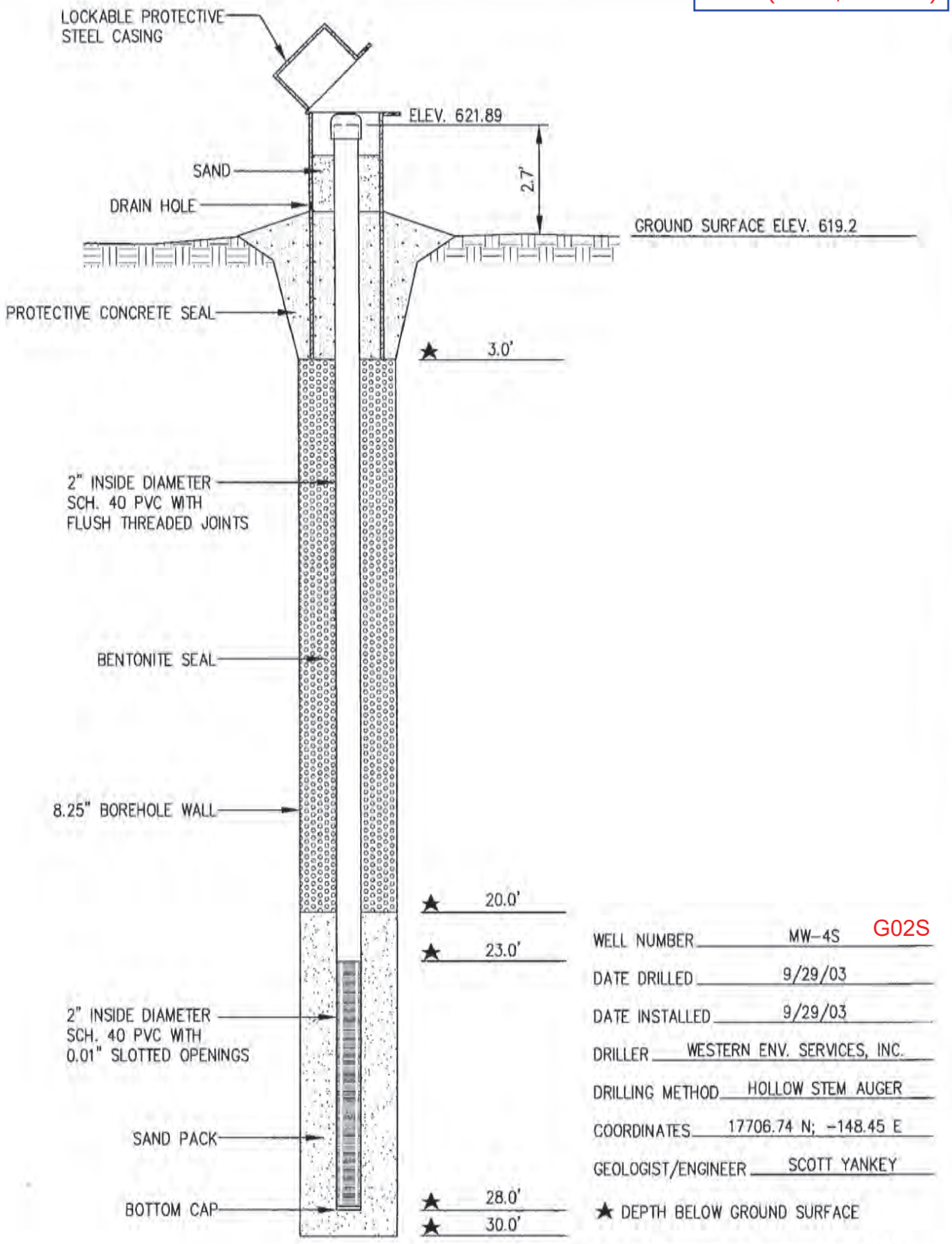
Electronic Filing: Received, Clerk's Office 06/20/2024

G02S (P02S, MW-4S)



G02S

WELL NUMBER MW-4S

DATE DRILLED 9/29/03

DATE INSTALLED 9/29/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 17706.74 N; -148.45 E

GEOLOGIST/ENGINEER SCOTT YANKEY

★ DEPTH BELOW GROUND SURFACE

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MONITORING WELL MW-4S CONSTRUCTION DETAIL

PHASE II HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

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Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50L (MW51L)

Site #: _____ County: Fulton Well #: ~~MW51L~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51a~~

State Plane Coordinate: X 16,174.9 Y -5.3 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: gravity

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hr

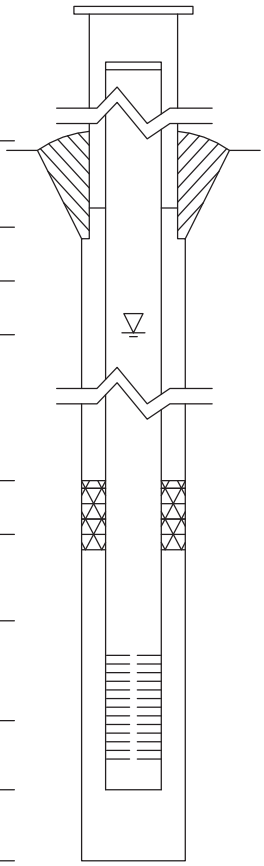
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.31	-3.47	Top of Protective Casing
623.83	-2.99	Top of Riser Pipe
620.84	0.00	Ground Surface
620.54	0.30	Top of Annular Sealant
615.27	5.57	Static Water Level (After Completion) 3/29/2007
620.54	0.30	Top of Seal
610.81	10.03	Top of Sand Pack
609.23	11.61	Top of Screen
604.52	16.32	Bottom of Screen
604.13	16.71	Bottom of Well
604.13	16.71	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	14.60
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	19.70
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50S (MW51S)

Site #: _____ County: Fulton Well #: ~~MW51S~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51b~~

State Plane Coordinate: X 16,180.8 Y -5.1 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

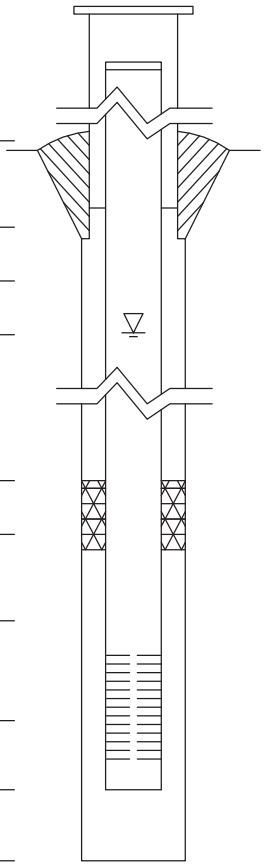
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



	Elevations (MSL)*	Depths (BGS) (0.01 ft.)
Top of Protective Casing	624.22	-3.38
Top of Riser Pipe	623.82	-2.98
Ground Surface	620.84	0.00
Top of Annular Sealant	620.54	0.30
Static Water Level (After Completion) 3/29/2007	614.98	5.86
Top of Seal	597.42	23.42
Top of Sand Pack	593.80	27.04
Top of Screen	591.67	29.17
Bottom of Screen	586.86	33.98
Bottom of Well	586.52	34.32
Bottom of Borehole	586.52	34.32

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.25
Bottom of Screen to End Cap	(feet)	0.34
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	37.30
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.7 Y 15,409.7 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time:

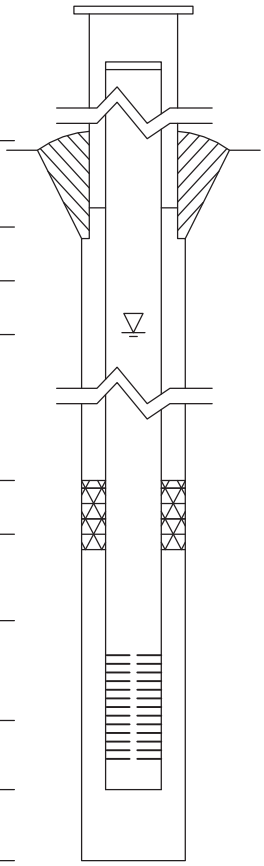
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand
(if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.35	-3.44	Top of Protective Casing
619.91	-3.00	Top of Riser Pipe
616.91	0.00	Ground Surface
614.81	2.10	Top of Annular Sealant
606.34	10.57	Static Water Level (After Completion) 1/30/2008
614.81	2.10	Top of Seal
606.77	10.14	Top of Sand Pack
604.87	12.04	Top of Screen
600.08	16.83	Bottom of Screen
599.70	17.21	Bottom of Well
599.19	17.72	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.15
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	20.32
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51a~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.3 Y 15,405.4 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

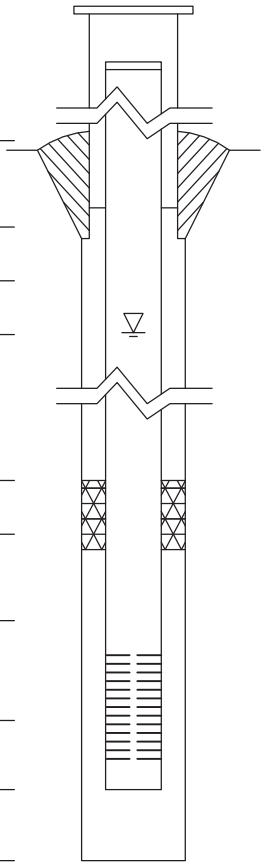
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.32	-3.52	Top of Protective Casing
619.81	-3.01	Top of Riser Pipe
616.80	0.00	Ground Surface
614.50	2.30	Top of Annular Sealant
606.39	10.41	Static Water Level (After Completion) 1/30/2008
597.05	19.75	Top of Seal
594.58	22.22	Top of Sand Pack
592.79	24.01	Top of Screen
588.01	28.79	Bottom of Screen
587.64	29.16	Bottom of Well
587.64	29.16	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	27.02
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	32.17
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.5 Y 14,660.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/22/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time: 12 hrs

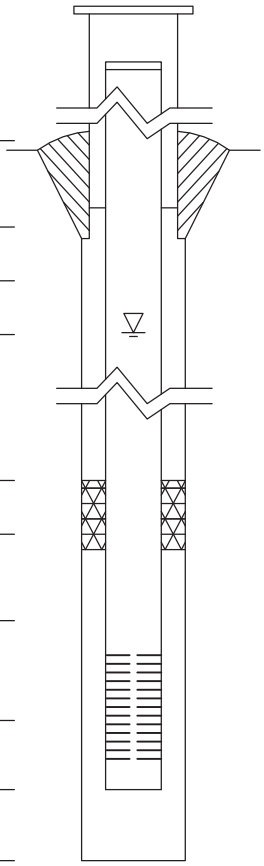
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material:
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.10	-3.40	Top of Protective Casing
619.64	-2.94	Top of Riser Pipe
616.70	0.00	Ground Surface
614.50	2.20	Top of Annular Sealant
587.92	28.78	Static Water Level (After Completion) 1/30/2008
591.25	25.45	Top of Seal
588.79	27.91	Top of Sand Pack
587.49	29.21	Top of Screen
582.90	33.80	Bottom of Screen
582.53	34.17	Bottom of Well
582.53	34.17	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.15
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	37.31
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.1 Y 14,655.3 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/21/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 min

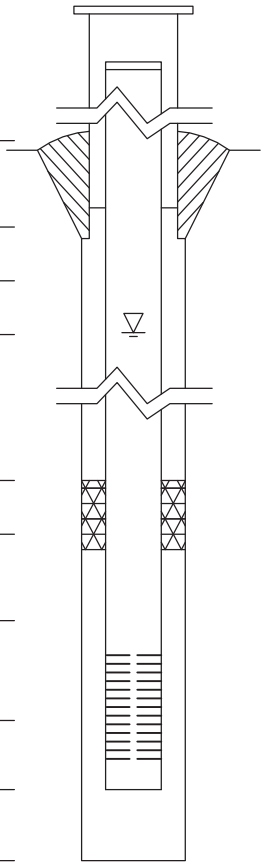
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.19	-3.66	Top of Protective Casing
619.64	-3.11	Top of Riser Pipe
616.53	0.00	Ground Surface
613.33	3.20	Top of Annular Sealant
584.08	32.45	Static Water Level (After Completion) 1/30/2008
582.26	34.27	Top of Seal
579.31	37.22	Top of Sand Pack
577.38	39.15	Top of Screen
572.60	43.93	Bottom of Screen
572.33	44.20	Bottom of Well
570.53	46.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	42.29
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	47.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53L

Site Name: Gypsum Management Facility Borehole #: ~~G53a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 506.3 Y 16,200.0 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

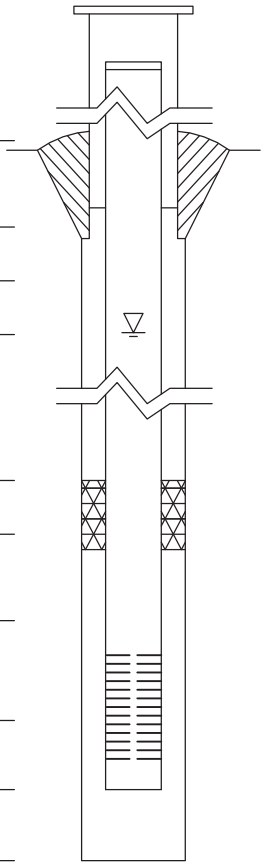
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.61	-3.32	Top of Protective Casing
623.28	-2.99	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
600.45	19.84	Static Water Level (After Completion) 3/4/2009
607.79	12.50	Top of Seal
605.67	14.62	Top of Sand Pack
603.32	16.97	Top of Screen
593.97	26.32	Bottom of Screen
593.50	26.79	Bottom of Well
593.50	26.79	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.96
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	29.78
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53S

Site Name: Gypsum Management Facility Borehole #: ~~G53~~

~~State~~ Plant ~~Plane~~ Coordinate: X 510.5 Y 16,199.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

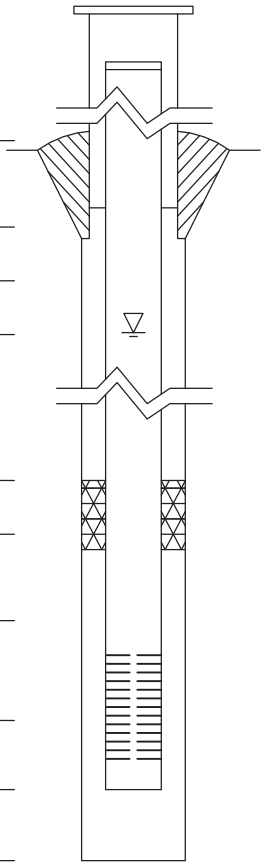
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.33	-3.04	Top of Protective Casing
623.17	-2.88	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
599.63	20.66	Static Water Level (After Completion) 3/4/2009
595.29	25.00	Top of Seal
592.29	28.00	Top of Sand Pack
589.65	30.64	Top of Screen
585.16	35.13	Bottom of Screen
584.73	35.56	Bottom of Well
584.25	36.04	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	33.52
Bottom of Screen to End Cap	(feet)	0.43
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	38.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: G54C

Site Name: Duck Creek Part 845 Groundwater Borehole #: G54C

State Plane Coordinate: X 2,348,250.1 Y 1,384,885.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Tad A. Gass Date Started: 2/3/2021 Date Finished: 2/5/2021

Report Form Completed By: Tad A. Gass Date: 2/23/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: tremie

Setting Time: 45 min.

Type of Bentonite Seal -- Granular (Pellet) Slurry (choose one)

Installation Method: gravity

Setting Time: 25 min.

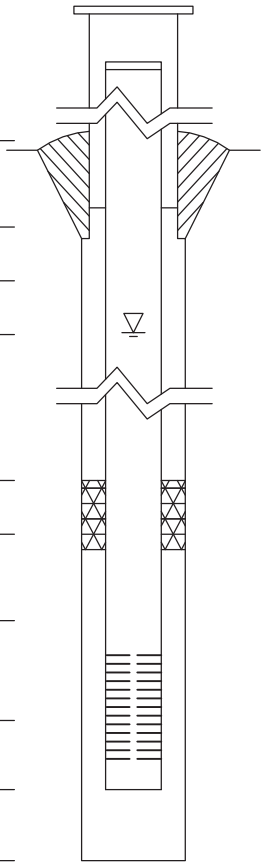
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.03	-3.43	Top of Protective Casing
622.72	-3.13	Top of Riser Pipe
619.59	0.00	Ground Surface
615.59	4.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
530.00	89.59	Top of Sand Pack
528.00	91.59	Top of Screen
518.09	101.50	Bottom of Screen
517.59	102.00	Bottom of Well
517.59	102.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	95.56
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.07
Total Length of Casing	(feet)	105.13
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54L

Site Name: Gypsum Management Facility Borehole #: ~~G54a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 463.8 Y 14,664.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

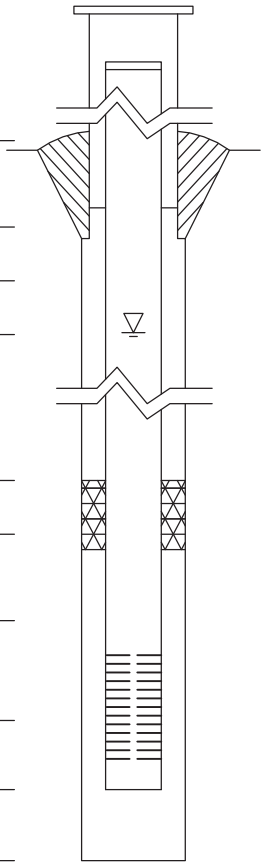
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.37	-3.09	Top of Protective Casing
623.00	-2.72	Top of Riser Pipe
620.28	0.00	Ground Surface
618.48	1.80	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
597.78	22.50	Top of Seal
595.28	25.00	Top of Sand Pack
592.96	27.32	Top of Screen
583.53	36.75	Bottom of Screen
583.06	37.22	Bottom of Well
583.06	37.22	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.04
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.43
Total Length of Casing	(feet)	39.94
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54S

Site Name: Gypsum Management Facility Borehole #: ~~G54~~

~~State~~ Plant ~~Plane~~ Coordinate: X 460.5 Y 14,664.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 60 minutes

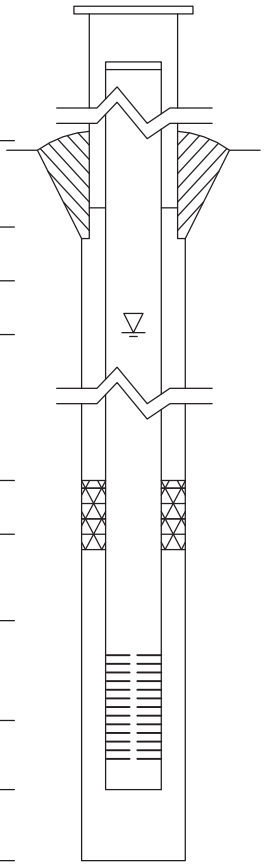
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.54	-3.26	Top of Protective Casing
623.13	-2.85	Top of Riser Pipe
620.28	0.00	Ground Surface
618.38	1.90	Top of Annular Sealant
580.98	39.30	Static Water Level (After Completion) 3/4/2009
580.78	39.50	Top of Seal
578.61	41.67	Top of Sand Pack
576.78	43.50	Top of Screen
572.31	47.97	Bottom of Screen
571.87	48.41	Bottom of Well
571.87	48.41	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	46.50
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.47
Total Length of Casing	(feet)	51.41
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55L

Site Name: Gypsum Management Facility Borehole #: ~~G55a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.1 Y 14,667.7 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNUAL SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 22 minutes

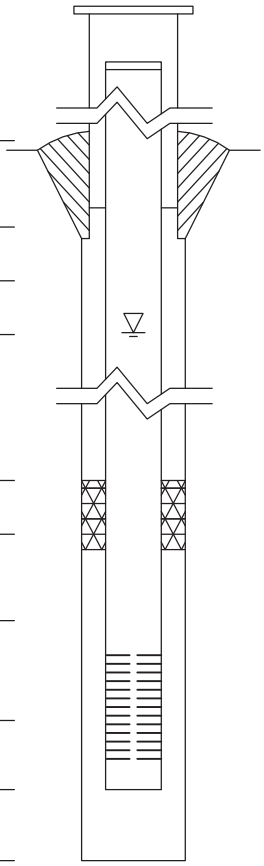
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.47	-3.69	Top of Protective Casing
623.28	-3.50	Top of Riser Pipe
619.78	0.00	Ground Surface
617.78	2.00	Top of Annular Sealant
585.79	33.99	Static Water Level (After Completion) 3/4/2009
597.95	21.83	Top of Seal
596.28	23.50	Top of Sand Pack
593.02	26.76	Top of Screen
583.66	36.12	Bottom of Screen
583.18	36.60	Bottom of Well
583.18	36.60	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: ( )
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.26
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	40.10
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55S

Site Name: Gypsum Management Facility Borehole #: ~~G55~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.0 Y 14,663.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 55 minutes

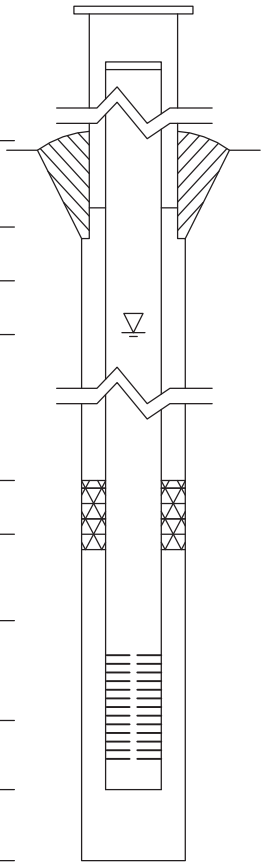
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.21	-3.43	Top of Protective Casing
622.91	-3.13	Top of Riser Pipe
619.78	0.00	Ground Surface
617.95	1.83	Top of Annular Sealant
586.49	33.29	Static Water Level (After Completion) 3/4/2009
582.78	37.00	Top of Seal
580.95	38.83	Top of Sand Pack
578.74	41.04	Top of Screen
574.29	45.49	Bottom of Screen
573.82	45.96	Bottom of Well
573.82	45.96	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	44.17
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	4.45
Total Length of Casing	(feet)	49.09
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G56L

Site Name: Gypsum Management Facility Borehole #: ~~G56a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 979.2 Y 14,708.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/16/2009 Date Finished: 2/16/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

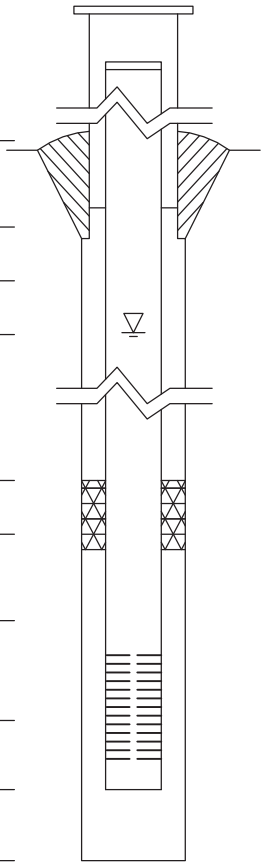
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.94	-3.03	Top of Protective Casing
622.37	-2.46	Top of Riser Pipe
619.91	0.00	Ground Surface
617.91	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
617.91	2.00	Top of Seal
608.91	11.00	Top of Sand Pack
606.14	13.77	Top of Screen
597.80	22.11	Bottom of Screen
597.02	22.89	Bottom of Well
597.02	22.89	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	16.23
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.34
Total Length of Casing	(feet)	26.35
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G56S

Site Name: Gypsum Management Facility Borehole #: ~~G56~~

~~State~~ Plant ~~Plane~~ Coordinate: X 978.8 Y 14,705.0 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/16/2009 Date Finished: 2/16/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 45 minutes

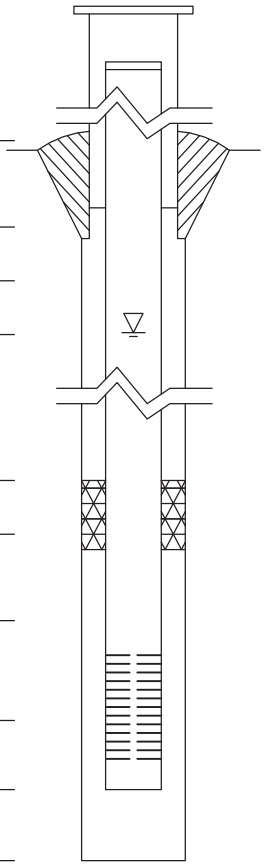
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



	Elevations (MSL)*	Depths (BGS) (0.01 ft.)
Top of Protective Casing	623.14	-3.23
Top of Riser Pipe	622.74	-2.83
Ground Surface	619.91	0.00
Top of Annular Sealant	617.95	1.96
Static Water Level (After Completion) 3/4/2009	589.36	30.55
Top of Seal	591.83	28.08
Top of Sand Pack	588.76	31.15
Top of Screen	586.74	33.17
Bottom of Screen	582.25	37.66
Bottom of Well	581.62	38.29
Bottom of Borehole	579.91	40.00

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	36.00
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	41.12
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G57L

Site Name: Gypsum Management Facility Borehole #: ~~G57a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 987.5 Y 15,064.7 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 1/30/2009 Date Finished: 1/30/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

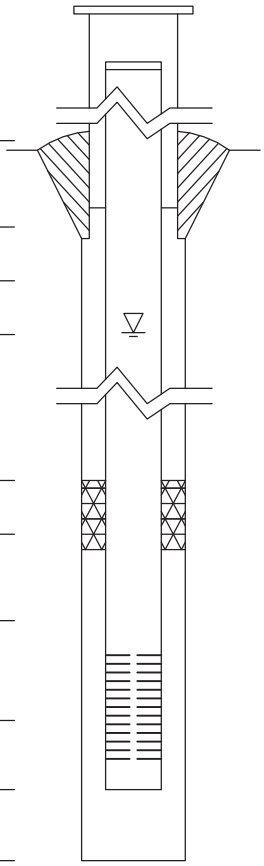
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.12	-3.14	Top of Protective Casing
622.93	-2.95	Top of Riser Pipe
619.98	0.00	Ground Surface
617.98	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
608.48	11.50	Top of Seal
605.48	14.50	Top of Sand Pack
603.81	16.17	Top of Screen
594.36	25.62	Bottom of Screen
593.98	26.00	Bottom of Well
593.98	26.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.12
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	28.95
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G57S

Site Name: Gypsum Management Facility Borehole #: ~~G57~~

~~State~~ Plant ~~Plane~~ Coordinate: X 987.5 Y 15,060.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 1/30/2009 Date Finished: 1/30/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 42 minutes

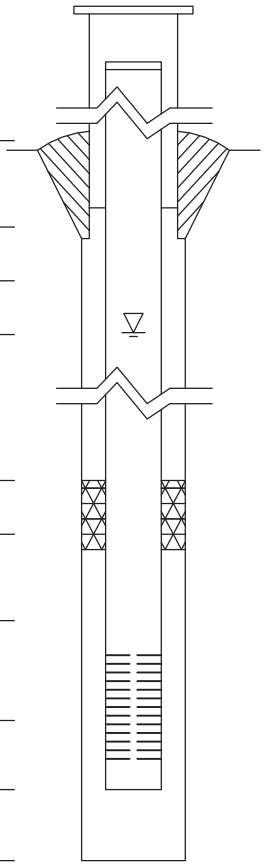
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand
(if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.96	-2.98	Top of Protective Casing
622.76	-2.78	Top of Riser Pipe
619.98	0.00	Ground Surface
617.98	2.00	Top of Annular Sealant
588.50	31.48	Static Water Level (After Completion) 3/4/2009
596.98	23.00	Top of Seal
593.18	26.80	Top of Sand Pack
590.33	29.65	Top of Screen
585.80	34.18	Bottom of Screen
585.36	34.62	Bottom of Well
581.98	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.43
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.53
Total Length of Casing	(feet)	37.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G58L

Site Name: Gypsum Management Facility Borehole #: ~~G58a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 989.0 Y 15,204.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/26/2009 Date Finished: 1/26/2009

Report Form Completed By: Suzanna Simpson Date: 1/30/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

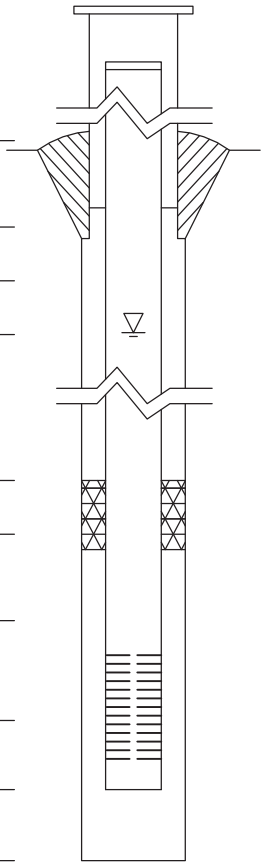
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.24	-3.20	Top of Protective Casing
623.04	-3.00	Top of Riser Pipe
620.04	0.00	Ground Surface
617.94	2.10	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
604.54	15.50	Top of Seal
601.49	18.55	Top of Sand Pack
599.35	20.69	Top of Screen
589.94	30.10	Bottom of Screen
589.48	30.56	Bottom of Well
589.48	30.56	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	23.69
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	9.41
Total Length of Casing	(feet)	33.56
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G58S

Site Name: Gypsum Management Facility Borehole #: ~~G58~~

~~State~~ Plant ~~Plane~~ Coordinate: X 989.6 Y 15,200.2 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/26/2009 Date Finished: 1/26/2009

Report Form Completed By: Suzanna Simpson Date: 1/30/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

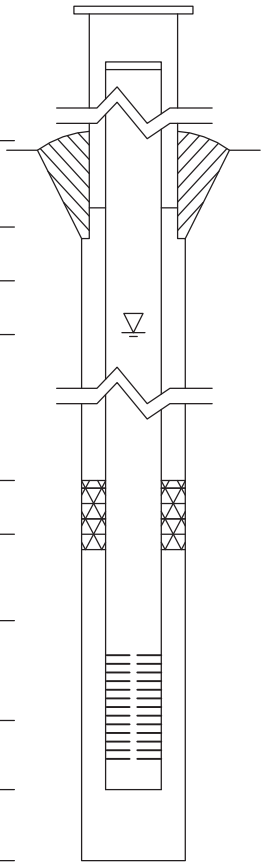
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.27	-3.23	Top of Protective Casing
623.05	-3.01	Top of Riser Pipe
620.04	0.00	Ground Surface
617.94	2.10	Top of Annular Sealant
582.62	37.42	Static Water Level (After Completion) 3/4/2009
593.04	27.00	Top of Seal
590.79	29.25	Top of Sand Pack
588.72	31.32	Top of Screen
584.24	35.80	Bottom of Screen
583.61	36.43	Bottom of Well
583.61	36.43	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.33
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	39.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G59L

Site Name: Gypsum Management Facility Borehole #: ~~G59a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 992.6 Y 15,343.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/23/2009 Date Finished: 1/23/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 30 minutes

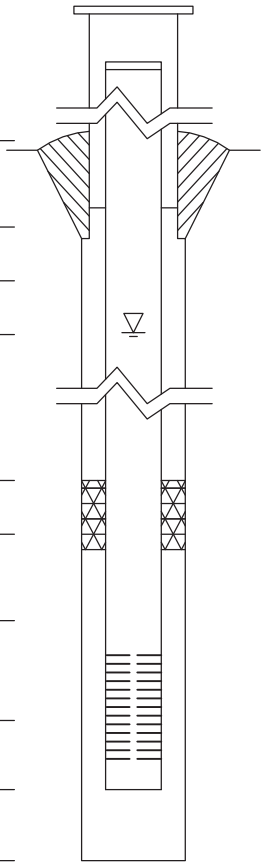
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.76	-2.61	Top of Protective Casing
622.45	-2.30	Top of Riser Pipe
620.15	0.00	Ground Surface
618.15	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
602.29	17.86	Top of Seal
599.47	20.68	Top of Sand Pack
597.24	22.91	Top of Screen
587.82	32.33	Bottom of Screen
587.12	33.03	Bottom of Well
587.12	33.03	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	25.21
Bottom of Screen to End Cap	(feet)	0.70
Screen Length (1st slot to last slot)	(feet)	9.42
Total Length of Casing	(feet)	35.33
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G59S

Site Name: Gypsum Management Facility Borehole #: ~~G59~~

~~State~~ Plant ~~Plane~~ Coordinate: X 992.6 Y 15,339.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/23/2009 Date Finished: 1/23/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 90 minutes

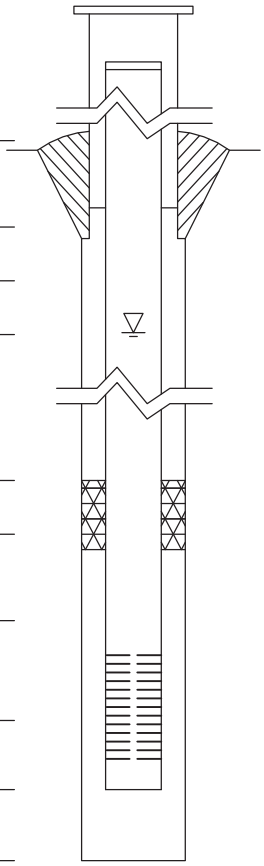
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



	Elevations (MSL)*	Depths (BGS) (0.01 ft.)
Top of Protective Casing	623.23	-3.08
Top of Riser Pipe	622.84	-2.69
Ground Surface	620.15	0.00
Top of Annular Sealant	618.15	2.00
Static Water Level (After Completion) 3/4/2009	578.24	41.91
Top of Seal	588.15	32.00
Top of Sand Pack	584.81	35.34
Top of Screen	582.77	37.38
Bottom of Screen	578.27	41.88
Bottom of Well	577.66	42.49
Bottom of Borehole	577.66	42.49

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	40.07
Bottom of Screen to End Cap	(feet)	0.61
Screen Length (1st slot to last slot)	(feet)	4.50
Total Length of Casing	(feet)	45.18
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G60L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG60b~~

~~State~~ Plant ~~Plane~~ Coordinate: X 1,049.8 Y 15,474.7 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/17/2008 Date Finished: 1/17/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time:

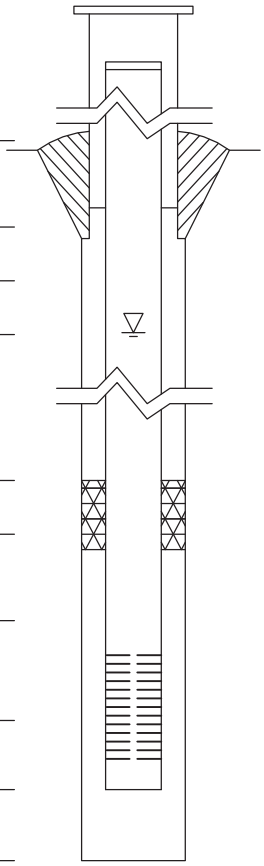
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material:
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
616.00	-3.55	Top of Protective Casing
615.49	-3.04	Top of Riser Pipe
612.45	0.00	Ground Surface
609.85	2.60	Top of Annular Sealant
591.43	21.02	Static Water Level (After Completion) 1/30/2008
596.03	16.42	Top of Seal
593.32	19.13	Top of Sand Pack
592.33	20.12	Top of Screen
587.54	24.91	Bottom of Screen
587.17	25.28	Bottom of Well
587.17	25.28	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	23.45
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	28.61
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G60S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG60~~

~~State~~ Plant ~~Plane~~ Coordinate: X 1,050.2 Y 15,469.5 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/16/2008 Date Finished: 1/16/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 22 min

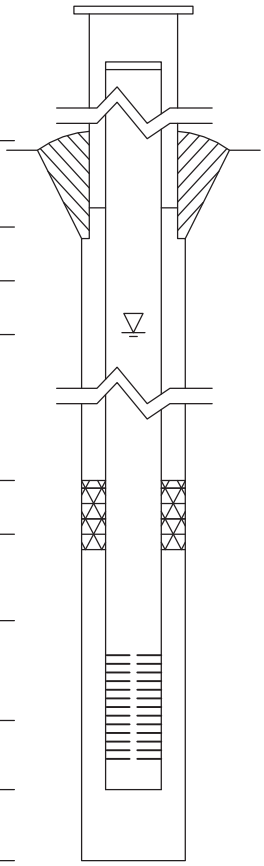
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
615.56	-3.37	Top of Protective Casing
615.11	-2.92	Top of Riser Pipe
612.19	0.00	Ground Surface
609.19	3.00	Top of Annular Sealant
582.46	29.73	Static Water Level (After Completion) 1/30/2008
584.51	27.68	Top of Seal
582.39	29.80	Top of Sand Pack
581.07	31.12	Top of Screen
576.28	35.91	Bottom of Screen
575.90	36.29	Bottom of Well
574.19	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.07
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	39.24
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G61L

Site Name: Gypsum Management Facility Borehole #: ~~G61a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.4 Y 15,640.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/21/2009 Date Finished: 1/21/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

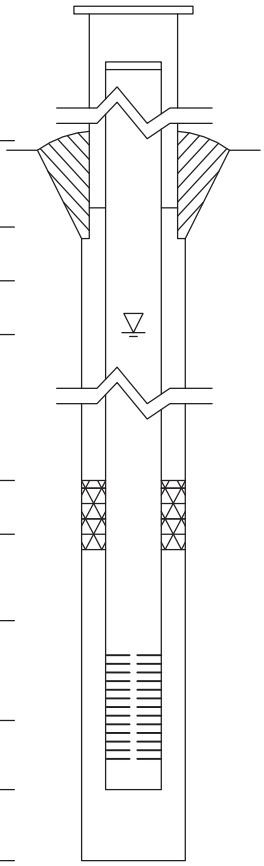
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.97	-2.97	Top of Protective Casing
622.77	-2.77	Top of Riser Pipe
620.00	0.00	Ground Surface
618.00	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
618.00	2.00	Top of Seal
612.60	7.40	Top of Sand Pack
610.36	9.64	Top of Screen
601.00	19.00	Bottom of Screen
600.10	19.90	Bottom of Well
600.10	19.90	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.41
Bottom of Screen to End Cap	(feet)	0.90
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	22.67
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

4/2000

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 W. JEFFERSON ST.
SPRINGFIELD, IL 62761

WATER WELL SEALING FORM

TYPE OR PRESS FIRMLY

RETURN ALL COPIES TO IDPH OR LOCAL HEALTH DEPARTMENT

This form shall be submitted to this Department or the local health department not more than 30 days after a water well, boring or monitoring well is sealed. Such wells are to be sealed not more than 30 days after they are abandoned in accordance with the sealing requirements in the Water Well Construction Code. THE LOCAL HEALTH DEPARTMENT OR REGIONAL PUBLIC HEALTH DEPARTMENT MUST BE NOTIFIED AT LEAST 48 HOURS PRIOR TO SEALING.

1. **Ownership (Name of Controlling Party)** Duck Creek Power Station - GMF (G61L)

2. **Well Location** 17751 N Cilco Road (Address - Lot Number) Canton (City) Fulton (County)

   General Description **Township** 6 (N)(~~S~~) **Range** 5 (E)(~~W~~) **Section** 18

   SW **Quarter of the** NE **Quarter of the** NW **Quarter**

3. **Year Drilled** 2009

4. **Drilling Permit Number (and date, if known)** n/a

5. **Type of Well** **Bored** ____ **Drilled** ✓ **Other** ____

6. **Total Depth** 19.9 **Diameter (inches)** 8

7. **Formation clear of obstruction** ✓ **Yes** ____ **No**

8. **DETAILS OF PLUGGING** *(riser pipe and screen pulled and annulus was grouted)*

   Filled with Bentonite grout (cement or other materials) **from** 0 **to** 19.9 **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

9. **CASING RECORD** **Upper 2 feet of casing removed** ✓ **Yes** ____ **No**

10. **Date well was sealed** **Month** March **Day** 14 **Year** 2017.

11. **Licensed water well driller or other person approved by the Department performing well sealing.**

    Rhonald W. Hasenyager, L.P.G. (Name) 196-000246 (Complete License Number)

    Hanson Professional Services Inc., 1525 S. 6th St. (Address) Springfield (City) IL 62703 (State/ZIP)

This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center. IL 482-0631

Printed by Authority of the State of Illinois
P.O. #530379 9.6M 4/00

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G61S

Site Name: Gypsum Management Facility Borehole #: ~~G61~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.8 Y 15,644.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/20/2009 Date Finished: 1/21/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 2.5 hours

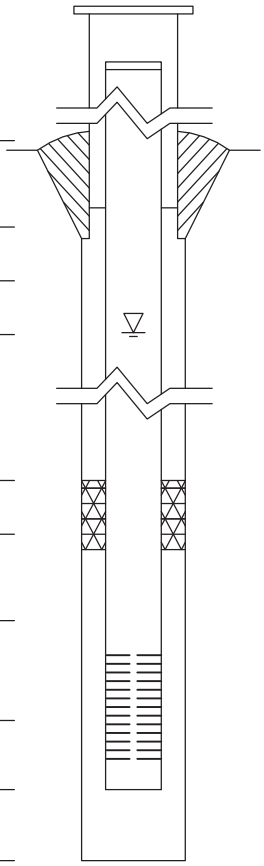
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.80	-2.80	Top of Protective Casing
622.58	-2.58	Top of Riser Pipe
620.00	0.00	Ground Surface
618.00	2.00	Top of Annular Sealant
587.62	32.38	Static Water Level (After Completion) 3/4/2009
595.00	25.00	Top of Seal
591.80	28.20	Top of Sand Pack
589.81	30.19	Top of Screen
585.37	34.63	Bottom of Screen
584.74	35.26	Bottom of Well
582.00	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.77
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.44
Total Length of Casing	(feet)	37.84
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G62L

Site Name: Gypsum Management Facility Borehole #: ~~G62~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.7 Y 15,785.2 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/21/2009 Date Finished: 1/22/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

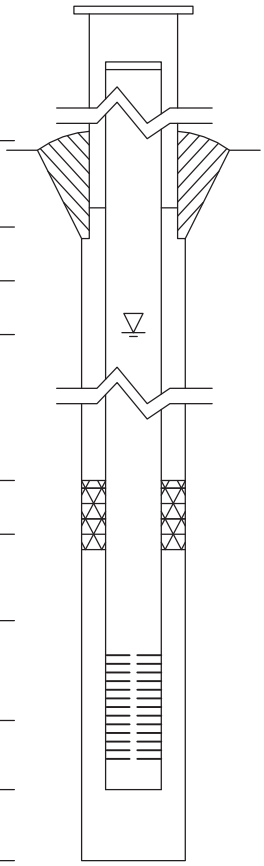
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Bentonite Chips (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.67	-3.65	Top of Protective Casing
623.48	-3.46	Top of Riser Pipe
620.02	0.00	Ground Surface
618.02	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
605.12	14.90	Top of Seal
602.12	17.90	Top of Sand Pack
599.71	20.31	Top of Screen
590.36	29.66	Bottom of Screen
589.90	30.12	Bottom of Well
582.02	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	23.77
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	33.58
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G63L

Site Name: Gypsum Management Facility Borehole #: ~~G63a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 998.0 Y 15,928.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/2/2009 Date Finished: 2/2/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 45 minutes

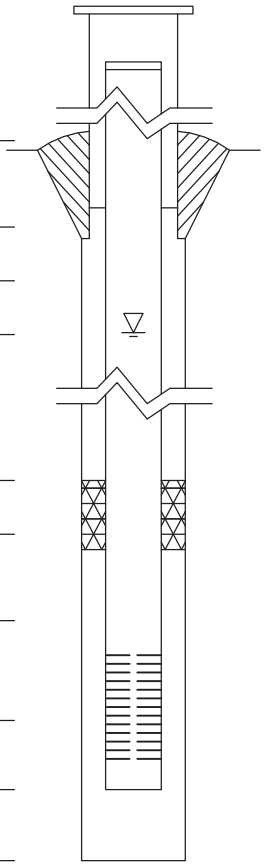
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.33	-3.21	Top of Protective Casing
622.98	-2.86	Top of Riser Pipe
620.12	0.00	Ground Surface
618.12	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
606.62	13.50	Top of Seal
603.62	16.50	Top of Sand Pack
601.65	18.47	Top of Screen
592.23	27.89	Bottom of Screen
591.76	28.36	Bottom of Well
591.76	28.36	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	21.33
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.42
Total Length of Casing	(feet)	31.22
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G63S

Site Name: Gypsum Management Facility Borehole #: ~~G63~~

~~State~~ Plant ~~Plane~~ Coordinate: X 998.3 Y 15,924.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/2/2009 Date Finished: 2/2/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 90 minutes

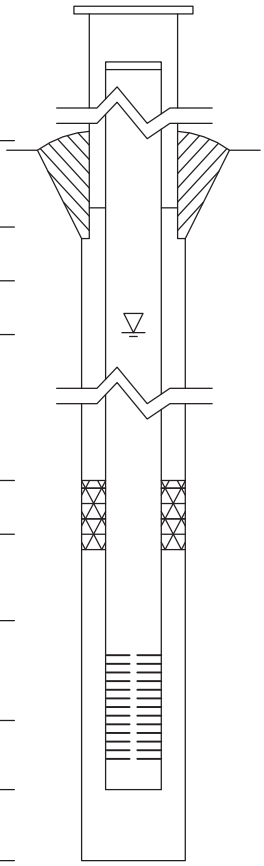
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.28	-3.16	Top of Protective Casing
623.09	-2.97	Top of Riser Pipe
620.12	0.00	Ground Surface
618.12	2.00	Top of Annular Sealant
586.64	33.48	Static Water Level (After Completion) 3/4/2009
590.62	29.50	Top of Seal
587.62	32.50	Top of Sand Pack
585.60	34.52	Top of Screen
581.11	39.01	Bottom of Screen
580.65	39.47	Bottom of Well
580.12	40.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	37.49
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	42.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G64L

Site Name: Gypsum Management Facility Borehole #: ~~G64a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 995.7 Y 16,069.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/22/2009 Date Finished: 1/22/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

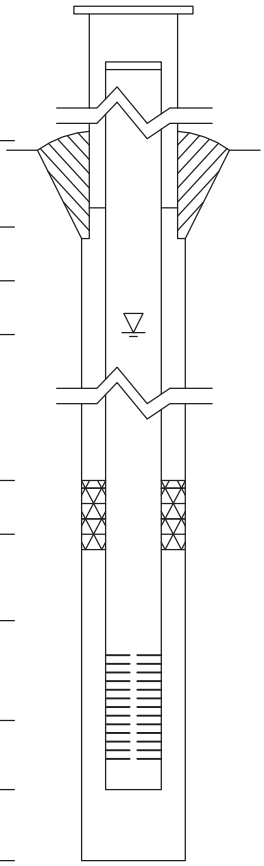
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.76	-2.74	Top of Protective Casing
622.54	-2.52	Top of Riser Pipe
620.02	0.00	Ground Surface
618.02	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
607.02	13.00	Top of Seal
604.22	15.80	Top of Sand Pack
601.90	18.12	Top of Screen
592.54	27.48	Bottom of Screen
592.07	27.95	Bottom of Well
592.07	27.95	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	20.64
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	30.47
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G64S

Site Name: Gypsum Management Facility Borehole #: ~~G64~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.9 Y 16,064.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/22/2009 Date Finished: 1/22/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 90 minutes

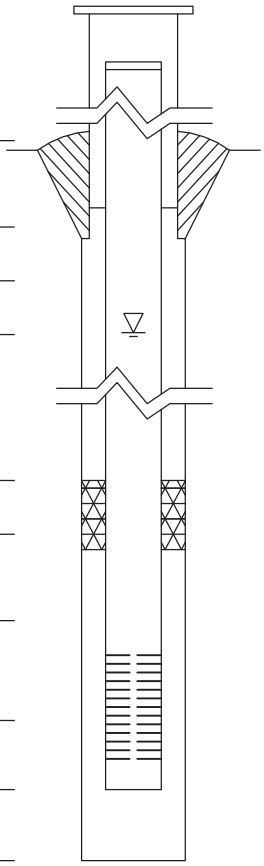
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.49	-3.47	Top of Protective Casing
622.98	-2.96	Top of Riser Pipe
620.02	0.00	Ground Surface
618.02	2.00	Top of Annular Sealant
587.70	32.32	Static Water Level (After Completion) 3/4/2009
590.92	29.10	Top of Seal
587.82	32.20	Top of Sand Pack
585.52	34.50	Top of Screen
581.03	38.99	Bottom of Screen
580.54	39.48	Bottom of Well
580.02	40.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	37.46
Bottom of Screen to End Cap	(feet)	0.49
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	42.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G65L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG65b~~

~~State~~ Plant ~~Plane~~ Coordinate: X 919.9 Y 13,986.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/15/2008 Date Finished: 1/15/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 min

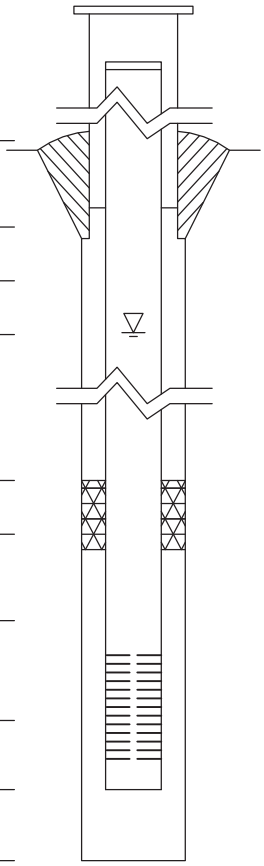
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.34	-3.27	Top of Protective Casing
612.84	-2.77	Top of Riser Pipe
610.07	0.00	Ground Surface
607.97	2.10	Top of Annular Sealant
587.76	22.31	Static Water Level (After Completion) 1/30/2008
596.16	13.91	Top of Seal
593.89	16.18	Top of Sand Pack
592.79	17.28	Top of Screen
587.99	22.08	Bottom of Screen
587.62	22.45	Bottom of Well
587.62	22.45	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	20.42
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.80
Total Length of Casing	(feet)	25.59
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G65S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG65a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 914.1 Y 13,985.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/15/2008 Date Finished: 1/15/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

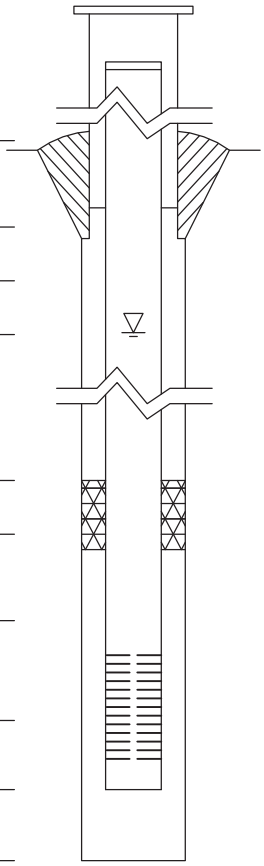
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.55	-3.61	Top of Protective Casing
613.04	-3.10	Top of Riser Pipe
609.94	0.00	Ground Surface
607.34	2.60	Top of Annular Sealant
584.66	25.28	Static Water Level (After Completion) 1/30/2008
586.43	23.51	Top of Seal
583.83	26.11	Top of Sand Pack
583.02	26.92	Top of Screen
578.24	31.70	Bottom of Screen
577.86	32.08	Bottom of Well
577.24	32.70	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.26
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	35.42
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G66L

Site Name: Gypsum Management Facility Borehole #: ~~G66a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 965.7 Y 14,240.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/4/2009 Date Finished: 2/4/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

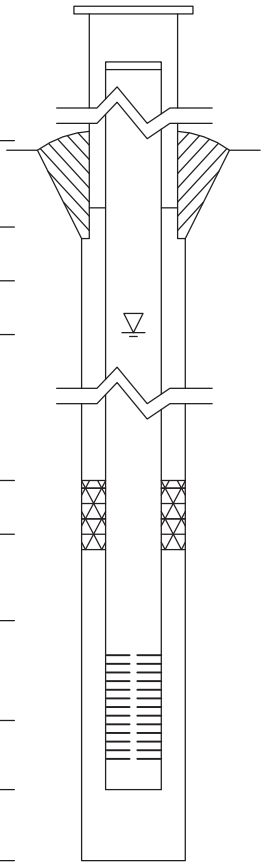
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.11	-3.25	Top of Protective Casing
617.82	-2.96	Top of Riser Pipe
614.86	0.00	Ground Surface
612.94	1.92	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
612.94	1.92	Top of Seal
607.28	7.58	Top of Sand Pack
605.02	9.84	Top of Screen
595.59	19.27	Bottom of Screen
595.12	19.74	Bottom of Well
595.12	19.74	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.80
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.43
Total Length of Casing	(feet)	22.70
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G66S

Site Name: Gypsum Management Facility Borehole #: ~~G66~~

~~State~~ Plant ~~Plane~~ Coordinate: X 964.9 Y 14,236.2 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/4/2009 Date Finished: 2/4/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

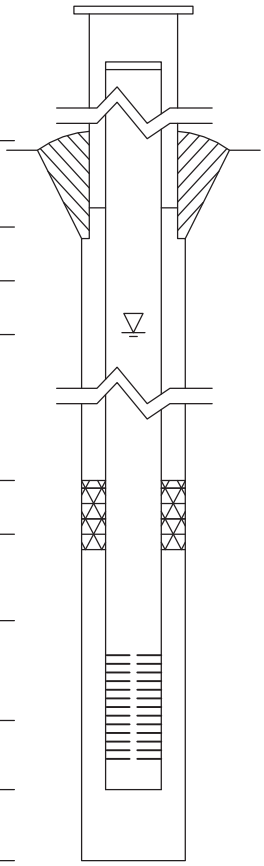
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.13	-3.27	Top of Protective Casing
617.84	-2.98	Top of Riser Pipe
614.86	0.00	Ground Surface
612.86	2.00	Top of Annular Sealant
590.54	24.32	Static Water Level (After Completion) 3/4/2009
584.38	30.48	Top of Seal
581.78	33.08	Top of Sand Pack
579.76	35.10	Top of Screen
575.27	39.59	Bottom of Screen
574.77	40.09	Bottom of Well
574.77	40.09	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	38.08
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	43.07
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G67L

Site Name: Gypsum Management Facility Borehole #: ~~G67a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 928.9 Y 14,527.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/3/2009 Date Finished: 2/3/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

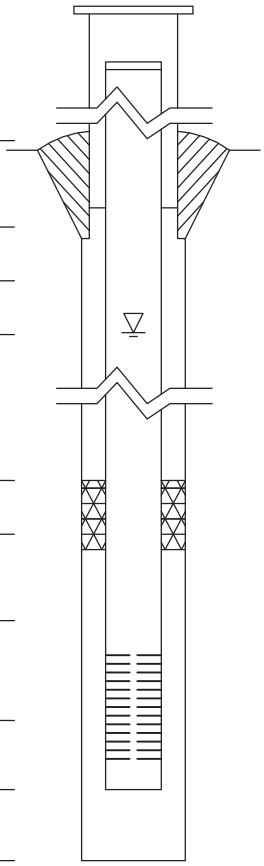
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
617.64	-3.00	Top of Protective Casing
617.22	-2.58	Top of Riser Pipe
614.64	0.00	Ground Surface
612.71	1.93	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
612.71	1.93	Top of Seal
609.12	5.52	Top of Sand Pack
607.28	7.36	Top of Screen
597.92	16.72	Bottom of Screen
597.46	17.18	Bottom of Well
597.46	17.18	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	9.94
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	19.76
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G67S

Site Name: Gypsum Management Facility Borehole #: ~~G67~~

~~State~~ Plant ~~Plane~~ Coordinate: X 925.2 Y 14,530.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/3/2009 Date Finished: 2/3/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 45 minutes

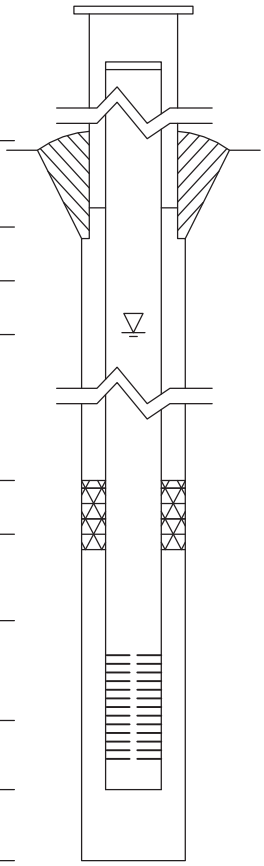
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand
(if applicable)

Installation Method: Gravity



	Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
	618.03	-3.39	Top of Protective Casing
	617.86	-3.22	Top of Riser Pipe
	614.64	0.00	Ground Surface
	612.64	2.00	Top of Annular Sealant
	590.81	23.83	Static Water Level (After Completion) 3/4/2009
	589.31	25.33	Top of Seal
	586.04	28.60	Top of Sand Pack
	583.55	31.09	Top of Screen
	579.06	35.58	Bottom of Screen
	578.43	36.21	Bottom of Well
	576.64	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.31
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	39.43
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G71L

Site Name: Gypsum Management Facility Borehole #: ~~G71a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 278.8 Y 14,106.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 11/20/2008 Date Finished: 11/20/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 26 minutes

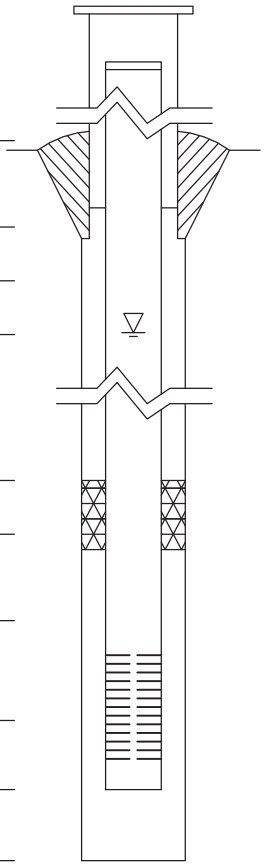
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.05	-3.11	Top of Protective Casing
617.62	-2.68	Top of Riser Pipe
614.94	0.00	Ground Surface
612.94	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
599.46	15.48	Top of Seal
597.02	17.92	Top of Sand Pack
595.14	19.80	Top of Screen
585.65	29.29	Bottom of Screen
584.74	30.20	Bottom of Well
584.74	30.20	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	22.48
Bottom of Screen to End Cap	(feet)	0.91
Screen Length (1st slot to last slot)	(feet)	9.40
Total Length of Casing	(feet)	32.79
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G71S

Site Name: Gypsum Management Facility Borehole #: ~~G71~~

~~State~~ Plant ~~Plane~~ Coordinate: X 277.1 Y 14,110.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 11/20/2008 Date Finished: 11/20/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

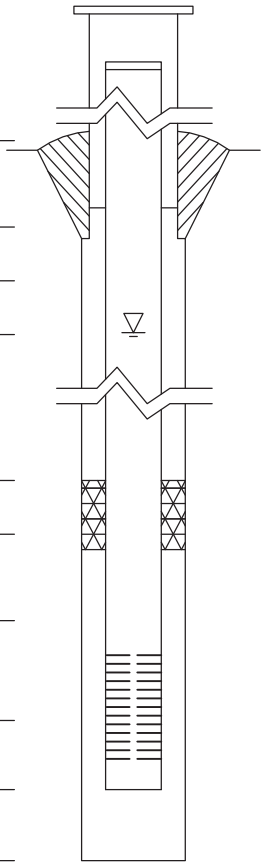
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



	Elevations (MSL)*	Depths (BGS) (0.01 ft.)
Top of Protective Casing	618.13	-3.19
Top of Riser Pipe	617.93	-2.99
Ground Surface	614.94	0.00
Top of Annular Sealant	612.84	2.10
Static Water Level (After Completion) 3/4/2009	577.22	37.72
Top of Seal	586.46	28.48
Top of Sand Pack	582.94	32.00
Top of Screen	580.98	33.96
Bottom of Screen	576.98	37.96
Bottom of Well	576.54	38.40
Bottom of Borehole	574.94	40.00

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	36.95
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	41.87
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G72L

Site Name: Gypsum Management Facility Borehole #: ~~G72a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 509.9 Y 13,904.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 11/19/2008 Date Finished: 11/19/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 21 minutes

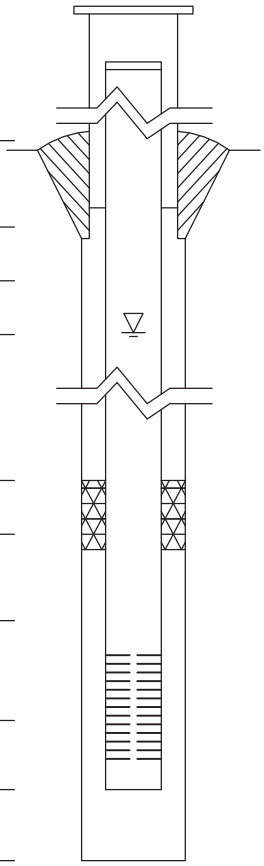
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
617.99	-2.98	Top of Protective Casing
617.80	-2.79	Top of Riser Pipe
615.01	0.00	Ground Surface
613.21	1.80	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
604.10	10.91	Top of Seal
601.66	13.35	Top of Sand Pack
600.36	14.65	Top of Screen
591.00	24.01	Bottom of Screen
590.22	24.79	Bottom of Well
590.22	24.79	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	17.44
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	27.58
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G72S

Site Name: Gypsum Management Facility Borehole #: ~~G72~~

~~State~~ Plant ~~Plane~~ Coordinate: X 504.9 Y 13,905.1 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 11/19/2008 Date Finished: 11/19/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

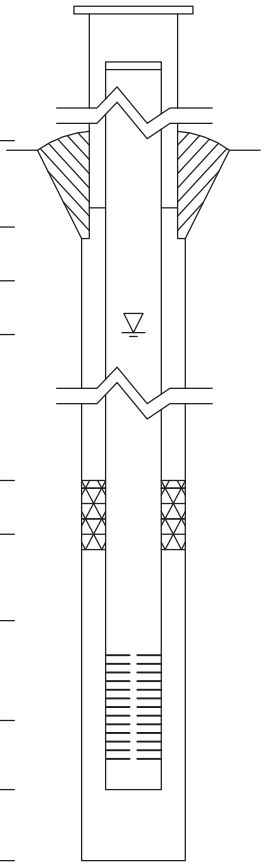
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Bentonite Chips (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.12	-3.11	Top of Protective Casing
617.68	-2.67	Top of Riser Pipe
615.01	0.00	Ground Surface
612.71	2.30	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
589.46	25.55	Top of Seal
587.18	27.83	Top of Sand Pack
584.85	30.16	Top of Screen
580.37	34.64	Bottom of Screen
579.92	35.09	Bottom of Well
575.61	39.40	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.83
Bottom of Screen to End Cap	(feet)	0.45
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	37.76
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

4/2000

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 W. JEFFERSON ST.
SPRINGFIELD, IL 62761

WATER WELL SEALING FORM

TYPE OR PRESS FIRMLY

RETURN ALL COPIES TO IDPH OR LOCAL HEALTH DEPARTMENT

This form shall be submitted to this Department or the local health department not more than 30 days after a water well, boring or monitoring well is sealed. Such wells are to be sealed not more than 30 days after they are abandoned in accordance with the sealing requirements in the Water Well Construction Code. THE LOCAL HEALTH DEPARTMENT OR REGIONAL PUBLIC HEALTH DEPARTMENT MUST BE NOTIFIED AT LEAST 48 HOURS PRIOR TO SEALING.

1. **Ownership (Name of Controlling Party)** Duck Creek Power Station - Recycle Pond (G72S)

2. **Well Location** 17751 N Cilco Road (Address - Lot Number) Canton (City) Fulton (County)

   General Description Township 6 (N)(S) Range 5 (E)(W) Section 18

   NE Quarter of the NW Quarter of the SW Quarter

3. **Year Drilled** 2008

4. **Drilling Permit Number (and date, if known)** n/a

5. **Type of Well** Bored ____ Drilled ✓ Other ____

6. **Total Depth** 35.09 **Diameter (inches)** 8

7. **Formation clear of obstruction** ✓ Yes ____ No

   After G72S was sealed, replacement well R72S was installed approximately 5 feet west in a blind-drilled borehole.

8. **DETAILS OF PLUGGING**

   Filled with Bentonite grout (cement or other materials) **from** 2 **to** 35.09 **ft.**

   Kind of plug Random soil **from** 0 **to** 2.0 **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

9. **CASING RECORD** **Upper 2 feet of casing removed** ✓ Yes ____ No

10. **Date well was sealed** Month November Day 9 Year 2016.

11. **Licensed water well driller or other person approved by the Department performing well sealing.**

    Rhonald W. Hasenyager, L.P.G. (Name) 196-000246 (Complete License Number)

    Hanson Professional Services Inc., 1525 S. 6th St. (Address) Springfield (City) IL 62703 (State/ZIP)

This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center. IL 482-0631

Printed by Authority of the State of Illinois
P.O. #530379 9.6M 4/00

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Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G73L

Site Name: Gypsum Management Facility Borehole #: ~~G73a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 799.5 Y 13,924.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/6/2009 Date Finished: 2/6/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 12+ hours

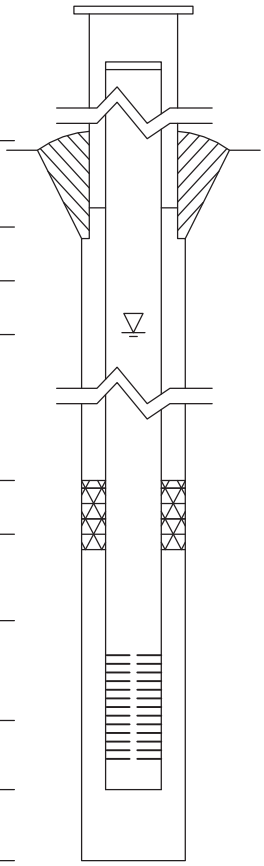
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.23	-3.59	Top of Protective Casing
617.58	-2.94	Top of Riser Pipe
614.64	0.00	Ground Surface
612.64	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
594.64	20.00	Top of Seal
592.22	22.42	Top of Sand Pack
590.01	24.63	Top of Screen
580.66	33.98	Bottom of Screen
579.88	34.76	Bottom of Well
579.88	34.76	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	27.57
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	37.70
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: P01L

Site Name: Gypsum Management Facility Borehole #: ~~P01b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -194.6 Y 16,744.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 11/10/2008 Date Finished: 11/10/2008

Report Form Completed By: Suzanna Simpson Date: 11/21/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

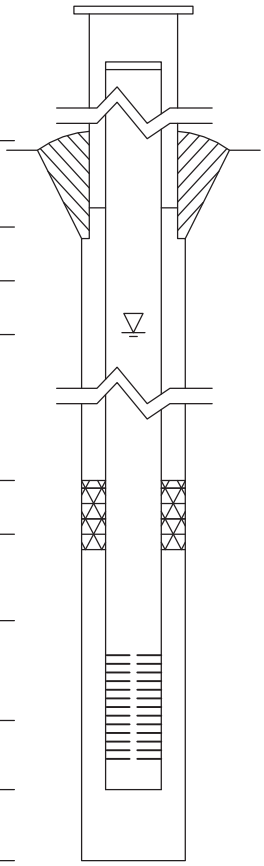
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
625.26	-3.26	Top of Protective Casing
624.99	-2.99	Top of Riser Pipe
622.00	0.00	Ground Surface
619.80	2.20	Top of Annular Sealant
604.00	18.00	Static Water Level (After Completion) 1/8/2009
619.80	2.20	Top of Seal
614.00	8.00	Top of Sand Pack
611.79	10.21	Top of Screen
602.44	19.56	Bottom of Screen
601.65	20.35	Bottom of Well
601.65	20.35	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	13.20
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	23.34
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: P01S

Site Name: Gypsum Management Facility Borehole #: ~~P01a~~

~~State~~ Plant ~~Plane~~ Coordinate: X -194.7 Y 16,754.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 11/10/2008 Date Finished: 11/10/2008

Report Form Completed By: Suzanna Simpson Date: 11/21/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

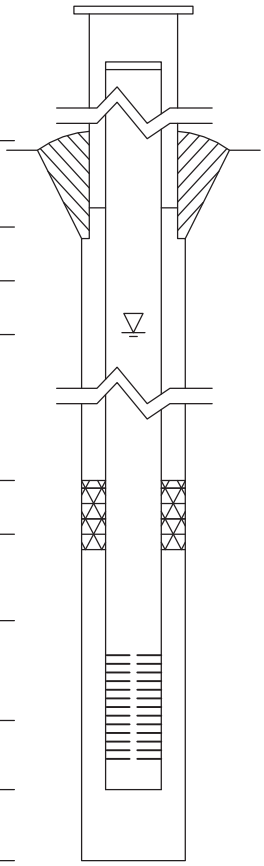
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.76	-2.76	Top of Protective Casing
624.52	-2.52	Top of Riser Pipe
622.00	0.00	Ground Surface
619.40	2.60	Top of Annular Sealant
604.00	18.00	Static Water Level (After Completion) 1/8/2009
602.50	19.50	Top of Seal
601.18	20.82	Top of Sand Pack
599.42	22.58	Top of Screen
594.94	27.06	Bottom of Screen
594.26	27.74	Bottom of Well
594.26	27.74	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

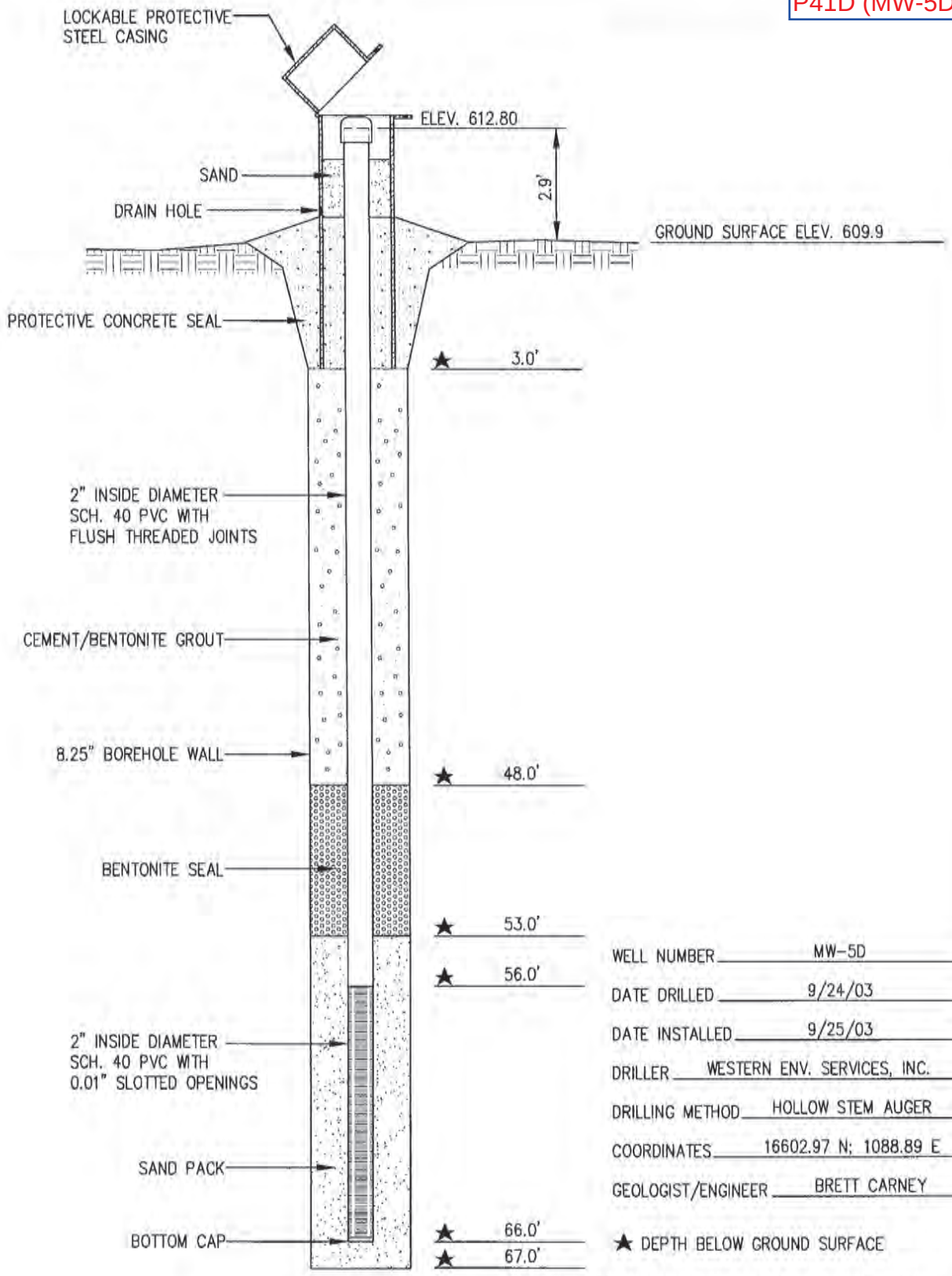
CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	25.10
Bottom of Screen to End Cap	(feet)	0.68
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	30.26
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

P41D (MW-5D)



WELL NUMBER MW-5D
DATE DRILLED 9/24/03
DATE INSTALLED 9/25/03
DRILLER WESTERN ENV. SERVICES, INC.
DRILLING METHOD HOLLOW STEM AUGER
COORDINATES 16602.97 N; 1088.89 E
GEOLOGIST/ENGINEER BRETT CARNEY

★ DEPTH BELOW GROUND SURFACE

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MONITORING WELL MW-5D CONSTRUCTION DETAIL

PHASE II HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

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Electronic Filing: Received, Clerk's Office 06/20/2024

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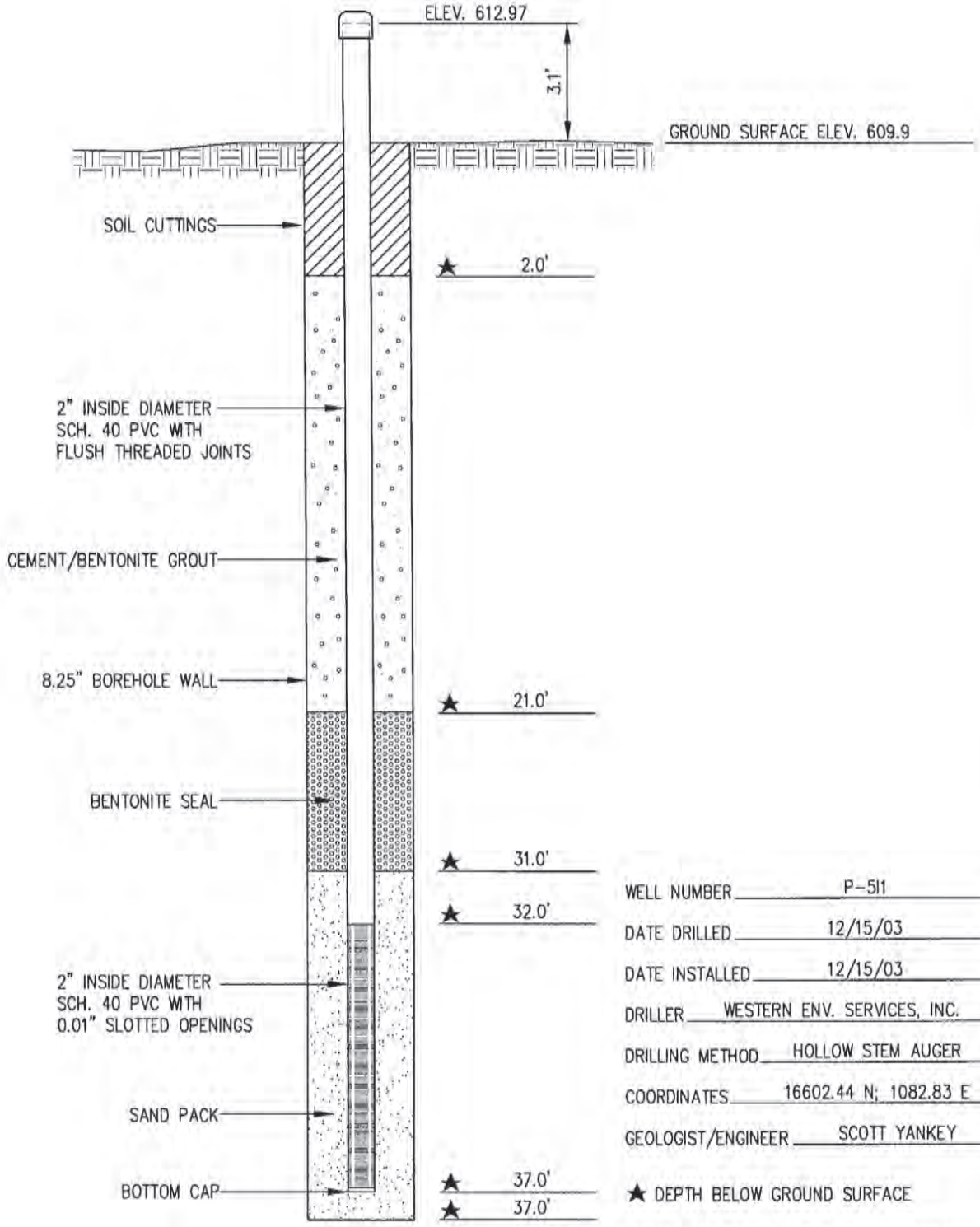

WELL NUMBER P-5I1
DATE DRILLED 12/15/03
DATE INSTALLED 12/15/03
DRILLER WESTERN ENV. SERVICES, INC.
DRILLING METHOD HOLLOW STEM AUGER
COORDINATES 16602.44 N; 1082.83 E
GEOLOGIST/ENGINEER SCOTT YANKEY

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PIEZOMETER P-5I1 CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

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Electronic Filing: Received, Clerk's Office 06/20/2024

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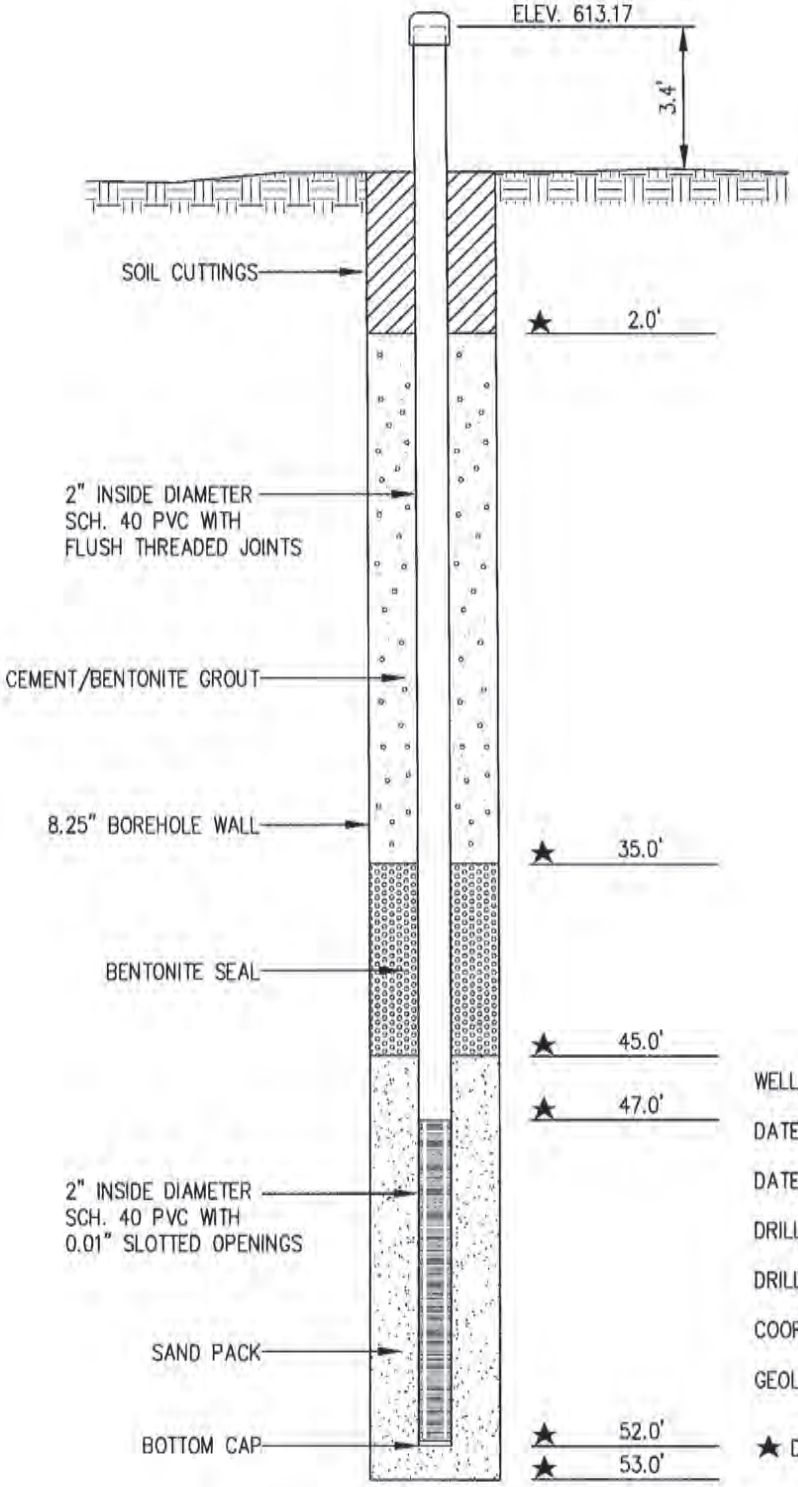

WELL NUMBER P-5I2
DATE DRILLED 12/16/03
DATE INSTALLED 12/16/03
DRILLER WESTERN ENV. SERVICES, INC.
DRILLING METHOD HOLLOW STEM AUGER
COORDINATES 16602.90 N; 1072.21 E
GEOLOGIST/ENGINEER SCOTT YANKEY

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PIEZOMETER P-5I2 CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 24, 2004 3:16 PM KDE
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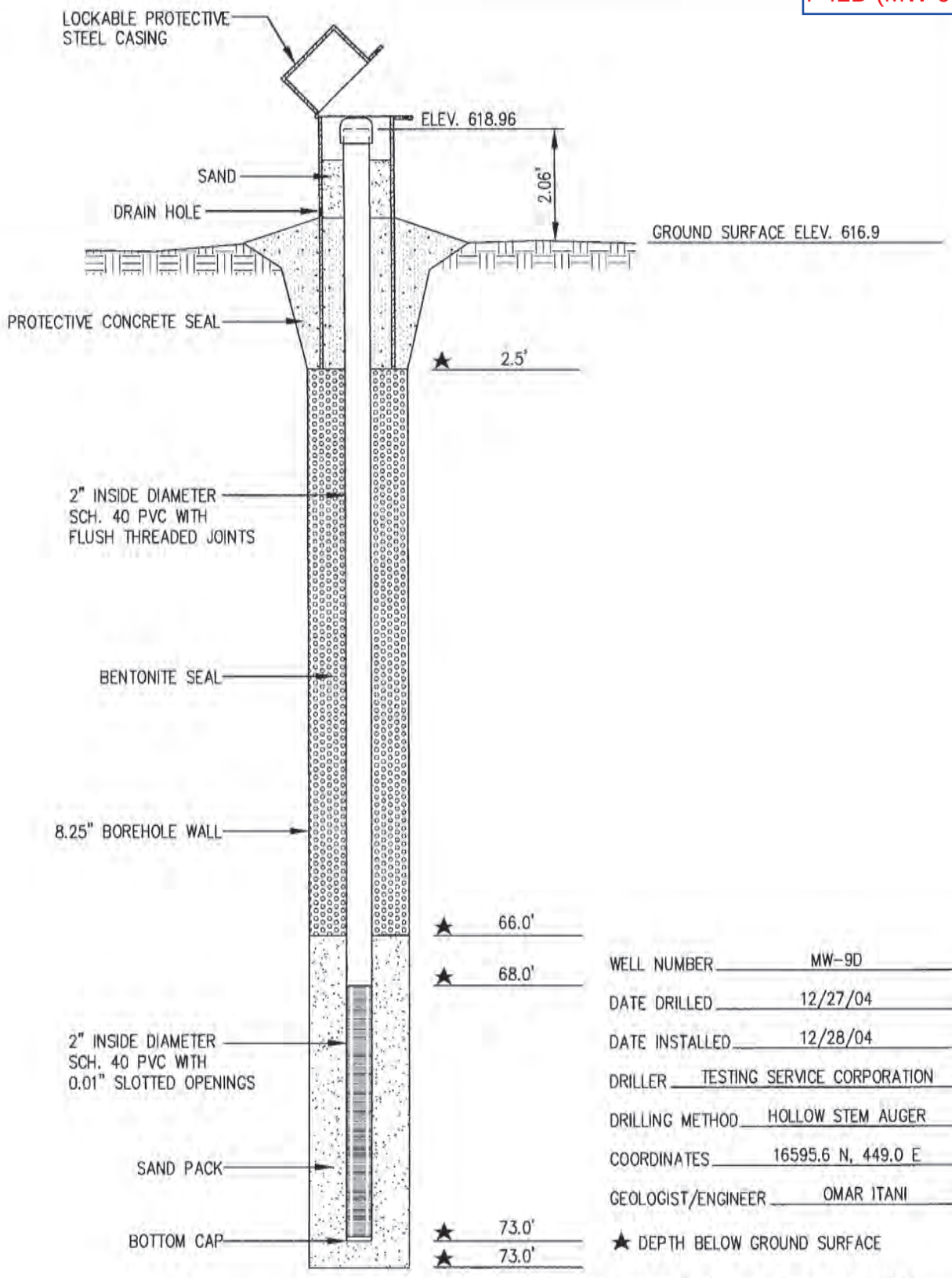
Electronic Filing: Received, Clerk's Office 06/20/2024

P42D (MW-9D)



WELL NUMBER MW-9D
DATE DRILLED 12/27/04
DATE INSTALLED 12/28/04
DRILLER TESTING SERVICE CORPORATION
DRILLING METHOD HOLLOW STEM AUGER
COORDINATES 16595.6 N, 449.0 E
GEOLOGIST/ENGINEER OMAR ITANI

★ DEPTH BELOW GROUND SURFACE

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Hanson Professional Services Inc.

MONITORING WELL MW-9D CONSTRUCTION DETAIL

PHASE IV HYDROGEOLOGIC SITE INVESTIGATION
AMEREN/CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010

FEB 07, 2005 1:19 PM KDE
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Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: 0570255197 County: Fulton Well #: P60

Site Name: Duck Creek Power Station - Ash Landfill Borehole #: P60

~~State~~ Plant ~~Plane~~ Coordinate: X 992.2 Y 15,477.1 (or) Latitude: 40° 30' 24.310" Longitude: 89° 59' 13.282"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 3/15/2017 Date Finished: 3/15/2017

Report Form Completed By: Suzanna L. Keim Date: 3/16/2017

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

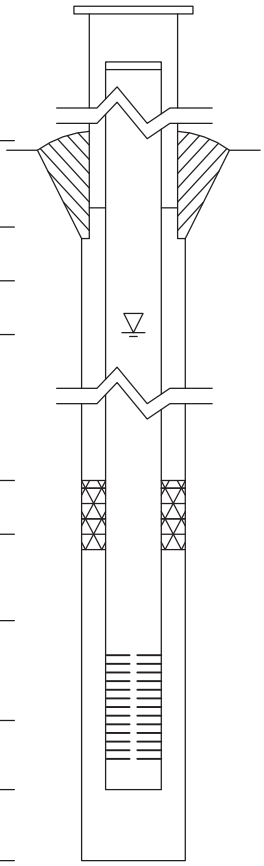
Type of Sand Pack: Quartz Sand

Grain Size: 10-40 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.82	-2.70	Top of Protective Casing
622.52	-2.40	Top of Riser Pipe
620.12	0.00	Ground Surface
618.12	2.00	Top of Annular Sealant
		Static Water Level (After Completion)
594.67	25.45	Top of Seal
592.10	28.02	Top of Sand Pack
590.57	29.55	Top of Screen
585.98	34.14	Bottom of Screen
585.50	34.62	Bottom of Well
585.50	34.62	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	31.95
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	4.59
Total Length of Casing	(feet)	37.02
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P61

Site Name: Duck Creek Part 845 Groundwater Borehole #: P61

State Plane Coordinate: X 2,346,779.3 Y 1,398,670.8 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

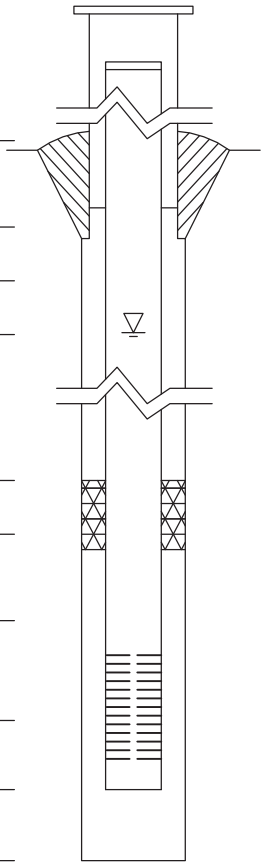
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.31	-3.21	Top of Protective Casing
613.96	-2.87	Top of Riser Pipe
611.09	0.00	Ground Surface
607.58	3.51	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
603.54	7.55	Top of Sand Pack
602.38	8.71	Top of Screen
592.72	18.37	Bottom of Screen
592.33	18.76	Bottom of Well
591.09	20.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	11.58
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	9.66
Total Length of Casing	(feet)	21.63
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P62

Site Name: Duck Creek Part 845 Groundwater Borehole #: P62

State Plane Coordinate: X 2,346,602.3 Y 1,398,887.3 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

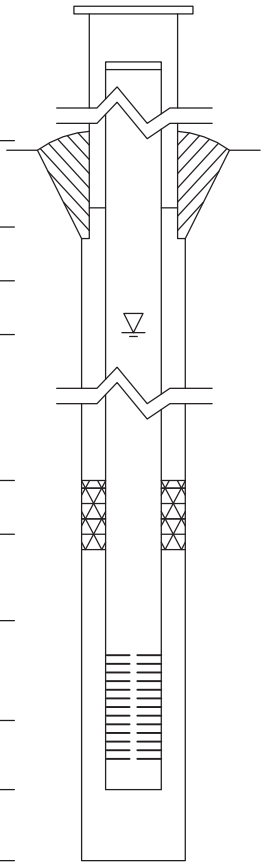
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.96	-3.15	Top of Protective Casing
613.54	-2.73	Top of Riser Pipe
610.81	0.00	Ground Surface
607.89	2.92	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
601.33	9.48	Top of Sand Pack
599.63	11.18	Top of Screen
595.03	15.78	Bottom of Screen
594.51	16.30	Bottom of Well
594.51	16.30	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	16.30
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	4.60
Total Length of Casing	(feet)	21.42
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P63

Site Name: Duck Creek Part 845 Groundwater Borehole #: P63

State Plane Coordinate: X 2,346,605.9 Y 1,399,026.6 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

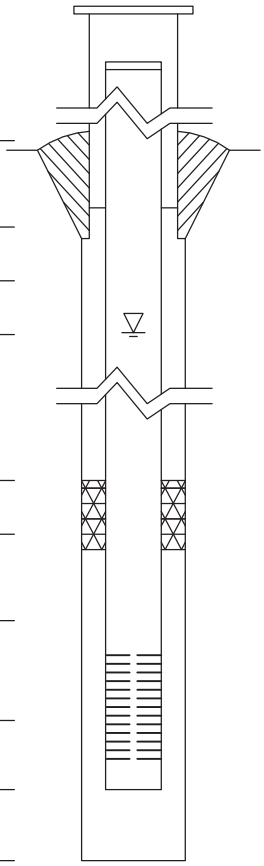
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.85	-2.52	Top of Protective Casing
614.47	-2.15	Top of Riser Pipe
612.33	0.00	Ground Surface
609.23	3.10	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
600.98	11.35	Top of Sand Pack
599.29	13.04	Top of Screen
594.70	17.63	Bottom of Screen
594.08	18.25	Bottom of Well
594.08	18.25	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.19
Bottom of Screen to End Cap	(feet)	0.62
Screen Length (1st slot to last slot)	(feet)	4.59
Total Length of Casing	(feet)	20.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P64

Site Name: Duck Creek Part 845 Groundwater Borehole #: P64

State Plane Coordinate: X 2,346,598.0 Y 1,399,305.9 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/25/2021 Date Finished: 2/25/2021

Report Form Completed By: Tad A. Gass Date: 2/25/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

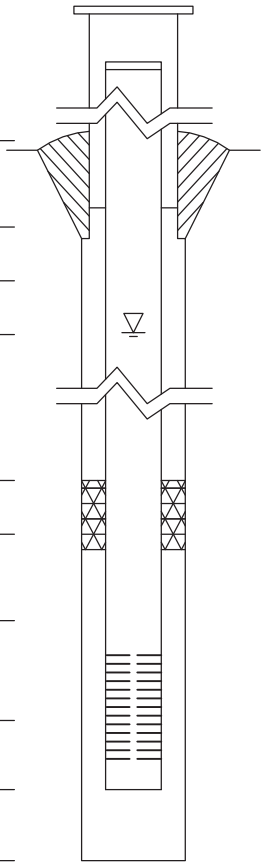
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
616.83	-2.78	Top of Protective Casing
616.47	-2.43	Top of Riser Pipe
614.04	0.00	Ground Surface
611.04	3.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
608.96	5.08	Top of Sand Pack
607.87	6.17	Top of Screen
598.08	15.96	Bottom of Screen
597.57	16.47	Bottom of Well
597.57	16.47	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	9.19
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	9.19
Total Length of Casing	(feet)	18.90
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: 0570255197 County: Fulton Well #: R61L

Site Name: Duck Creek Power Station - Ash Landfill Borehole #: R61L

~~State~~ Plant ~~Plane~~ Coordinate: X 994.3 Y 15,649.9 (or) Latitude: 40° 30' 26.021" Longitude: 89° 59' 13.252"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 3/14/2017 Date Finished: 3/14/2017

Report Form Completed By: Suzanna L. Keim Date: 3/16/2017

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 75 minutes

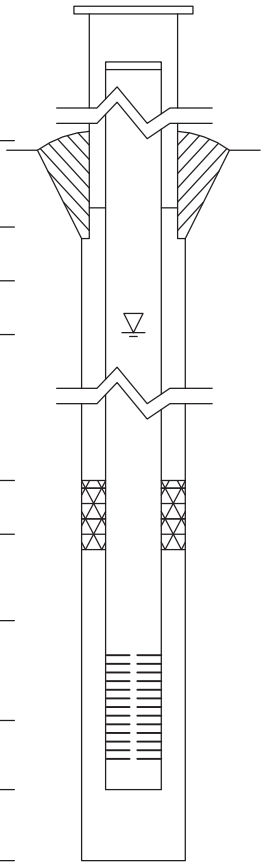
Type of Sand Pack: Quartz Sand

Grain Size: 10-40 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.99	-3.03	Top of Protective Casing
622.69	-2.73	Top of Riser Pipe
619.96	0.00	Ground Surface
617.96	2.00	Top of Annular Sealant
		Static Water Level (After Completion)
605.16	14.80	Top of Seal
603.14	16.82	Top of Sand Pack
601.42	18.54	Top of Screen
591.79	28.17	Bottom of Screen
591.29	28.67	Bottom of Well
591.29	28.67	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	21.27
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.63
Total Length of Casing	(feet)	31.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: R72S

Site Name: Duck Creek Power Station - Recycle Pond Borehole #: R72S

~~State~~ Plant ~~Plane~~ Coordinate: X 500.0 Y 13,905.4 (or) Latitude: 40° 30' 8.792" Longitude: 89° 59' 19.692"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 11/9/2016 Date Finished: 11/9/2016

Report Form Completed By: Suzanna L. Keim Date: 11/18/2016

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 50 minutes

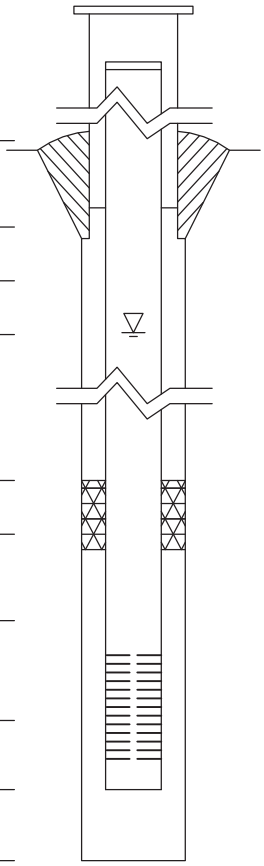
Type of Sand Pack: Quartz Sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.11	-3.00	Top of Protective Casing
617.87	-2.76	Top of Riser Pipe
615.11	0.00	Ground Surface
613.01	2.10	Top of Annular Sealant
		Static Water Level (After Completion)
590.01	25.10	Top of Seal
587.06	28.05	Top of Sand Pack
585.28	29.83	Top of Screen
580.62	34.49	Bottom of Screen
580.16	34.95	Bottom of Well
580.16	34.95	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	6.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.59
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	4.66
Total Length of Casing	(feet)	37.71
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX C
GEOTECHNICAL LABORATORY REPORTS

Electronic Filing: Received, Clerk's Office 06/20/2024

GEOTECHNOLOGY INC
FROM THE GROUND UP

Via email: dramsey@ramgeoeng.com

April 5, 2021 J037264.01.6001

Mr. Douglas P. Ramsey, P.E.
Ramsey Geotechnical Engineering
1701 W. Market Street
Bloomington, Illinois 61701

Re: Duck Creek Power Station
Fulton County, Illinois

Dear Mr. Ramsey:

Included in this report are the test results from a bulk sample of gypsum received in our laboratory on March 15, 2021. The sample was tested in general accordance with the test method listed below.

Test to Determine	Method of Test
Hydraulic Conductivity of Soil Using Flexible Wall Permeameter	ASTM D5084

We trust this is the information you require. Please contact the undersigned if you have any questions regarding this report.

Respectfully submitted,

GEOTECHNOLOGY, INC.

Janet M. May
Illinois Laboratory Manager

JMM/LPH:jmm

Attachment: Test Result Summary
Hydraulic Conductivity Test Data Sheet
Proctor Curve (Provided by Ramsey)
Testing Assignment Sheets

Electronic Filing: Received, Clerk's Office 06/20/2024

TEST RESULT SUMMARY

Duck Creek Power Station
Fulton County, Illinois

Sample Number/ Material	Optimum Moisture Content, %	Maximum Dry Unit Weight, pcf	Percent Compact	Moisture Content, %	Dry Unit Weight, pcf	Hydraulic Conductivity, cm/sec	Range of Hydraulic Gradient
LSN-3781/ Gypsum	27.0	81.0	91.2	28.8	73.9	6.7×10^{-4}	0.2 - 2.2

Notes and abbreviations:
% - Percent
cm/sec - Centimeters per second
pcf - Pounds per cubic foot

R001355

Electronic Filing: Received, Clerk's Office 06/20/2024

HYDRAULIC CONDUCTIVITY TEST DATA

(ASTM D 5084)

JOB NO.: J037264.01.6002
PROJECT: Duck Creek Bottom Ash Basins
SAMPLE NO.: LSN-3781
MATERIAL: Gypsum

ASTM D698 Results
Maximum Dry Unit Weight, pcf: 81.0
Optimum Water Content, %: 27.0

Initial Unit Weight

WET UNIT WEIGHT, pcf: 95.2
DRY UNIT WEIGHT, pcf: 73.9
Percent Compact: 91.2%

Unit Weight as Tested

WET UNIT WEIGHT, pcf: 95.2
DRY UNIT WEIGHT, pcf: 69.4

	Initial	After Test**
LENGTH, in.:	2.878	
DIAMETER, in.:	2.878	
WET WT., gms.:	467.82	
AREA, sq.in.:	6.505	

	Initial	As Tested
LENGTH, cm:	7.310	
DIAMETER, cm:	7.310	
AREA, sq cm:	41.970	

INITIAL MOISTURE CONTENT

WET WT SPLE+TARE	754.45
DRY WT SPLE+TARE	649.86
TARE WEIGHT	286.63
% MOISTURE	28.8

FINAL MOISTURE CONTENT

WET WT SPLE+TARE	784.98
DRY WT SPLE+TARE	649.86
TARE WEIGHT	286.63
% MOISTURE	37.2

B VALUE (before Permeation): 95%
Cell / Back Pressure, psi: 88 / 85
Percent Wet of Optimum: 1.8

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP °C	ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC	HYDRAULIC GRADIENT	HYDRAULIC HEAD	HEAD LOSS,%	k (in/sec)
0.0	30-Mar-21	10:19 AM	20.8	0	7.32	23.70			2.24	16.38		
0.0	30-Mar-21	10:20 AM	20.8	1	10.18	20.51	2.86	7.0E-04	1.41	10.33	36.94	2.8E-04
0.0	30-Mar-21	10:22 AM	20.8	2	13.33	17.40	3.15	7.1E-04	0.56	4.07	60.60	2.8E-04
0.0	30-Mar-21	10:24 AM	20.8	2	14.46	16.18	1.13	6.6E-04	0.24	1.72	57.74	2.6E-04
0.0	30-Mar-21	11:32 AM	20.8	0	8.77	23.40			2.00	14.63		
0.0	30-Mar-21	11:33 AM	20.8	1	11.43	20.73	2.66	6.9E-04	1.27	9.30	36.43	2.7E-04
0.0	30-Mar-21	11:34 AM	20.8	1	13.10	19.03	1.67	6.9E-04	0.81	5.93	36.24	2.7E-04
0.0	30-Mar-21	11:36 AM	20.8	2	14.83	17.30	1.73	6.7E-04	0.34	2.47	58.35	2.6E-04

Average Temp. = 20.8

AVERAGE K = 6.9E-04
Corrected K for 20°C = 6.7E-04

AVERAGE K = 2.7E-04
Corrected K for 20°C = 2.6E-04

** Measurements not available at end of test.

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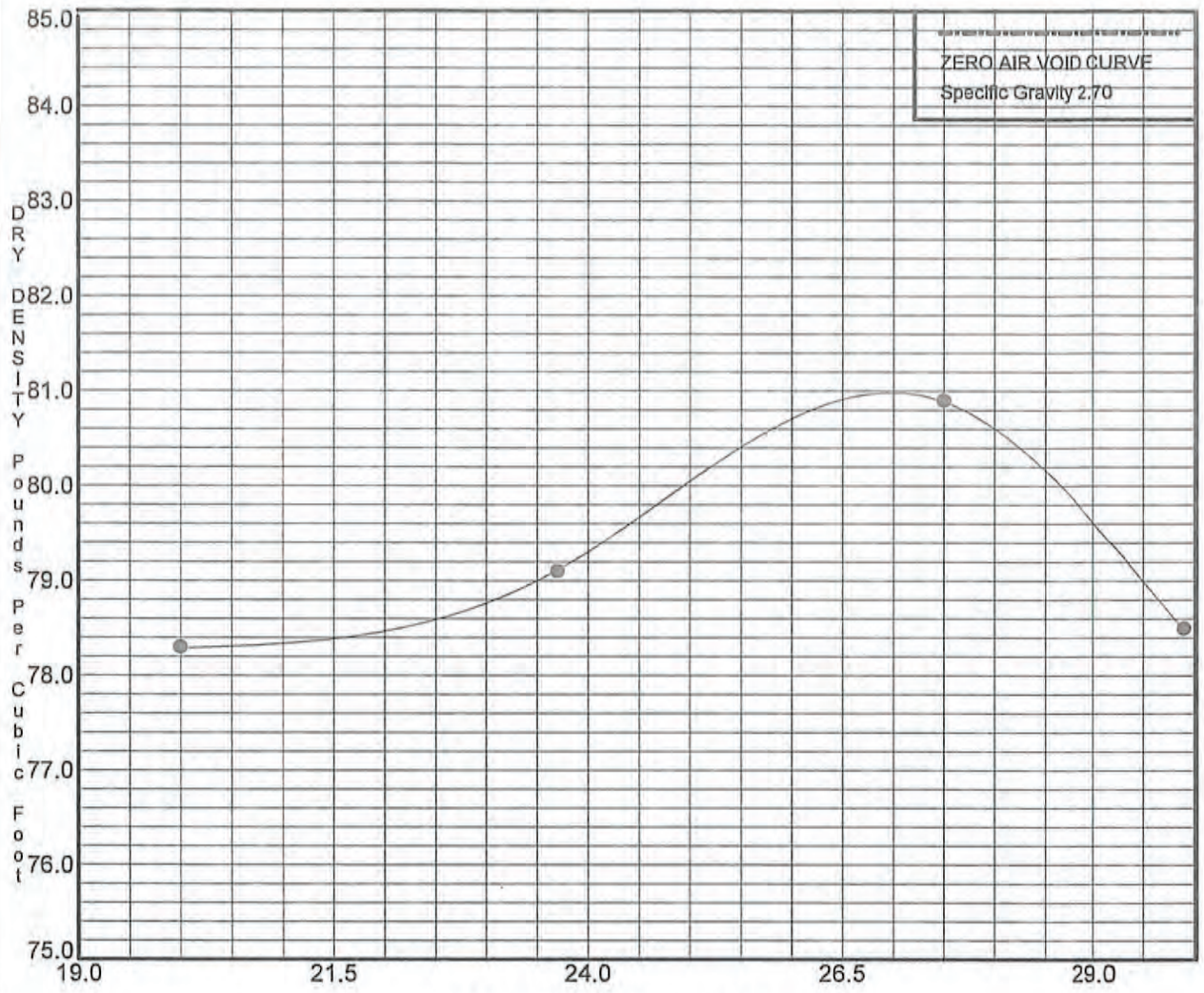

SPECIMEN IDENTIFICATION	CLASSIFICATION
Gypsum	Gypsum
LSN-3781	

MOISTURE/DENSITY RELATIONSHIP	
Standard ASTM D698/AASHTO T99	
Modified ASTM D1557/AASHTO T180	
Maximum Dry Density (PCF)	81.0
Optimum Water Content (%)	27.0

NOTES :

PROJECT Duck Creek Bottom Ash Basins JOB NO. 21-026

LOCATION Fulton County, Illinois DATE March 18, 2021

Gypsum

MOISTURE-DENSITY RELATIONSHIP

Ramsey Geotechnical Engineering

Bloomington, IL 61701

R001357

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21.026

DUCK CREEK BOTTOM ASH BASIN

Hanson Professional Services Inc.

Subcontract Agreement: RGE2014

Task Order No. 20E0111A/3000A

SCHEDULE OF LABORATORY TESTING

Sample ID	Routine Testing [1]											Complex Testing [1]															Analytical Testing [1]							
	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB01																																	
6A																																	
7A																																	
8A																																	
10A																																	
11A																																	
12A																																	
Comp1				x	x			x			x			x																			
ST9																					x	DONE.											
14A																																	
ST15																																	
Comp2				x	x			x			x			x																			
ST15																					x	DONE											
17A																																	
18A																																	
19A																																	
Comp3				x	x			x			x			x																			
20A																																	
21A																																	
22A																																	
23A																																	
Comp4				x	x			x			x			x																			

Note 1: All testing to be in accordance with *Laboratory Testing Specifications*.

See Task Order or Attachment for any special instructions regarding scheduled testing.

R001358

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SCHEDULE OF LABORATORY TESTING

Sample ID	Routine Testing											Complex Testing												Analytical Testing						
	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB02																																
3A																																
4A																																
6A																																
7A																																
8A																																
Comp1				x	x			x			x			x																		
ST5																					x	DONE										
9A																																
ST10																																
11A																																
Comp2				x	x			x			x			x																		
ST10																					x	DONE										
12A																																
ST13																																
Comp3				x	x			x			x			x																		
ST13																					x	DONE										
15A																																
16A																																
17A																																
18A																																
19A																																
20A																																
Comp4				x	x			x			x			x																		

R001359

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SCHEDULE OF LABORATORY TESTING

	Routine Testing											Complex Testing												Analytical Testing						
Sample ID	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB03																																
4A																																
6A																																
7A																																
8A																																
Comp1				x	x			x			x			x																	
ST5																					x	Done										
ST10*				x	x			x			x			x																	
ST10^																					x	Done										
11A																																
12A																																
13A																																
Comp3				x	x			x			x			x																	
Gypsum				x	x			x	x		x			x							x*	*Remolded permeability*										

* If sand is present in Shelby tube.

^ if sufficient sample, use lower portion of Shelby tube.

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GEOTECHNICS
Soil & Material Testing
A DIVISION OF KLINGNER
4510 Paris Gravel Road • Hannibal, MO 63401 • voice 573.221.7714 • fax 573.221.7762

March 26, 2021 21-1004

Hanson Professional Services, Inc.
1525 S. Sixth St.
Springfield, IL 62703-6801

Attn: Mr. Rhonald Hasenyager

RE: Duck Creek Power Station GMF: Fulton County, IL

Dear Mr. Hasenyager:

In accordance with your request, we have completed the analysis of the samples obtained from the exploration borings from the above mentioned project. The selected samples were analyzed in accordance with the applicable ASTM standards. A laboratory results summary sheet is included for your reference.

As always, if you have any questions do not hesitate to contact us.

Sincerely,

GEOTECHNICS, A DIVISION OF KLINGNER

Brian Joseph Sick

Brian Joseph Sick, P.E.
Geotechnical Services Department Manager

Enclosure: Data Results Summary, Laboratory Analysis Data Reports

R001361

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Job #: 21-1004

Duck Creek Power Station
Hanson Professional Services

Date: 3/26/2021

SAMPLE NO.	DEPTH	% Gravel	% Sand	% Silt	% Clay	USCS	LL	PL	PI	Sp. Gr.	Hyd. Cond.	Moist.	WET DENS.	DRY DENS.
SB50-Comp 1	5-19	0.0	2.6	81.8	15.6	CL	32	23	9	2.68		24.9	121.5	97.3
SB50-Comp 2	21-31	3.4	26.5	46.1	24.0	CL	28	18	10	2.70		21.1	141.4	116.7
SB50-Comp 3	31-39	3.6	32.0	50.5	13.9	CL	27	18	9	2.70		17.1	143.2	122.3
SB50-Comp 4	41-51	12.9	37.8	34.3	15.0	SC-SM	21	15	6	2.70		7.7	144.2	133.8
SB50/ST10-12	10-12										6.34E-07	25.9	123.5	98.0
SB50/ST22-24	22-24										2.59E-07	21.8	129.5	106.3
SB54C-Comp 1	7-19	0.2	11.6	66.1	22.1	CL	35	22	13	2.68		18.6	134.2	113.1
SB54C-Comp 2	25-33	1.0	18.4	49.1	31.5	CL	40	18	22	2.68		24.6	122.1	98.0
SB54C-Comp 3	35-41	10.6	25.8	45.2	18.4	CL-ML	24	19	5	2.64		18.2	133.6	113.0
SB54C-Comp 4	47-73	7.4	36.3	38.0	18.3	CL	21	13	8	2.67		9.8	141.0	128.4
SB54C/ST14-16	14-16										7.06E-08	22.2	127.0	104.0
SB54C/ST32-34	32-34										7.47E-07	21.9	128.2	105.1
SB54C/ST44-46	44-46										5.39E-06	12.2	141.5	126.1
SB54C/ST76-78	76-78										4.11E-08	12.6	138.7	123.2
SB62-Comp 1	7-19	0.0	11.5	62.0	26.5	CL	35	22	13	2.65		19.3	124.9	104.7
SB62-Comp 2	23-33	0.0	23.0	48.6	28.4	CL	29	17	12	2.70		21.5	126.6	104.1
SB62-Comp 3	33-39	2.9	23.4	57.5	16.2	CL-ML	26	19	7	2.65		14.5	133.0	116.1
SB62-Comp 4	41-51	2.8	40.7	38.7	17.8	CL-ML	21	15	6	2.64		10.0	138.6	126.1
SB62/ST12-14	12-14										1.94E-07	21.1	127.8	105.5
SB62/ST26-28	26-28										2.28E-06	23.2	129.8	105.3
SB62/ST38-40	38-40										1.09E-06	15.6	136.8	118.4

Lab Results

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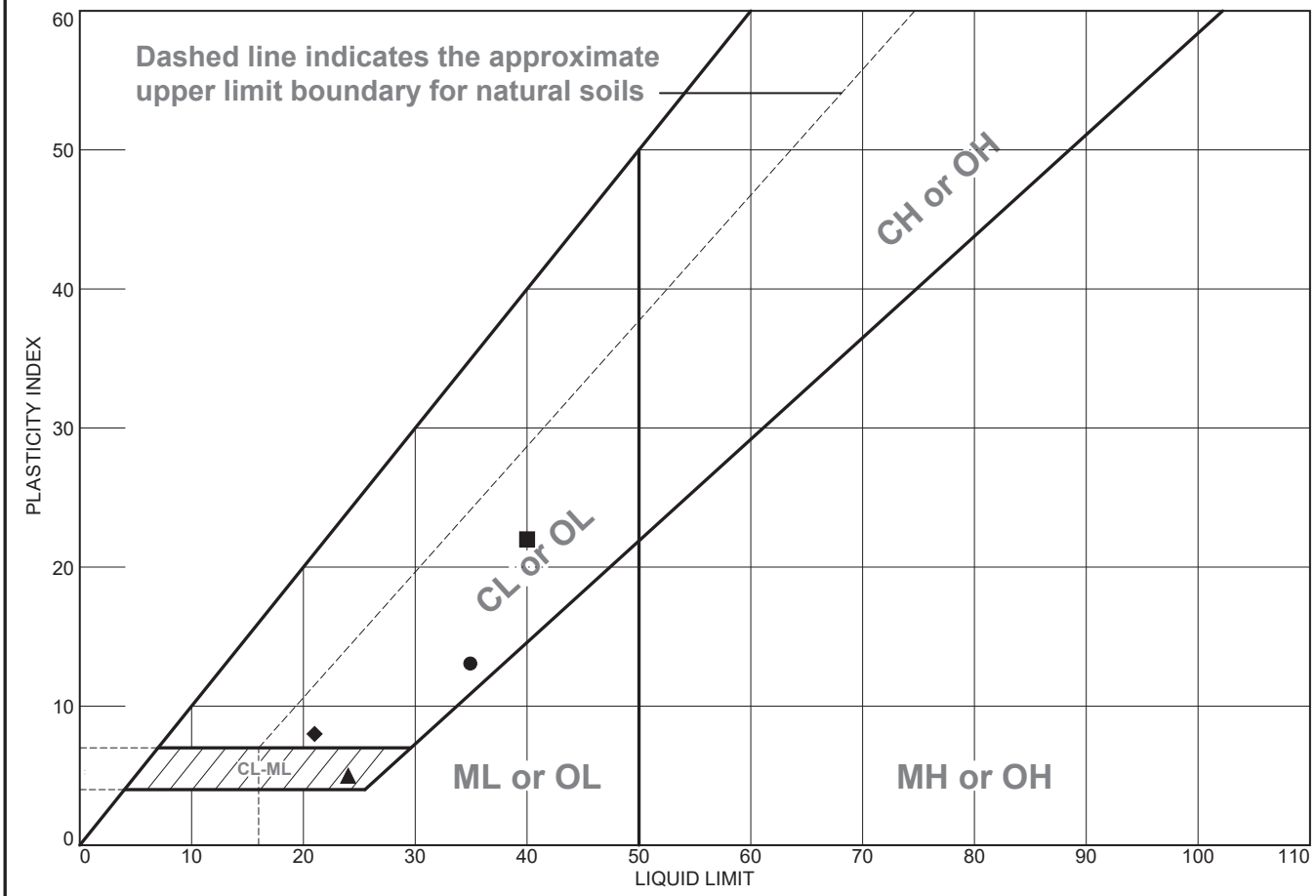
LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist	35	22	13	94.5	88.2	CL
■	Lean Clay with Sand (CL), Yellow Brown, Silty, Moist	40	18	22	95.5	80.6	CL
▲	Sandy Silty Clay (CL-ML), Gray, Moist	24	19	5	79.9	63.6	CL-ML
◆	Sandy Lean Clay (CL), Gray, Silty	21	13	8	80.1	56.3	CL

Project No. 21-1004 **Client:** Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

●**Location:** G54C **Depth:** 7 to 19 ft. **Sample Number:** Comp 1
■**Location:** G54C **Depth:** 25 to 33 ft. **Sample Number:** Comp 2
▲**Location:** G54C **Depth:** 35 to 41 ft. **Sample Number:** Comp 3
◆**Location:** G54C **Depth:** 47 to 73 ft. **Sample Number:** Comp 4

Remarks:
●Moisture Content = 18.6%
■Moisture Content = 24.6%
▲Moisture Content = 18.2%
◆Moisture Content = 9.8%

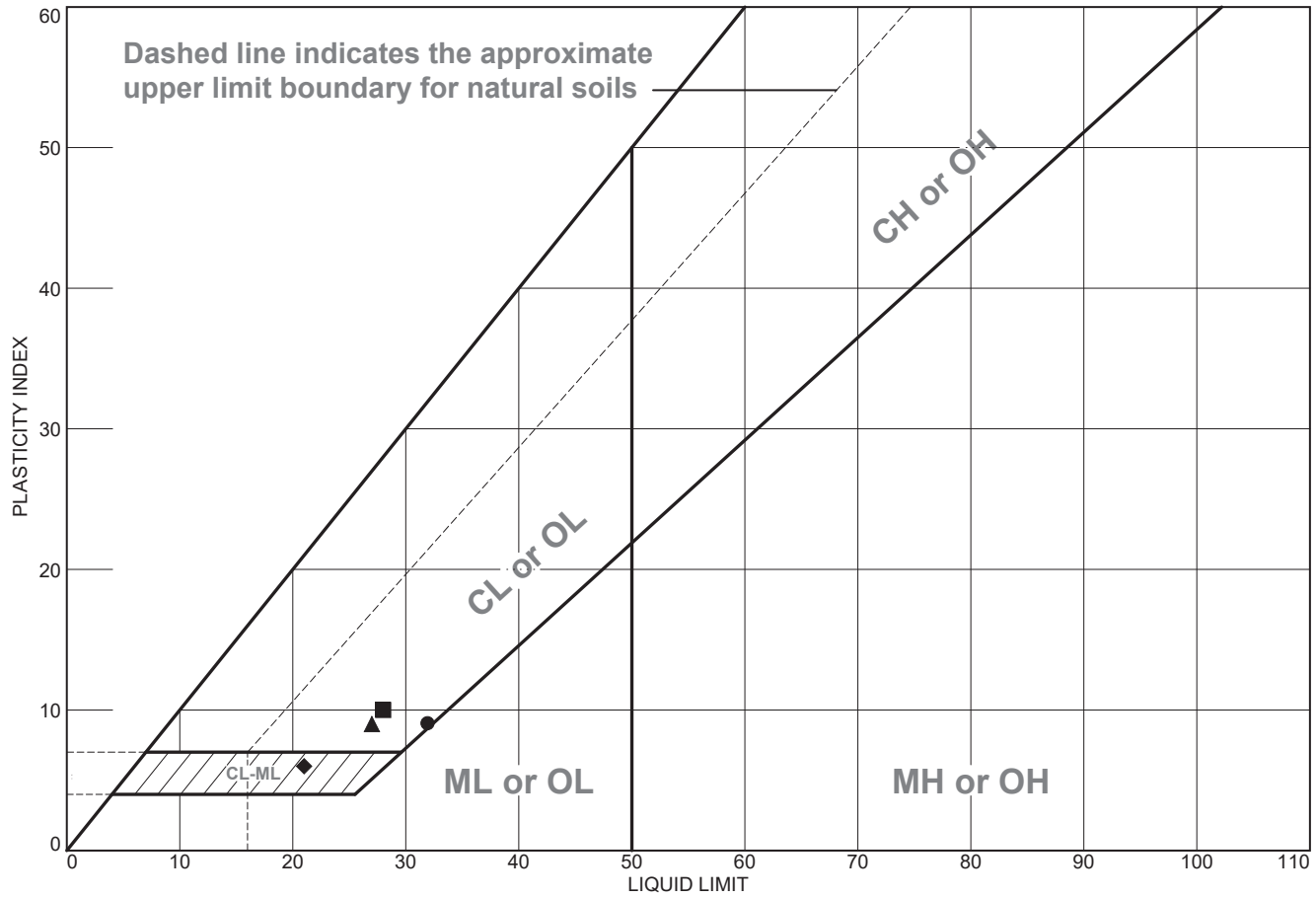
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Figure

Tested By: AJK **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay (CL), Light Brown, Silty, Moist	32	23	9	99.5	97.4	CL
■	Lean Clay with Sand (CL), Yellow Brown/Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist	28	18	10	86.3	70.1	CL
▲	Sandy Lean Clay (CL), Gray, Silty, Moist	27	18	9	85.9	64.4	CL
◆	Silty, Clayey Sand (SC-SM), Gray, Dry	21	15	6	75.0	49.3	SC-SM

Project No. 21-1004 **Client:** Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

●**Location:** SB50 **Depth:** 5 to 19 ft. **Sample Number:** Comp 1
■**Location:** SB50 **Depth:** 21 to 31 ft. **Sample Number:** Comp 2
▲**Location:** SB50 **Depth:** 31 to 39 ft. **Sample Number:** Comp 3
◆**Location:** SB50 **Depth:** 41 to 51 ft. **Sample Number:** Comp 4

Remarks:
●Moisture Content = 24.9%
■Moisture Content = 21.1%
▲Moisture Content = 17.1%
◆Moisture Content = 7.7%

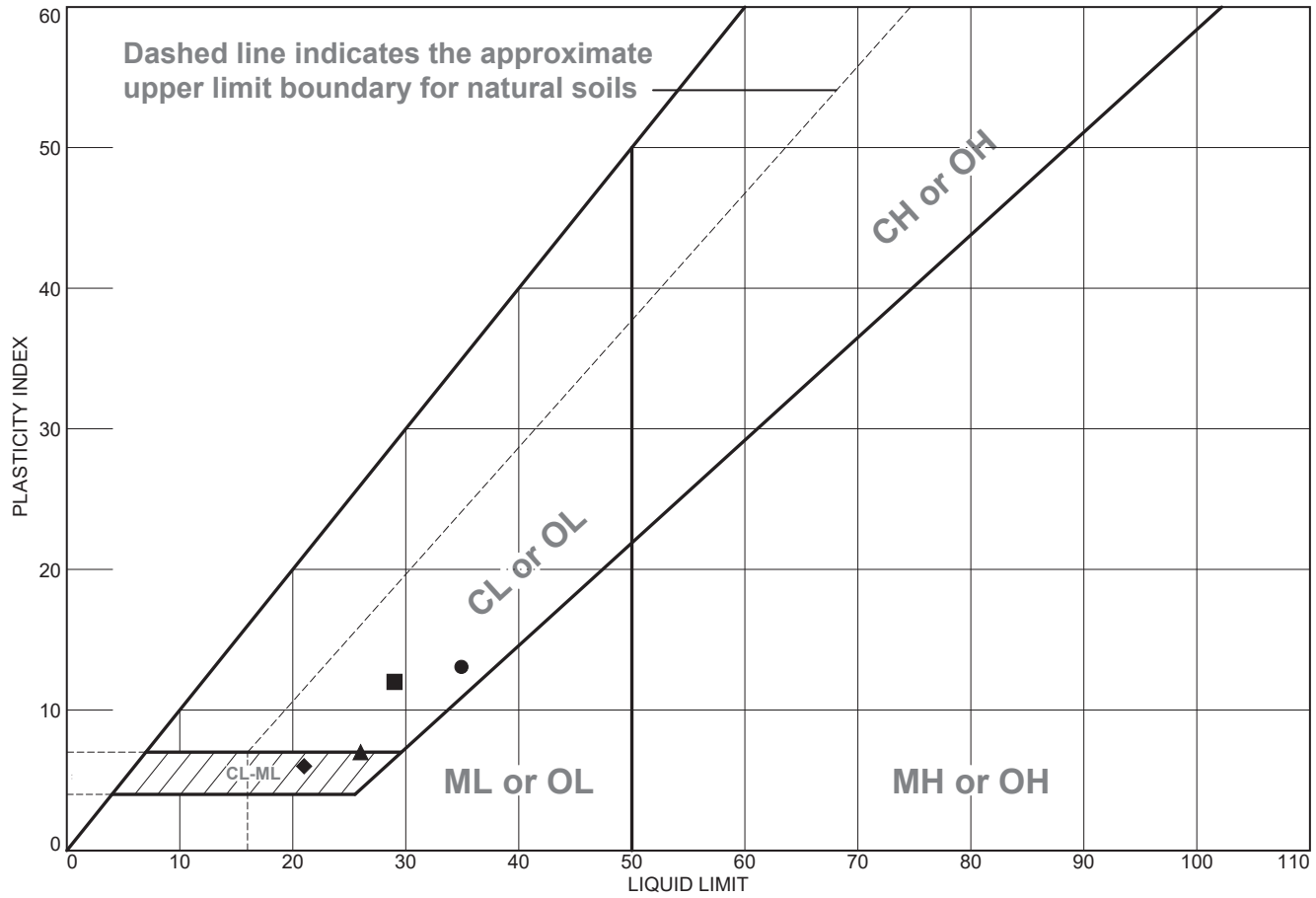
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Figure

Tested By: ○ NAS □ NAS △ AJK ◇ AJK **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist	35	22	13	93.1	88.5	CL
■	Lean Clay with Sand (CL), Gray, Silty, Moist	29	17	12	94.3	77.0	CL
▲	Silty Clay with Sand (CL-ML), Gray, Moist	26	19	7	88.5	73.7	CL-ML
◆	Sandy Silty Clay (CL-ML), Gray, Dry	21	15	6	83.5	56.5	CL-ML

Project No. 21-1004 **Client:** Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

●**Location:** SB62 **Depth:** 7 to 19 ft. **Sample Number:** Comp 1
■**Location:** SB62 **Depth:** 23 to 33 ft. **Sample Number:** Comp 2
▲**Location:** SB62 **Depth:** 33 to 39 ft. **Sample Number:** Comp 3
◆**Location:** SB62 **Depth:** 41 to 51 ft. **Sample Number:** Comp 4

Remarks:
●Moisture Content = 19.3%
■Moisture Content = 21.5%
▲Moisture Content = 14.5%
◆Moisture Content = 10.0%

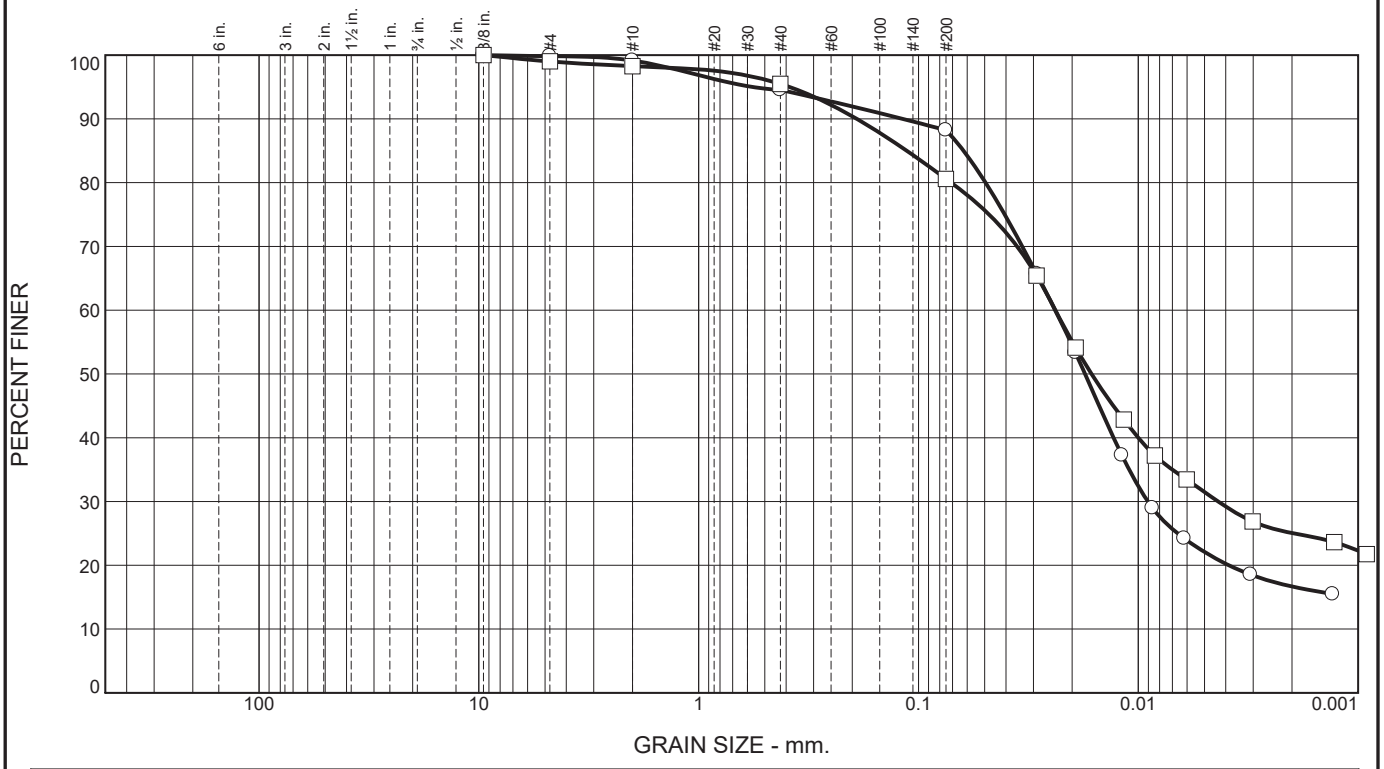
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Figure

Tested By: AJK **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	0.2	11.6	66.1	22.1	CL	35	22	13
□	0.0	1.0	18.4	49.1	31.5	CL	40	18	22

SIEVE inches size	○	□
3/8	100.0	100.0
GRAIN SIZE		
D_{60}	0.0239	0.0238
D_{30}	0.0090	0.0043
D_{10}		
COEFFICIENTS		
C_c		
C_u		

SIEVE number size	○	□
#4	99.8	99.0
#10	99.1	98.3
#40	94.5	95.5
#200	88.2	80.6

Material Description

○ Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

□ Lean Clay with Sand (CL), Yellow Brown, Silty, Moist

REMARKS:

○ Moisture Content = 18.6%

□ Moisture Content = 24.6%

○ Location: G54C Depth: 7 to 19 ft. Sample Number: Comp 1

□ Location: G54C Depth: 25 to 33 ft. Sample Number: Comp 2

GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.

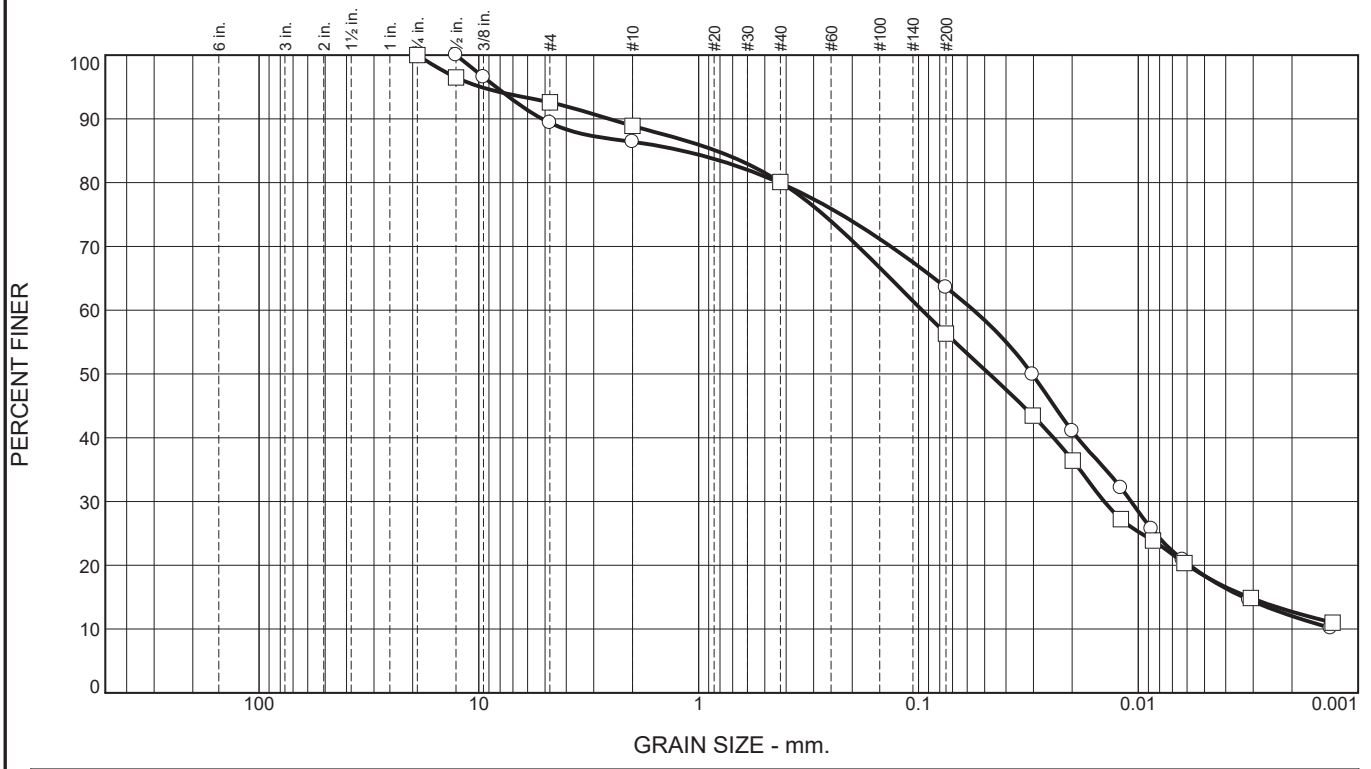
Project: Duck Creek Power Station GMF

Project No.: 21-1004 Figure

Tested By: MAS/NAS **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	10.6	25.8	45.2	18.4	CL-ML	24	19	5
□	0.0	7.4	36.3	38.0	18.3	CL	21	13	8

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/4		100.0
.5	100.0	96.5
3/8	96.6	

	GRAIN SIZE ○	GRAIN SIZE □
D_{60}	0.0562	0.0963
D_{30}	0.0108	0.0143
D_{10}		
	COEFFICIENTS	
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	89.4	92.6
#10	86.4	88.9
#40	79.9	80.1
#200	63.6	56.3

Material Description

○ Sandy Silty Clay (CL-ML), Gray, Moist

□ Sandy Lean Clay (CL), Gray, Silty

REMARKS:

○ Moisture Content = 18.2%

□ Moisture Content = 9.8%

○ Location: G54C Depth: 35 to 41 ft. Sample Number: Comp 3

□ Location: G54C Depth: 47 to 73 ft. Sample Number: Comp 4

GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

Project No.: 21-1004 Figure

Tested By: ○ DAW/NAS □ MAS/NAS **Checked By:** BJS

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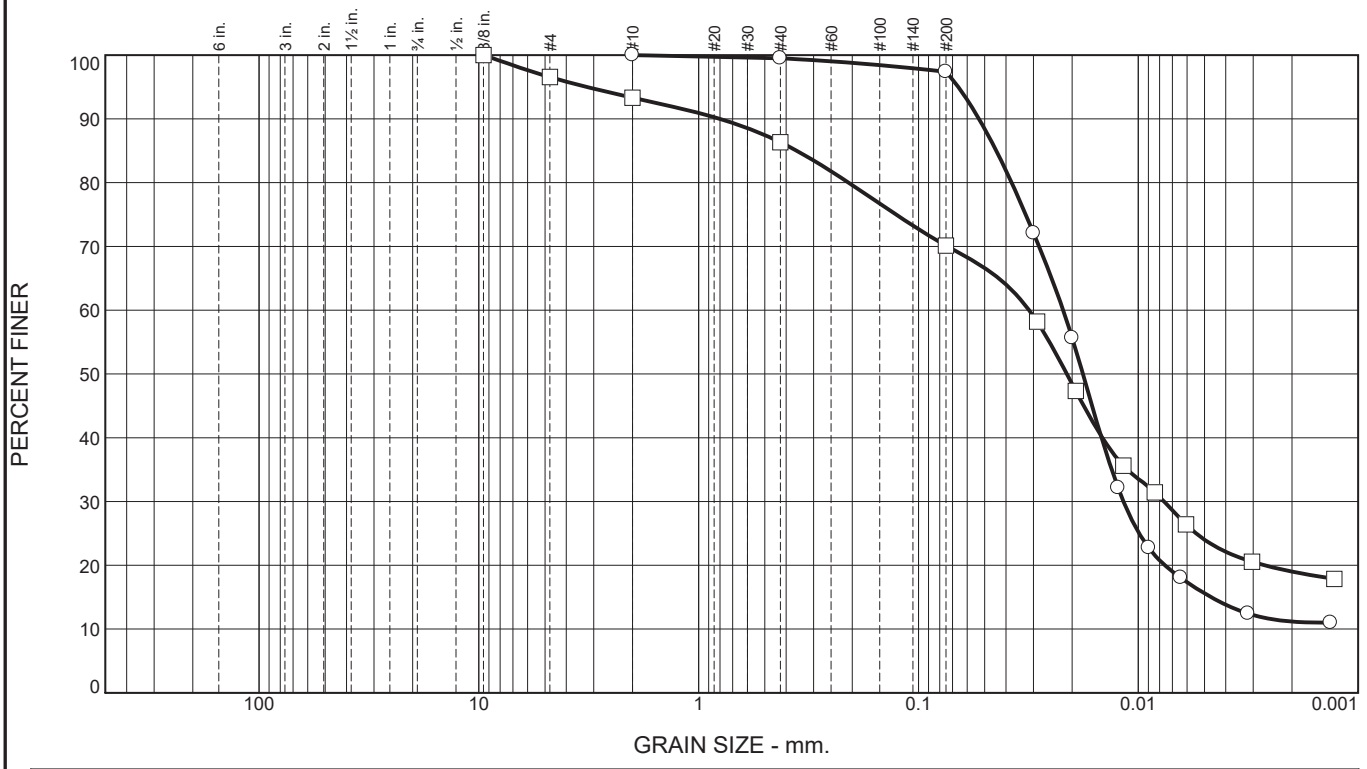
Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	0.0	2.6	81.8	15.6	CL	32	23	9
□	0.0	3.4	26.5	46.1	24.0	CL	28	18	10

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/8		100.0
GRAIN SIZE		
D_{60}	0.0220	0.0314
D_{30}	0.0117	0.0076
D_{10}		
COEFFICIENTS		
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4		96.6
#10	100.0	93.3
#40	99.5	86.3
#200	97.4	70.1

Material Description

○ Lean Clay (CL), Light Brown, Silty, Moist

□ Lean Clay with Sand (CL), Yellow Brown/Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist

REMARKS:

○ Moisture Content = 24.9%

□ Moisture Content = 21.1%

○ Location: SB50 Depth: 5 to 19 ft. Sample Number: Comp 1

□ Location: SB50 Depth: 21 to 31 ft. Sample Number: Comp 2

GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

Project No.: 21-1004 Figure

Tested By: MAS/NAS **Checked By:** BJS

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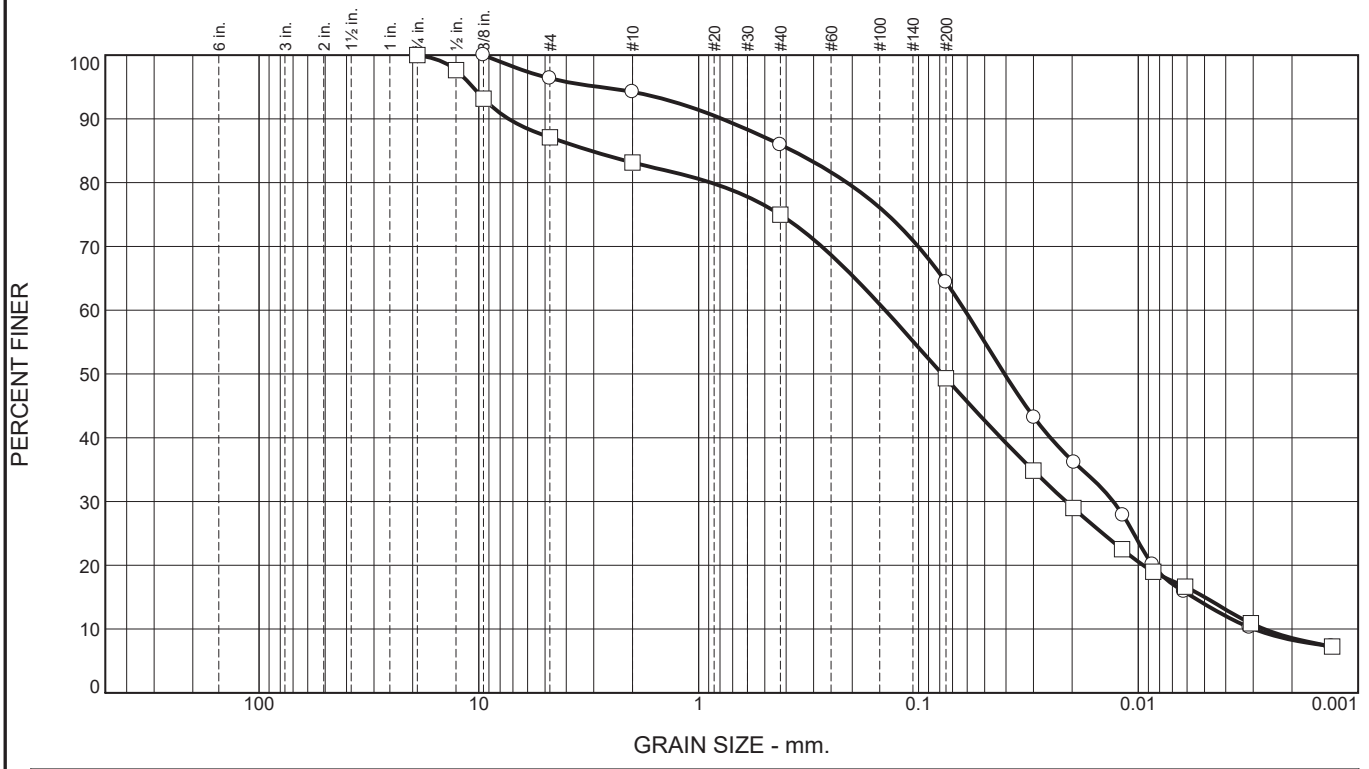
Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	3.6	32.0	50.5	13.9	CL	27	18	9
□	0.0	12.9	37.8	34.3	15.0	SC-SM	21	15	6

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/4		100.0
.5		97.6
3/8	100.0	93.2
GRAIN SIZE		
D_{60}	0.0616	0.1419
D_{30}	0.0130	0.0213
D_{10}	0.0030	0.0027
COEFFICIENTS		
C_c	0.92	1.19
C_u	20.67	53.01

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	96.4	87.1
#10	94.2	83.2
#40	85.9	75.0
#200	64.4	49.3

Material Description

○ Sandy Lean Clay (CL), Gray, Silty, Moist

□ Silty, Clayey Sand (SC-SM), Gray, Dry

REMARKS:

○ Moisture Content = 17.1%

□ Moisture Content = 7.7%

○ Location: SB50 Depth: 31 to 39 ft. Sample Number: Comp 3

□ Location: SB50 Depth: 41 to 51 ft. Sample Number: Comp 4

GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.

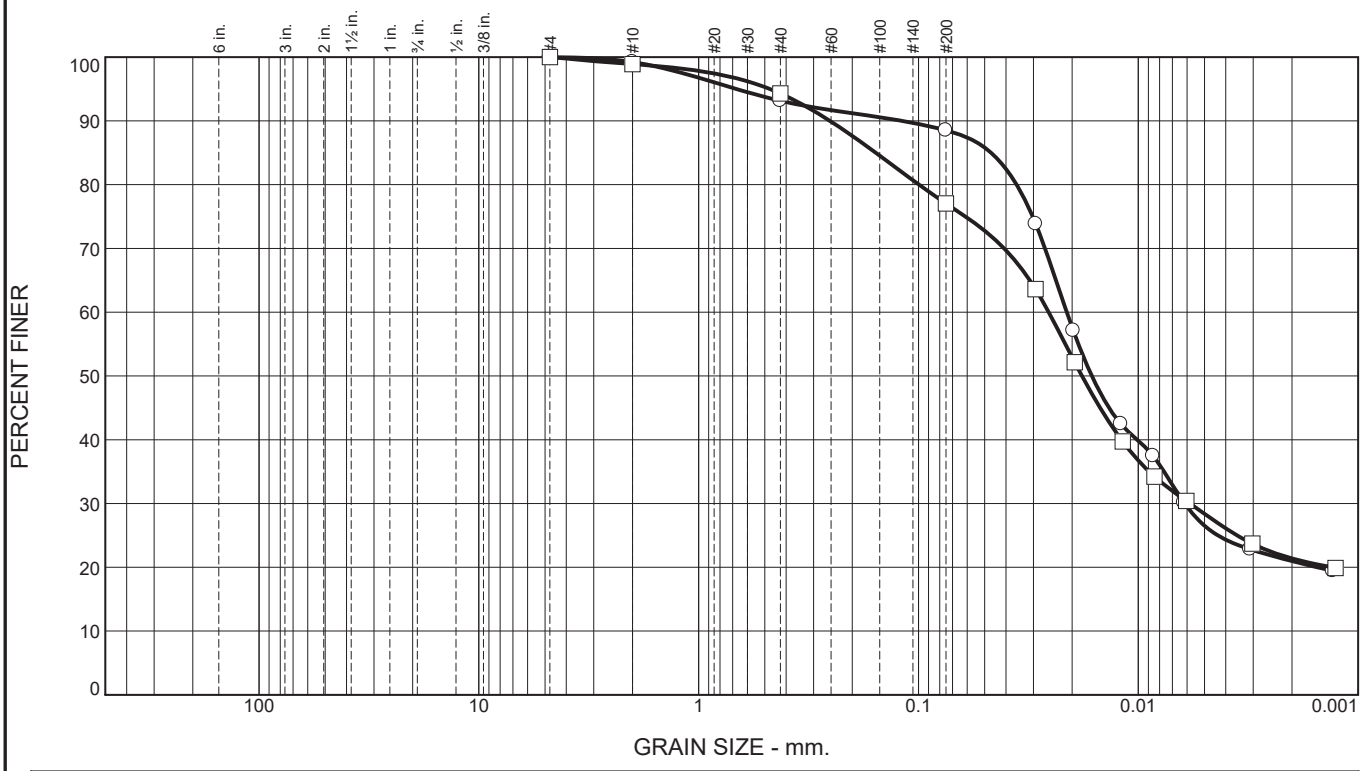
Project: Duck Creek Power Station GMF

Project No.: 21-1004 Figure

Tested By: ○ MAS □ MAS/NAS **Checked By:** NAS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	0.0	11.5	62.0	26.5	CL	35	22	13
□	0.0	0.0	23.0	48.6	28.4	CL	29	17	12

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	
	GRAIN SIZE		
D_{60}	0.0212	0.0256	
D_{30}	0.0062	0.0058	
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	100.0	100.0
#10	99.2	98.9
#40	93.1	94.3
#200	88.5	77.0

Material Description

○ Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

□ Lean Clay with Sand (CL), Gray, Silty, Moist

REMARKS:

○ Moisture Content = 19.3%

□ Moisture Content = 21.5%

○ Location: SB62 Depth: 7 to 19 ft. Sample Number: Comp 1

□ Location: SB62 Depth: 23 to 33 ft. Sample Number: Comp 2

GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.

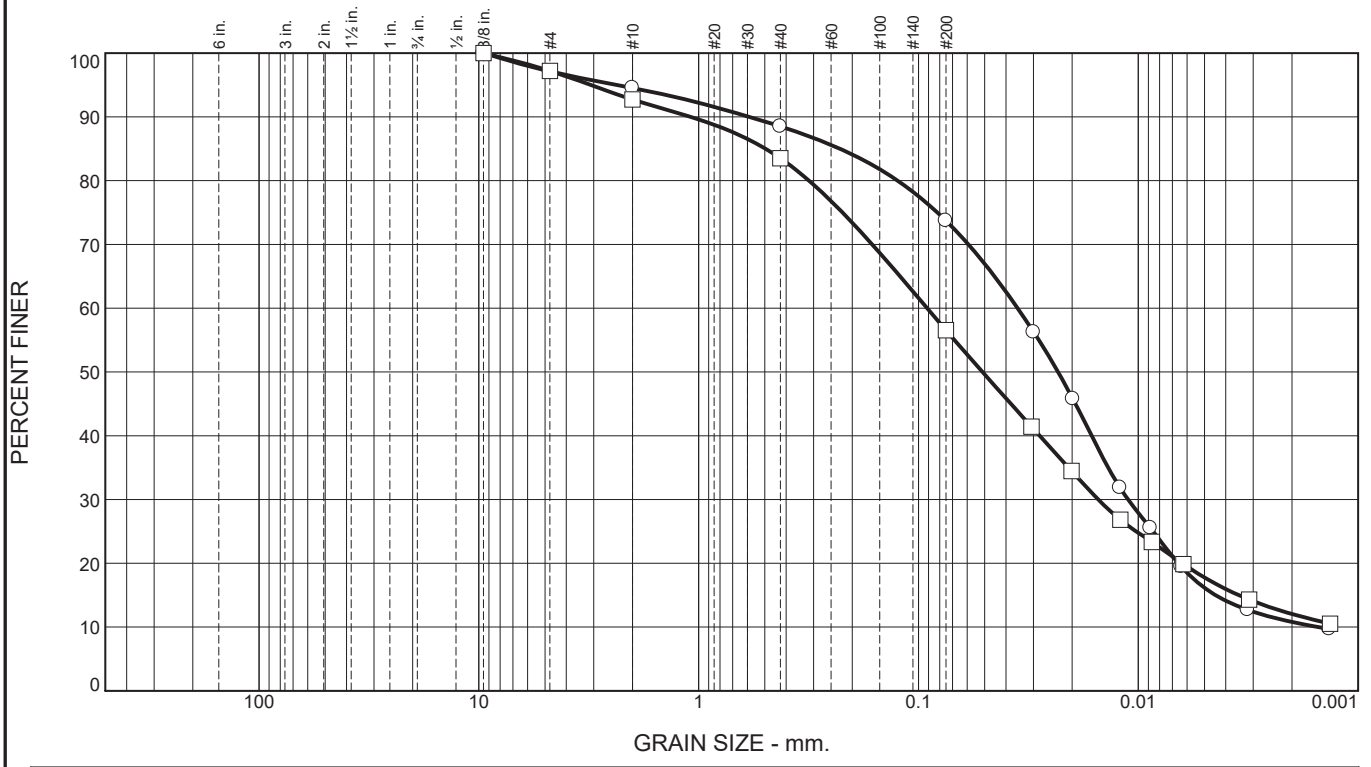
Project: Duck Creek Power Station GMF

Project No.: 21-1004 Figure

Tested By: DAW/NAS **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	2.9	23.4	57.5	16.2	CL-ML	26	19	7
□	0.0	2.8	40.7	38.7	17.8	CL-ML	21	15	6

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/8	100.0	100.0
	GRAIN SIZE	
D_{60}	0.0354	0.0913
D_{30}	0.0111	0.0152
D_{10}	0.0015	
	COEFFICIENTS	
C_c	2.31	
C_u	23.34	

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	97.1	97.2
#10	94.5	92.7
#40	88.5	83.5
#200	73.7	56.5

Material Description

○ Silty Clay with Sand (CL-ML), Gray, Moist

□ Sandy Silty Clay (CL-ML), Gray, Dry

REMARKS:

○ Moisture Content = 14.5%

□ Moisture Content = 10.0%

○ Location: SB62 Depth: 33 to 39 ft. Sample Number: Comp 3

□ Location: SB62 Depth: 41 to 51 ft. Sample Number: Comp 4

GEOTECHNICS
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4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

Project No.: 21-1004 Figure

Tested By: DAW/NAS **Checked By:** BJS

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#1 Maximum Particle Size: 3/8”

Sample Depth: 7 to 19 ft. Percent Passing No. 4 Sieve: 99.8%

Sample Type: SS Percent Passing No. 200 Sieve: 88.2%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp1		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	26.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99844		
Tare No.	239		
Wt. of Tare & Dry Soil	99.02		
Wt. of Tare	48.70		
Wt. of Dry Soil **(M_s)**	50.32		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.70		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99665		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	673.23		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.689		
Specific Gravity @ 20ºC=K*G_t	2.68		

Sample Obtained By: Geotechnics Date: 2/4/2021

Tested By Technician: NAS Date: 2/15/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay with Sand (CL), Yellow Brown, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#2 Maximum Particle Size: 3/8”

Sample Depth: 25 to 33 ft. Percent Passing No. 4 Sieve: 99.0%

Sample Type: SS Percent Passing No. 200 Sieve: 80.6%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp2		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	21.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99979		
Tare No.	231		
Wt. of Tare & Dry Soil	93.41		
Wt. of Tare	49.02		
Wt. of Dry Soil **(M_s)**	44.39		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	642.30		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99799		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	670.15		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.684		
Specific Gravity @ 20ºC=K*G_t	2.68		

Sample Obtained By: Geotechnics Date: 2/4/2021

Tested By Technician: NAS Date: 2/15/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Silty Clay (CL-ML), Gray, Moist

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#3 Maximum Particle Size: 1/2”

Sample Depth: 35 to 41 ft. Percent Passing No. 4 Sieve: 89.4%

Sample Type: SS Percent Passing No. 200 Sieve: 63.6%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp3		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	26.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99844		
Tare No.	237		
Wt. of Tare & Dry Soil	105.00		
Wt. of Tare	49.34		
Wt. of Dry Soil **(M_s)**	55.66		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	642.24		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99665		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	676.82		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.640		
Specific Gravity @ 20ºC=K*G_t	2.64		

Sample Obtained By: Geotechnics Date: 2/4/2021

Tested By Technician: NAS Date: 2/16/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Lean Clay (CL), Gray, Silty, Dry

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#4 Maximum Particle Size: 3/4”

Sample Depth: 47 to 73 ft. Percent Passing No. 4 Sieve: 92.6%

Sample Type: SS Percent Passing No. 200 Sieve: 56.3%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp4		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	25.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99884		
Tare No.	228		
Wt. of Tare & Dry Soil	105.70		
Wt. of Tare	49.94		
Wt. of Dry Soil **(M_s)**	55.76		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.40		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99705		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	666.34		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.678		
Specific Gravity @ 20ºC=K*G_t	2.67		

Sample Obtained By: Geotechnics Date: 2/4/2021

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Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay (CL), Light Brown, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#1 Maximum Particle Size: #10

Sample Depth: 5 to 19 ft. Percent Passing No. 4 Sieve: 100.0%

Sample Type: SS Percent Passing No. 200 Sieve: 97.4%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp1		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	24.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99897		
Tare No.	233		
Wt. of Tare & Dry Soil	96.94		
Wt. of Tare	49.38		
Wt. of Dry Soil **(M_s)**	47.56		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.88		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99717		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	671.72		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.684		
Specific Gravity @ 20ºC=K*G_t	2.68		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/12/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay with Sand (CL), YBrn/Lt Brn mot. Lt Gray, RBrn Ox, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#2 Maximum Particle Size: 3/8

Sample Depth: 21 to 31 ft. Percent Passing No. 4 Sieve: 96.6%

Sample Type: SS Percent Passing No. 200 Sieve: 70.1%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp2		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	21.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99979		
Tare No.	236		
Wt. of Tare & Dry Soil	97.27		
Wt. of Tare	49.36		
Wt. of Dry Soil **(M_s)**	47.91		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.87		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99799		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	662.03		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.699		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/12/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Lean Clay (CL), Gray, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#3 Maximum Particle Size: 3/8

Sample Depth: 31 to 39 ft. Percent Passing No. 4 Sieve: 96.4%

Sample Type: SS Percent Passing No. 200 Sieve: 64.4%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp3		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	26.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99858		
Tare No.	220		
Wt. of Tare & Dry Soil	98.97		
Wt. of Tare	49.09		
Wt. of Dry Soil **(M_s)**	49.88		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.27		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99679		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	662.68		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.701		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/15/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Silty, Clayey Sand (SC-SM), Gray, Dry

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#4 Maximum Particle Size: 3/4

Sample Depth: 41 to 51 ft. Percent Passing No. 4 Sieve: 87.1%

Sample Type: SS Percent Passing No. 200 Sieve: 49.3%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp4		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	25.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99884		
Tare No.	237		
Wt. of Tare & Dry Soil	99.71		
Wt. of Tare	49.44		
Wt. of Dry Soil **(M_s)**	50.27		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.83		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99705		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	673.49		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.701		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/12/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#1 Maximum Particle Size: #4

Sample Depth: 7 to 19 ft. Percent Passing No. 4 Sieve: 100.0%

Sample Type: SS Percent Passing No. 200 Sieve: 88.5%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp1		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	24.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99909		
Tare No.	239		
Wt. of Tare & Dry Soil	88.7		
Wt. of Tare	48.66		
Wt. of Dry Soil **(M_s)**	40.04		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.95		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99730		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	666.87		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.648		
Specific Gravity @ 20ºC=K*G_t	2.65		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/16/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay with Sand (CL), Gray, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#2 Maximum Particle Size: #4

Sample Depth: 23 to 33 ft. Percent Passing No. 4 Sieve: 100.0%

Sample Type: SS Percent Passing No. 200 Sieve: 77.0%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp2		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	26.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99858		
Tare No.	234		
Wt. of Tare & Dry Soil	101.50		
Wt. of Tare	49.10		
Wt. of Dry Soil **(M_s)**	52.40		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.27		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99679		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	664.27		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.701		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/16/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Silty Clay with Sand (CL-ML), Gray, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#3 Maximum Particle Size: 3/8”

Sample Depth: 33 to 39 ft. Percent Passing No. 4 Sieve: 97.1%

Sample Type: SS Percent Passing No. 200 Sieve: 73.7%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp3		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	26.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99844		
Tare No.	223		
Wt. of Tare & Dry Soil	103.96		
Wt. of Tare	49.21		
Wt. of Dry Soil **(M_s)**	54.75		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	647.24		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99665		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	676.33		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.650		
Specific Gravity @ 20ºC=K*G_t	2.65		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/17/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Silty Clay (CL-ML), Gray, Dry

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#4 Maximum Particle Size: 3/8”

Sample Depth: 41 to 51 ft. Percent Passing No. 4 Sieve: 97.2%

Sample Type: SS Percent Passing No. 200 Sieve: 56.5%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp4		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	23.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99921		
Tare No.	231		
Wt. of Tare & Dry Soil	99.47		
Wt. of Tare	49.03		
Wt. of Dry Soil **(M_s)**	50.44		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.59		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99742		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	662.94		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.642		
Specific Gravity @ 20ºC=K*G_t	2.64		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/17/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF**
CLIENT **Hanson Professional Services, Inc.**
LOCATION
SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Lean Clay (CL/CH), Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist**

LIQUID LIMIT
PLASTIC LIMIT
P.I.

BORING NO. **G-54C**
SAMPLE NO. **14-16**

SAMPLE TYPE **ST**
DEPTH **14-16 ft.**

SPECIFIC GRAVITY, Gs
TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **22.2%**
INITIAL DRY DENSITY **104.0 P.C.F.**

FINAL WATER CONTENT **23.9%**
FINAL DRY DENSITY **103.0 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
14:18		0.200	7.818	42.077		1.49	8.10	33.050	210.9		243.950		
14:18	15:10	0.200	7.818	42.077	3120	1.78	7.80	30.100	210.9	1.03	241.000	7.25E-08	7.35E-08
15:10	15:44	0.200	7.818	42.077	2040	1.96	7.62	28.300	210.9	1.00	239.200	6.83E-08	6.93E-08
15:44	16:36	0.200	7.818	42.077	3120	2.23	7.35	25.600	210.9	1.00	236.500	6.76E-08	6.86E-08
													7.06E-08

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 7.06 E-08 CM/SEC

REMARKS: Testing Completed 2/17/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF**
CLIENT **Hanson Professional Services, Inc.**
LOCATION
SAMPLING DATE **2/4/2021**

SAMPLE DESCRIPTION **Sandy Lean Clay (CL), Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist**

LIQUID LIMIT
PLASTIC LIMIT
P.I.

BORING NO. **G-54C**
SAMPLE NO. **32-34**

SAMPLE TYPE **ST**
DEPTH **32-34 ft.**

SPECIFIC GRAVITY, Gs
TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **21.9%**
INITIAL DRY DENSITY **105.1 P.C.F.**

FINAL WATER CONTENT **21.4%**
FINAL DRY DENSITY **106.7 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
8:33		0.200	7.523	40.438		3.65	5.72	10.350	210.9		221.250		
8:33	10:02	0.200	7.523	40.438	5340	7.87	1.44	-32.150	210.9	1.01	178.750	7.43E-07	7.54E-07
10:02	10:25	0.200	7.523	40.438	1380	8.80	0.52	-41.400	210.9	0.99	169.500	7.16E-07	7.27E-07
10:25	10:36	0.200	7.523	40.438	660	9.22	0.08	-45.700	210.9	1.05	165.200	7.24E-07	7.35E-07
													7.47E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 7.47 E-07 CM/SEC

REMARKS: Testing Completed 2/19/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF**
CLIENT **Hanson Professional Services, Inc.**
LOCATION
SAMPLING DATE **2/4/2021**

SAMPLE DESCRIPTION **Silty Sand (SM), Light Gray to Gray, Clayey, With Sandy Lean Clay Seams and Sand Pockets, Moist**

LIQUID LIMIT
PLASTIC LIMIT
P.I.

BORING NO. **G-54C**
SAMPLE NO. **44-46**

SAMPLE TYPE **ST**
DEPTH **44-46 ft.**

SPECIFIC GRAVITY, Gs
TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **12.2%**
INITIAL DRY DENSITY **126.1 P.C.F.**

FINAL WATER CONTENT **12.3%**
FINAL DRY DENSITY **127.4 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
9:12		0.200	7.752	41.447		7.21	2.54	-23.350	210.9		187.550		
9:12	9:15	0.200	7.752	41.447	180	8.15	1.58	-32.850	210.9	1.02	178.050	5.40E-06	5.48E-06
9:15	9:18	0.200	7.752	41.447	180	9.02	0.69	-41.650	210.9	1.02	169.250	5.27E-06	5.35E-06
9:18	9:20	0.200	7.752	41.447	120	9.58	0.13	-47.250	210.9	1.00	163.650	5.24E-06	5.32E-06
													5.39E-06

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 5.39 E-06 CM/SEC

REMARKS: Testing Completed 2/22/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/4/2021**

SAMPLE DESCRIPTION **Sandy Lean Clay (CL), Light Gray, Silty, With Fat Clay Seam, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **G-54C** SAMPLE NO. **76-78**

SAMPLE TYPE **ST** DEPTH **76-78 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **12.6%** INITIAL DRY DENSITY **123.2 P.C.F.**

FINAL WATER CONTENT **13.9%** FINAL DRY DENSITY **122.0 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
7:13		0.200	7.660	41.592		5.75	3.85	-9.500	210.9		201.400		
7:13	9:36	0.200	7.660	41.592	8580	6.13	3.48	-13.250	210.9	0.97	197.650	4.03E-08	4.09E-08
9:36	11:26	0.200	7.660	41.592	6600	6.41	3.20	-16.050	210.9	1.00	194.850	3.98E-08	4.04E-08
11:26	11:59	0.200	7.660	41.592	1980	6.50	3.11	-16.950	210.9	1.00	193.950	4.31E-08	4.37E-08
													4.11E-08

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 4.11 E-08 CM/SEC

REMARKS: Testing Completed 2/24/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF**
CLIENT **Hanson Professional Services, Inc.**
LOCATION
SAMPLING DATE **2/2/2021**

SAMPLE DESCRIPTION **Silt (ML), Yellow Brown mottled Light Brown/Light Gray, Black Oxidation, Clayey, Moist**

LIQUID LIMIT
PLASTIC LIMIT
P.I.

BORING NO. **SB-50**
SAMPLE NO. **10-12**

SAMPLE TYPE **ST**
DEPTH **10-12 ft.**

SPECIFIC GRAVITY, Gs
TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **25.9%**
INITIAL DRY DENSITY **98.0 P.C.F.**

FINAL WATER CONTENT **23.4%**
FINAL DRY DENSITY **106.1 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
8:44		0.200	7.112	39.443		2.88	6.86	19.900	140.6		160.500		
8:44	10:49	0.200	7.112	39.443	7500	6.52	3.15	-16.850	140.6	1.02	123.750	6.25E-07	6.35E-07
10:49	11:56	0.200	7.112	39.443	4020	8.14	1.52	-33.100	140.6	1.01	107.500	6.31E-07	6.41E-07
11:56	13:09	0.200	7.112	39.443	4380	9.63	0.02	-48.050	140.6	1.01	92.550	6.16E-07	6.26E-07
													6.34E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 6.34 E-07 CM/SEC

REMARKS: Testing Completed 2/15/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/2/2021**

SAMPLE DESCRIPTION **Lean Clay with Sand (CL), Light Gray/Gray mottled Yellow Brown, Silty, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **SB-50** SAMPLE NO. **22-24**

SAMPLE TYPE **ST** DEPTH **22-24 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **21.8%** INITIAL DRY DENSITY **106.3 P.C.F.**

FINAL WATER CONTENT **21.7%** FINAL DRY DENSITY **106.2 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
9:25		0.200	7.391	41.931		1.68	7.91	31.150	210.9		242.050		
9:25	10:45	0.200	7.391	41.931	4800	3.30	6.23	14.650	210.9	1.04	225.550	2.59E-07	2.63E-07
10:45	12:50	0.200	7.391	41.931	7500	5.58	3.88	-8.500	210.9	1.03	202.400	2.55E-07	2.58E-07
12:50	13:54	0.200	7.391	41.931	3840	6.64	2.80	-19.200	210.9	1.02	191.700	2.49E-07	2.53E-07
													2.59E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 2.59 E-07 CM/SEC

REMARKS: Testing Completed 2/16/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Fill: Lean Clay (CL), Light Brown mottled Gray, Silty, Trace Sand, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **SB-62** SAMPLE NO. **12-14**

SAMPLE TYPE **ST** DEPTH **12-14 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **21.1%** INITIAL DRY DENSITY **105.5 P.C.F.**

FINAL WATER CONTENT **24.5%** FINAL DRY DENSITY **102.7 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
15:45		0.200	7.264	42.028		5.07	4.80	-1.350	210.9		209.550		
15:45	16:53	0.200	7.264	42.028	4080	6.01	3.83	-10.900	210.9	1.03	200.000	1.98E-07	2.01E-07
16:53	17:27	0.200	7.264	42.028	2040	6.44	3.40	-15.200	210.9	1.00	195.700	1.84E-07	1.87E-07
17:27	17:53	0.200	7.264	42.028	1560	6.76	3.08	-18.400	210.9	1.00	192.500	1.83E-07	1.85E-07
													1.94E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 1.94 E-07 CM/SEC

REMARKS: Testing Completed 3/1/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF**
CLIENT **Hanson Professional Services, Inc.**
LOCATION
SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Lean Clay with Sand (CL), Yellow Brown mottled Reddish Brown and Light Brown, Silty, Moist**

LIQUID LIMIT
PLASTIC LIMIT
P.I.

BORING NO. **SB-62**
SAMPLE NO. **26-28**

SAMPLE TYPE **ST**
DEPTH **26-28 ft.**

SPECIFIC GRAVITY, Gs
TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **23.2%**
INITIAL DRY DENSITY **105.3 P.C.F.**

FINAL WATER CONTENT **21.5%**
FINAL DRY DENSITY **108.1 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
14:11		0.200	7.574	41.689		3.25	6.63	16.900	105.5		122.400		
14:11	14:36	0.200	7.574	41.689	1500	5.33	4.54	-3.950	105.5	1.00	101.550	2.26E-06	2.30E-06
14:36	15:11	0.200	7.574	41.689	2100	7.64	2.24	-27.000	105.5	1.00	78.500	2.23E-06	2.26E-06
15:11	15:28	0.200	7.574	41.689	1020	8.59	1.30	-36.450	105.5	0.99	69.050	2.28E-06	2.32E-06
													2.28E-06

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 2.28 E-06 CM/SEC

REMARKS: Testing Completed 2/25/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF**
CLIENT **Hanson Professional Services, Inc.**
LOCATION
SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Sandy Lean Clay (CL), Light Gray, Silty, With Silt Seam, Moist**

LIQUID LIMIT
PLASTIC LIMIT
P.I.

BORING NO. **SB-62**
SAMPLE NO. **38-40**

SAMPLE TYPE **ST**
DEPTH **38-40 ft.**

SPECIFIC GRAVITY, Gs
TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **15.6%**
INITIAL DRY DENSITY **118.4 P.C.F.**

FINAL WATER CONTENT **16.4%**
FINAL DRY DENSITY **116.5 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
15:45		0.200	7.620	41.834		4.33	5.50	5.850	210.9		216.750		
15:45	16:03	0.200	7.620	41.834	1080	5.68	4.14	-7.700	210.9	1.01	203.200	1.09E-06	1.11E-06
16:03	16:26	0.200	7.620	41.834	1380	7.27	2.54	-23.650	210.9	1.01	187.250	1.08E-06	1.10E-06
16:26	16:44	0.200	7.620	41.834	1080	8.41	1.40	-35.050	210.9	1.00	175.850	1.06E-06	1.08E-06
													1.09E-06

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 1.09 E-06 CM/SEC

REMARKS: Testing Completed 2/26/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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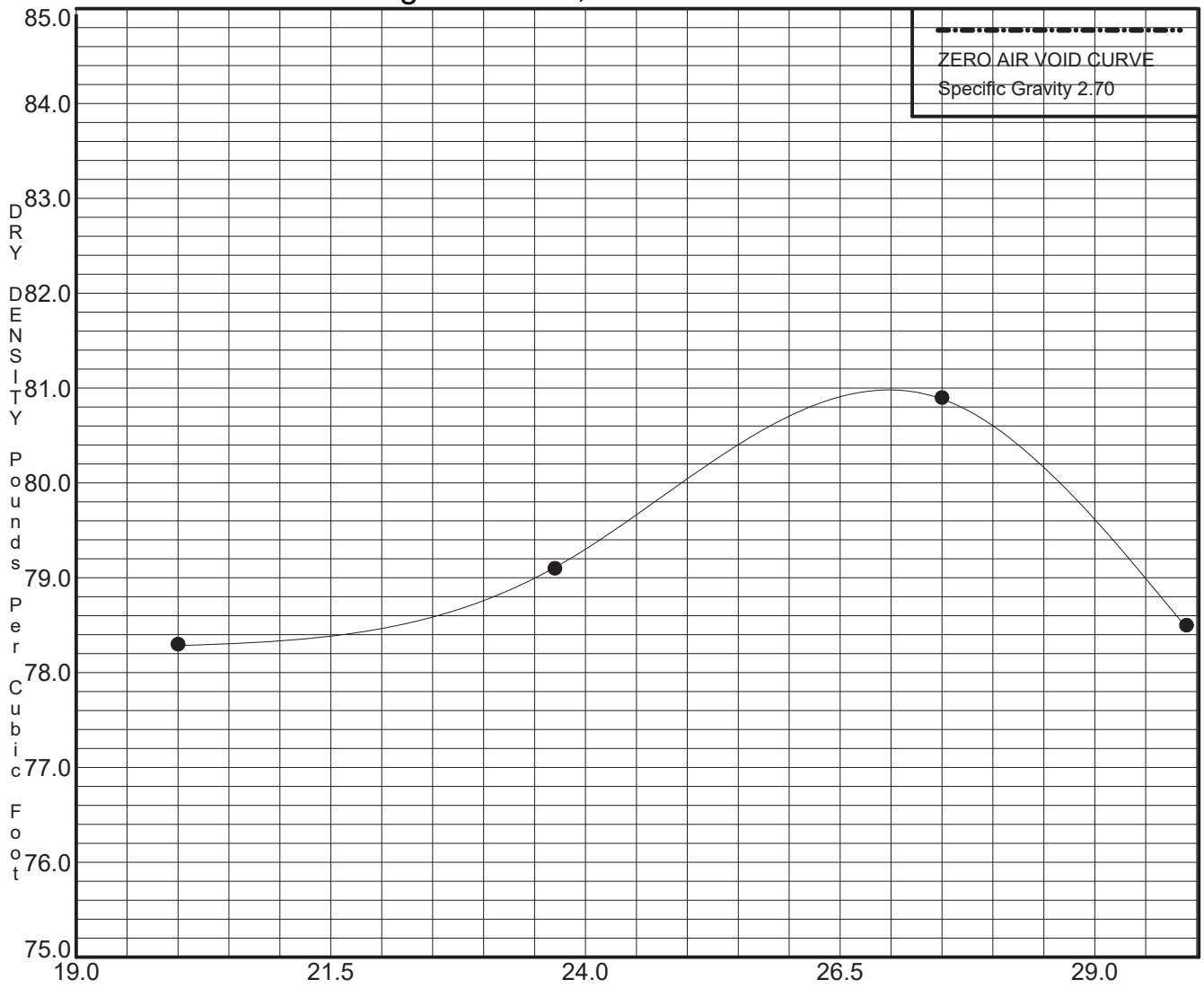

SPECIMEN IDENTIFICATION	CLASSIFICATION
Gypsum	Gypsum

MOISTURE/DENSITY RELATIONSHIP		NOTES :
	Standard ASTM D698/AASHTO T99	
	Modified ASTM D1557/AASHTO T180	
Maximum Dry Density (PCF)	**81.0**	
Optimum Water Content (%)	**27.0**	

PROJECT **Duck Creek Bottom Ash Basins** JOB NO. **21-026**

LOCATION **Fulton County, Illinois** DATE **March 18, 2021**

Gypsum

MOISTURE-DENSITY RELATIONSHIP

Ramsey Geotechnical Engineering

Bloomington, IL 61701

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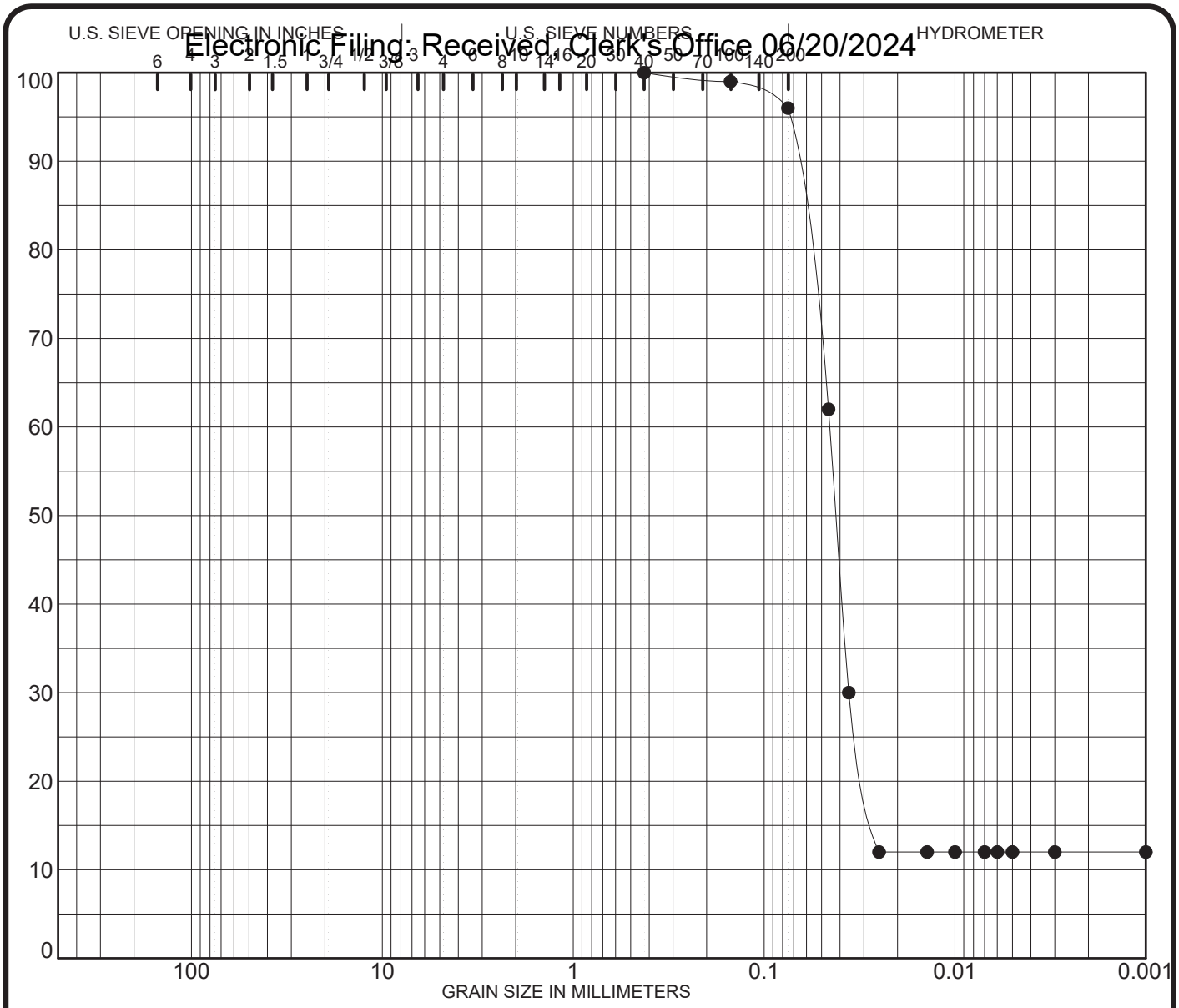


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

SPECIMEN IDENTIFICATION	SIEVE	% PASS	CLASSIFICATION
Gypsum	3/8	100.0	Gypsum
	#4	100.0	
	#8	100.0	
	#10	100.0	
NOTES:	# 16	100.0	
Specific Gravity - 2.31	# 30	100.0	
	# 40	100.0	
	# 50		
	# 80		
	# 100	99.0	
	# 200	96.0	

%GRAVEL	%SAND	%SILT	%CLAY
0	4		

MC%	γdry (pcf)	LL	PL	PI
32.5				

Density/Moisture Relationship: Standard

Max PCF 81.0 Opt. WC% 27.0

PROJECT **Duck Creek Bottom Ash Basins - Fulton County, Illinois**

JOB NO. **21-026**

DATE March 18, 2021

Gypsum

SOIL DATA SHEET

Ramsey Geotechnical Engineering

Bloomington, IL 61701

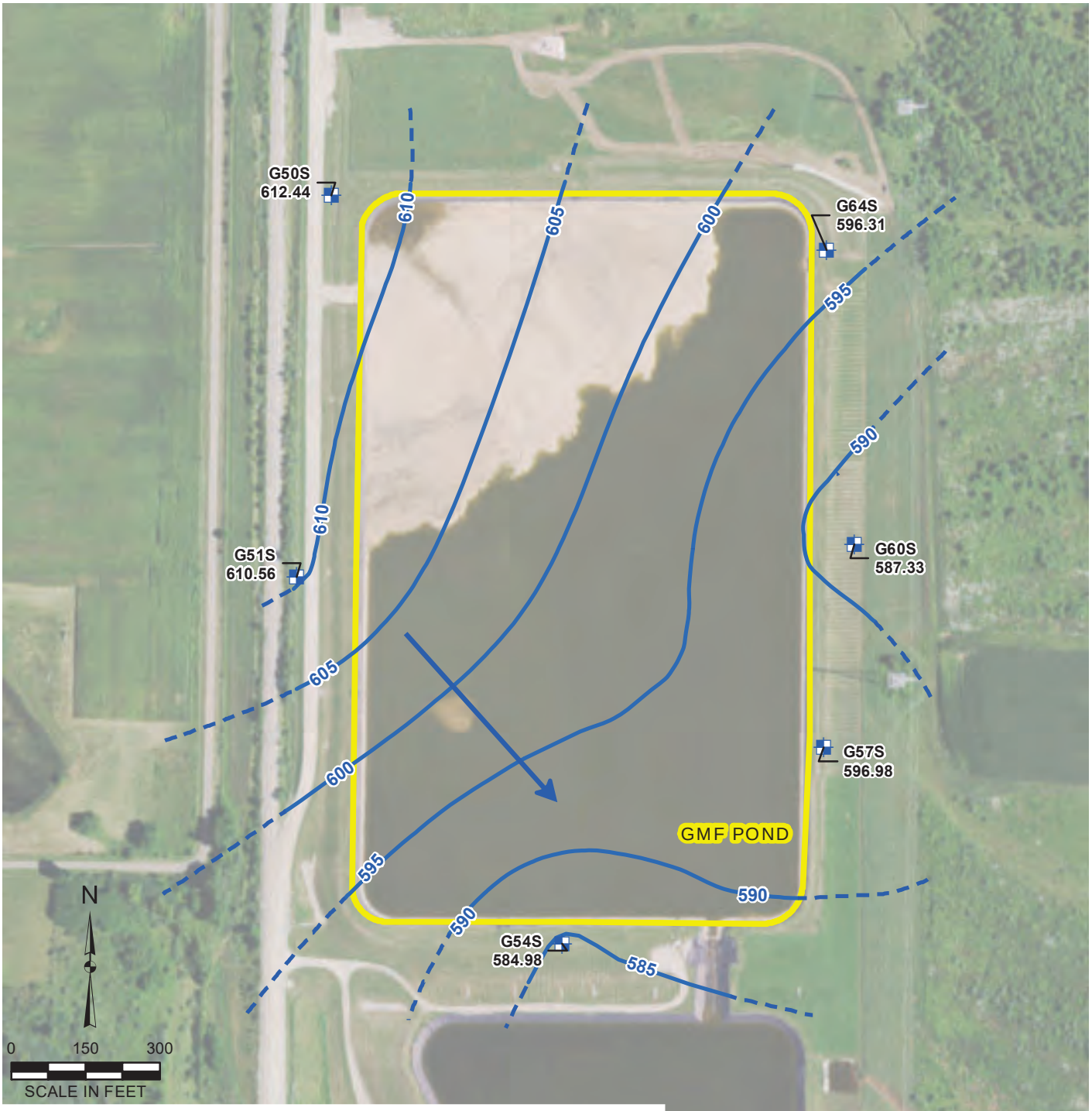
Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX D
GROUNDWATER CONTOUR MAPS AND ELEVATIONS

Electronic Filing: Received, Clerk's Office 06/20/2024

GROUNDWATER CONTOUR MAPS

Electronic Filing: Received, Clerk's Office 06/20/2024



DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/7/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 1: DECEMBER 2, 2015

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2212285MXD\GW_Contours\Round_01\R1_DuckCreekGMFP_GW_Contours.mxd Author: sstolz; Date/Time: 3/2/2017, 2:44:52 PM

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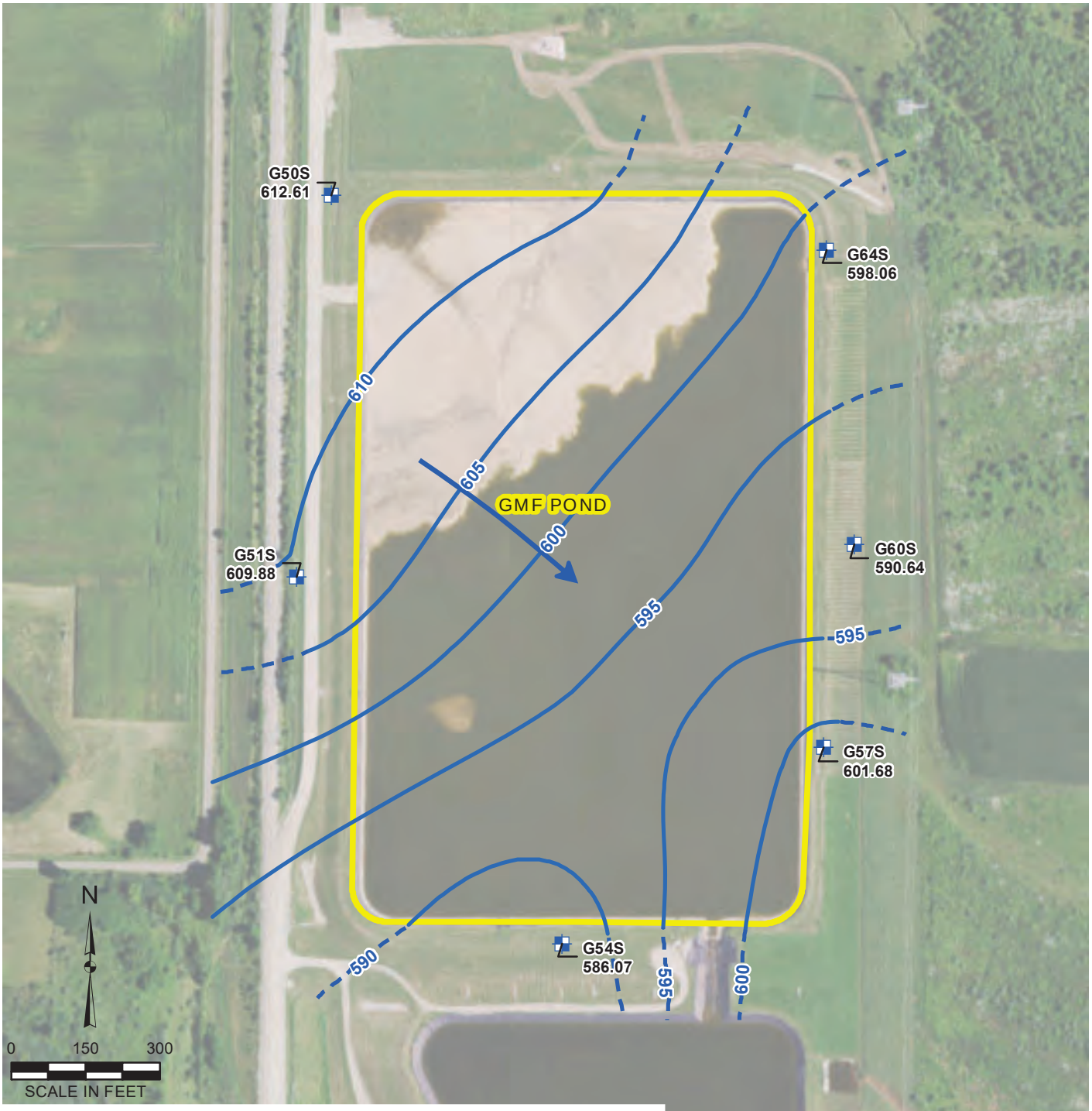

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REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 2: JANUARY 25, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

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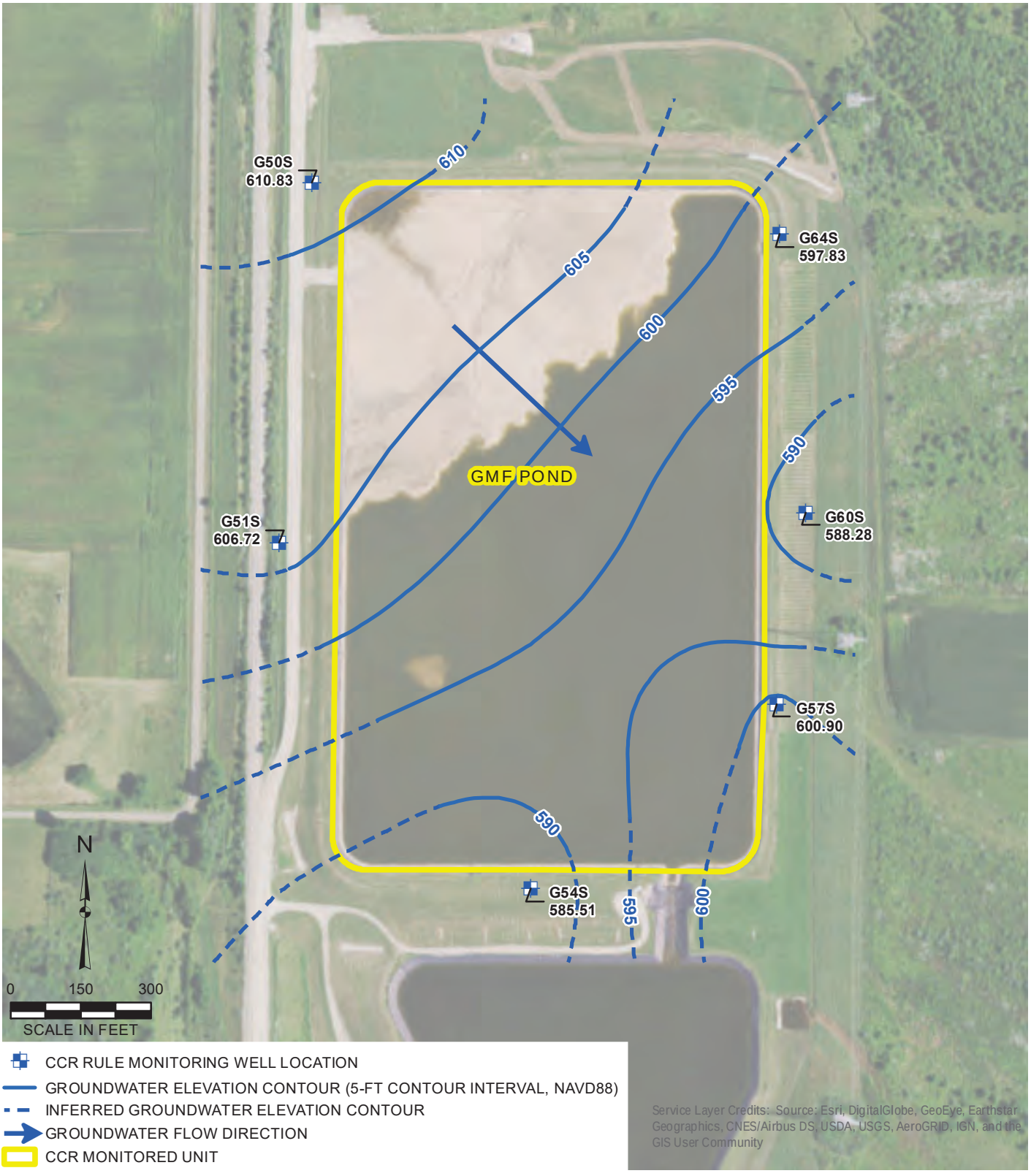

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REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 3: APRIL 18, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

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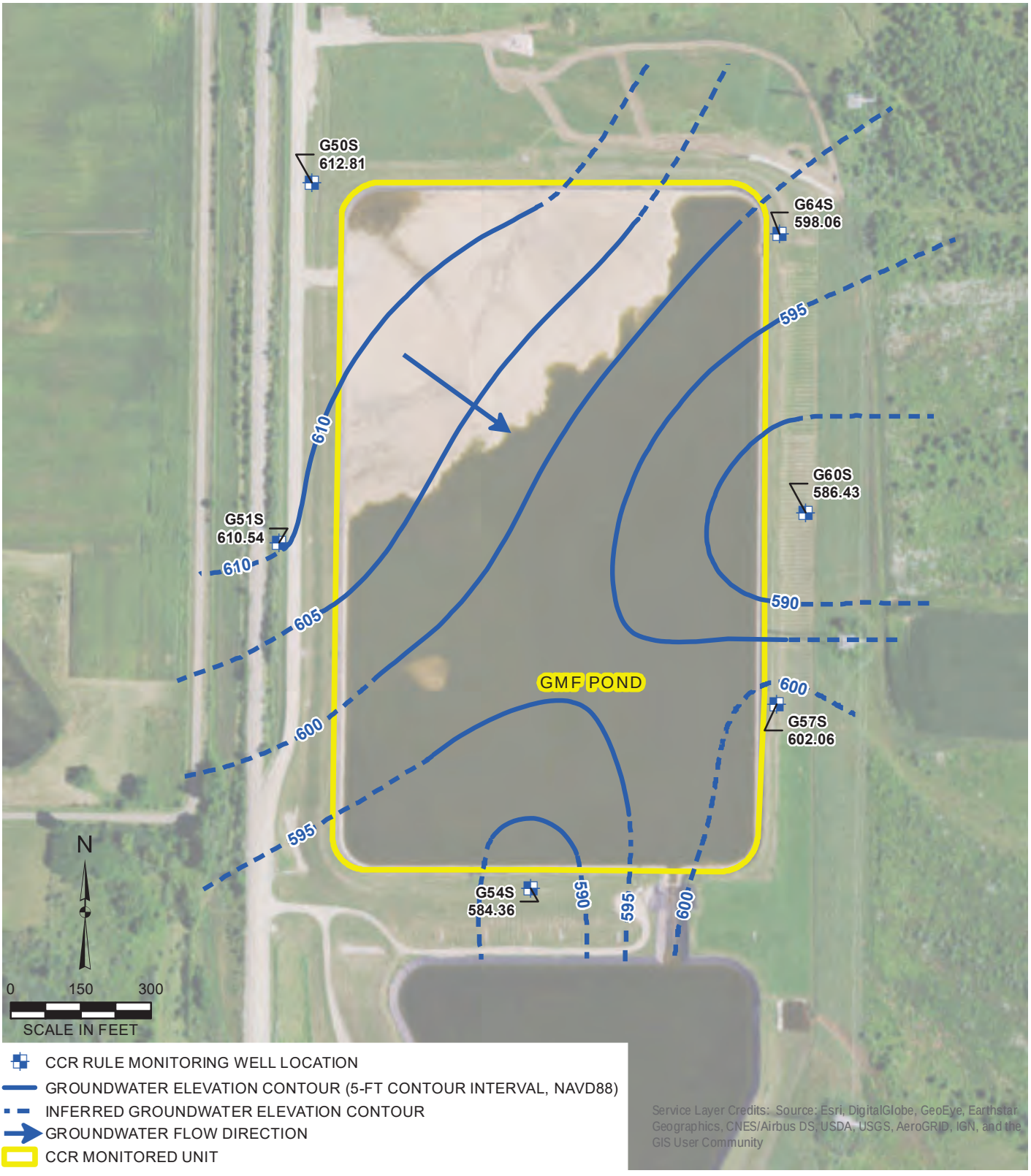

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REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 4: AUGUST 9, 2016

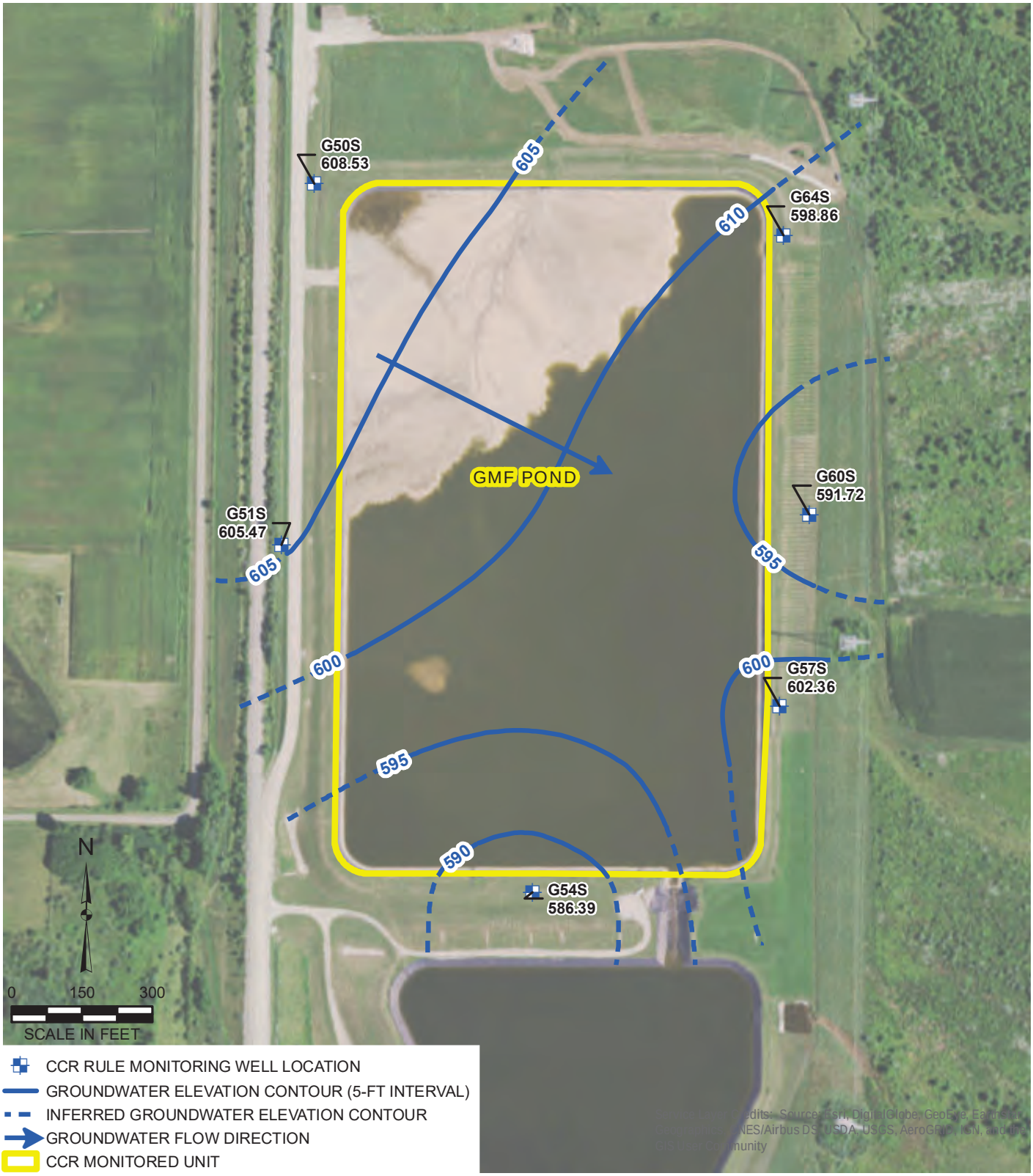
DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

Electronic Filing: Received, Clerk's Office 06/20/2024



DRAWN BY/DATE:
SDS 3/6/17
REVIEWED BY/DATE:
ANS 3/6/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 5: OCTOBER 14, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

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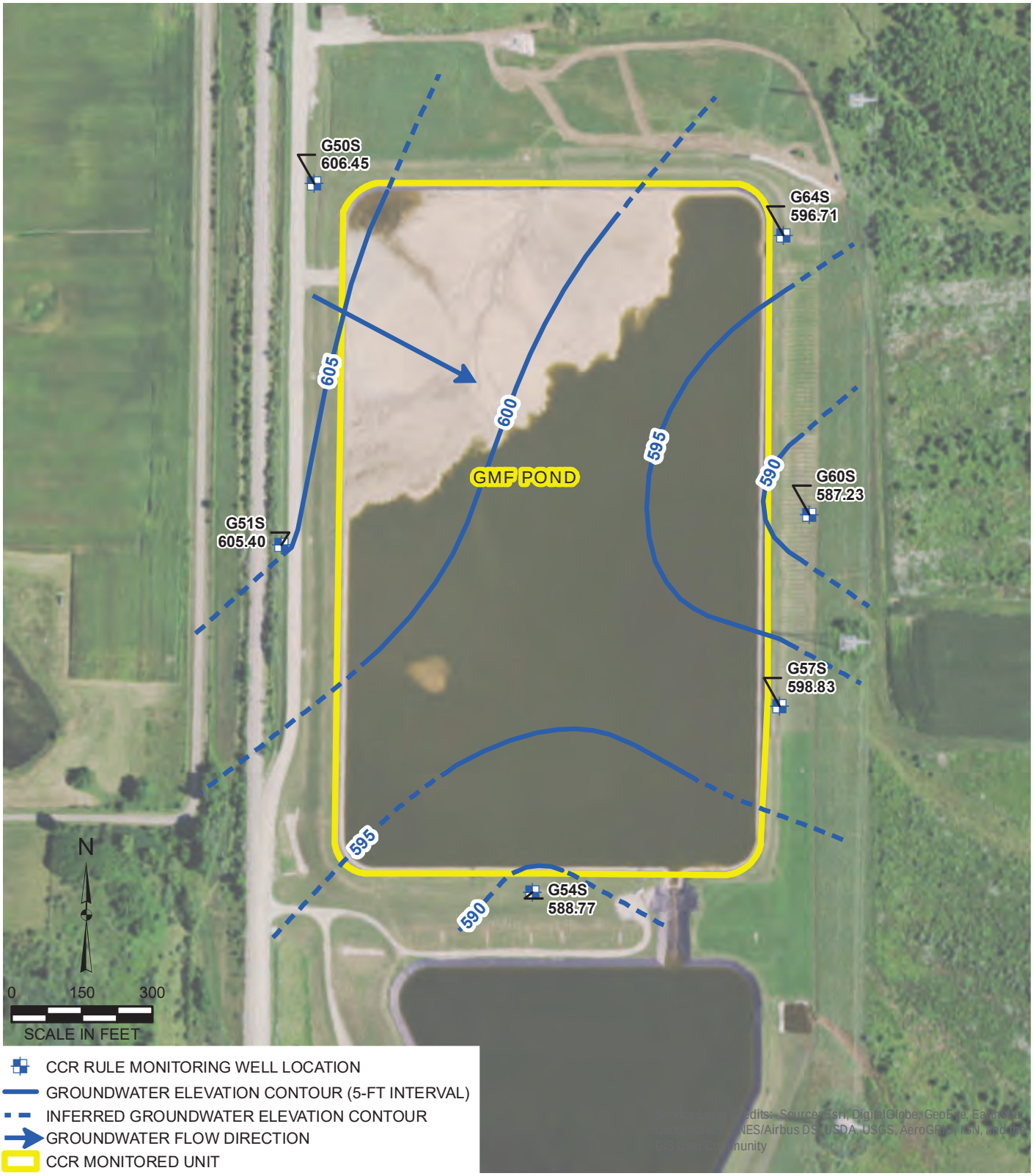

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REVIEWED BY/DATE:
ANS 3/6/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 6: JANUARY 9, 2017

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

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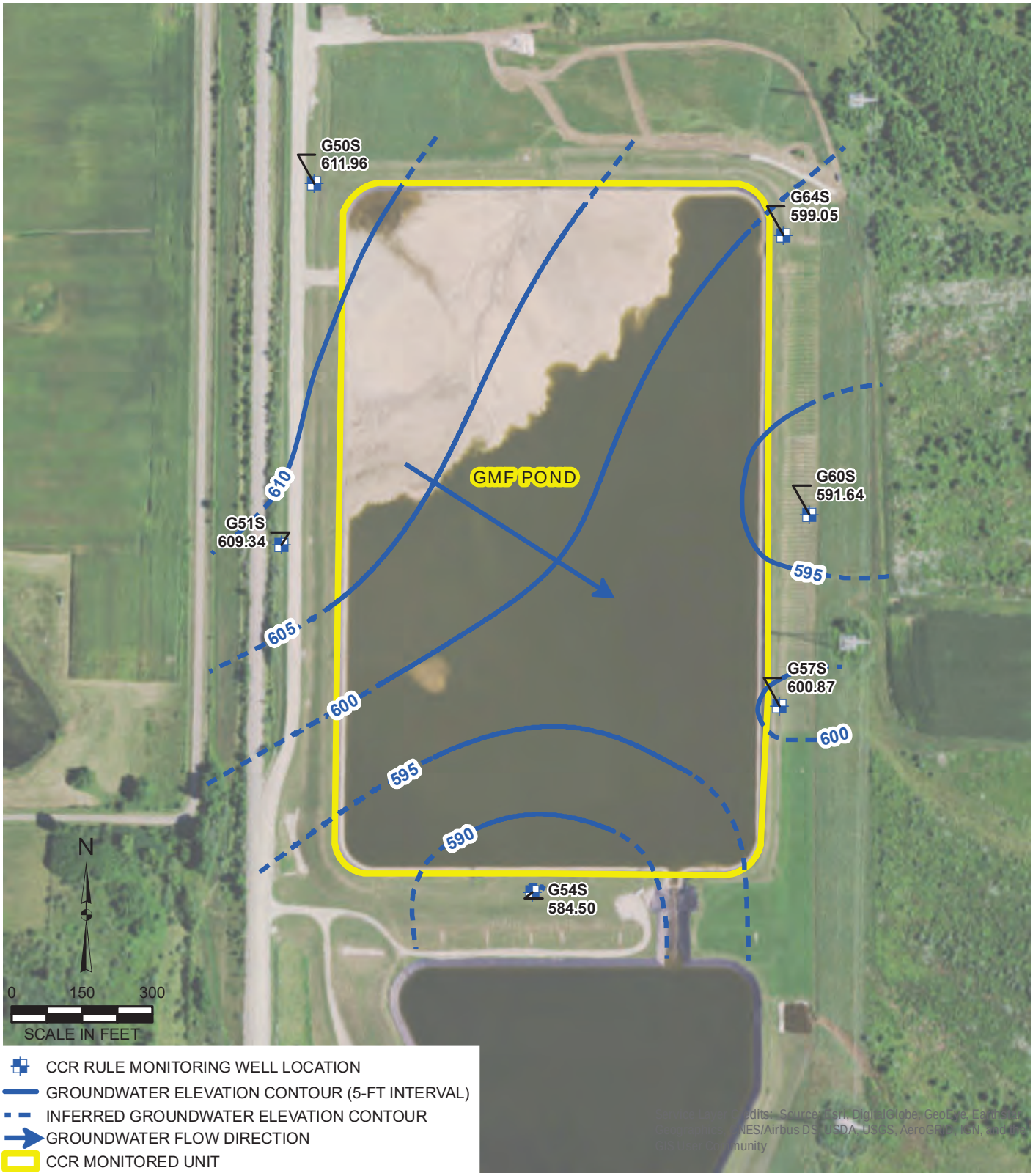

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REVIEWED BY/DATE:
ANS 5/25/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 7: APRIL 2, 2017

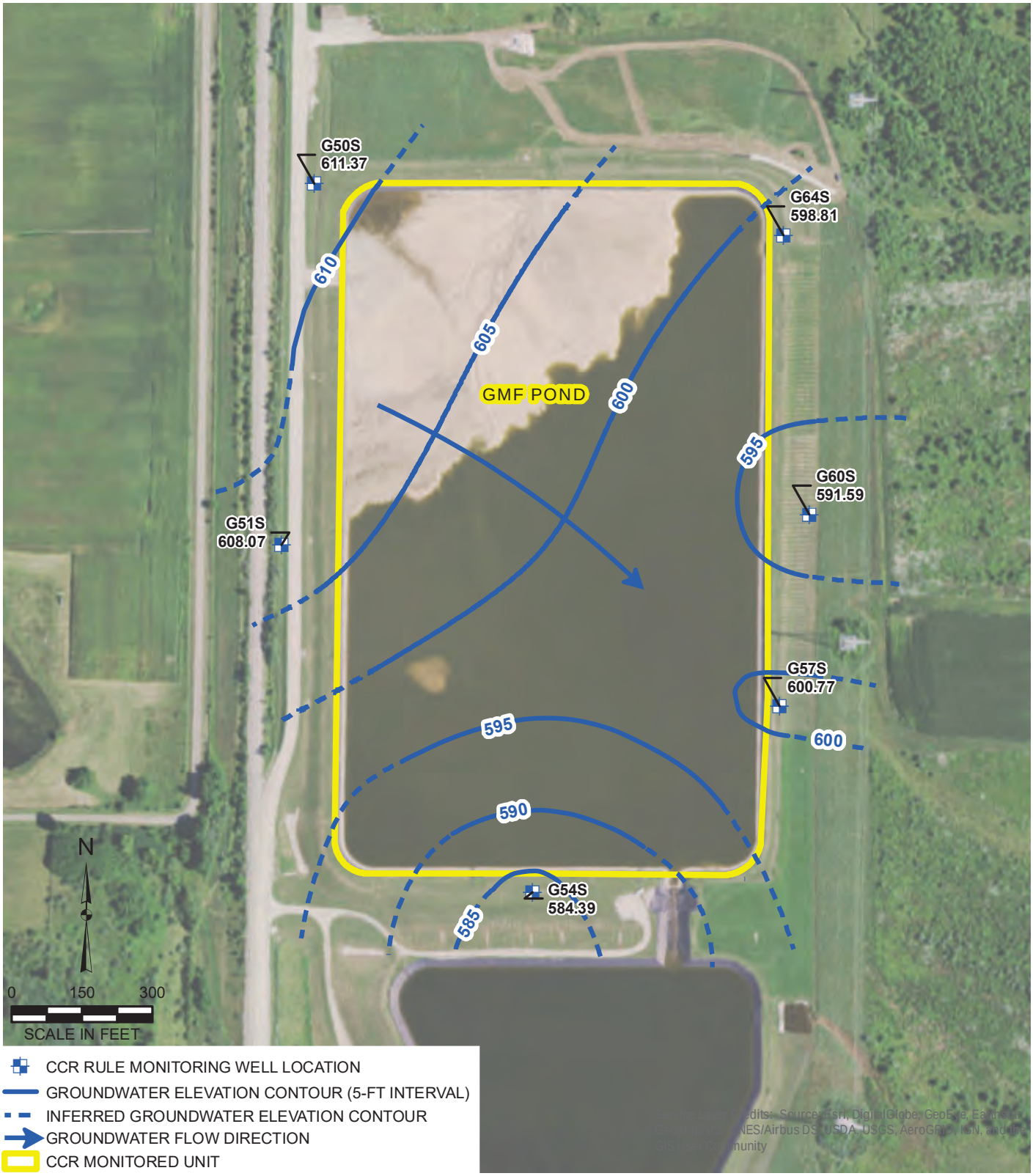
DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

Electronic Filing: Received, Clerk's Office 06/20/2024



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DRAWN BY/DATE:
SDS 7/26/17
REVIEWED BY/DATE:
ANS 7/28/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 8: JUNE 28, 2017

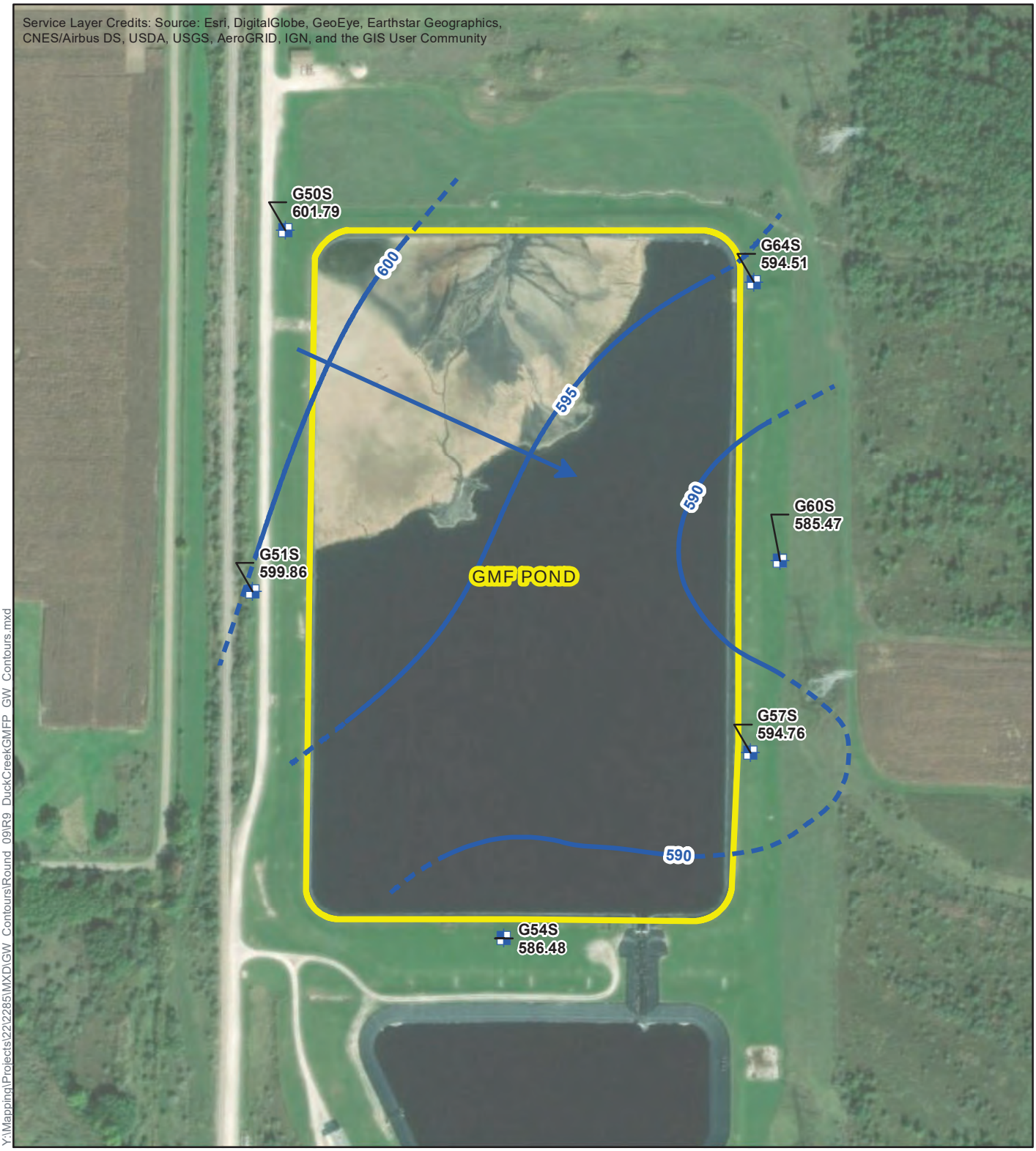
DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

Electronic Filing: Received, Clerk's Office 06/20/2024



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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
NOVEMBER 8, 2017

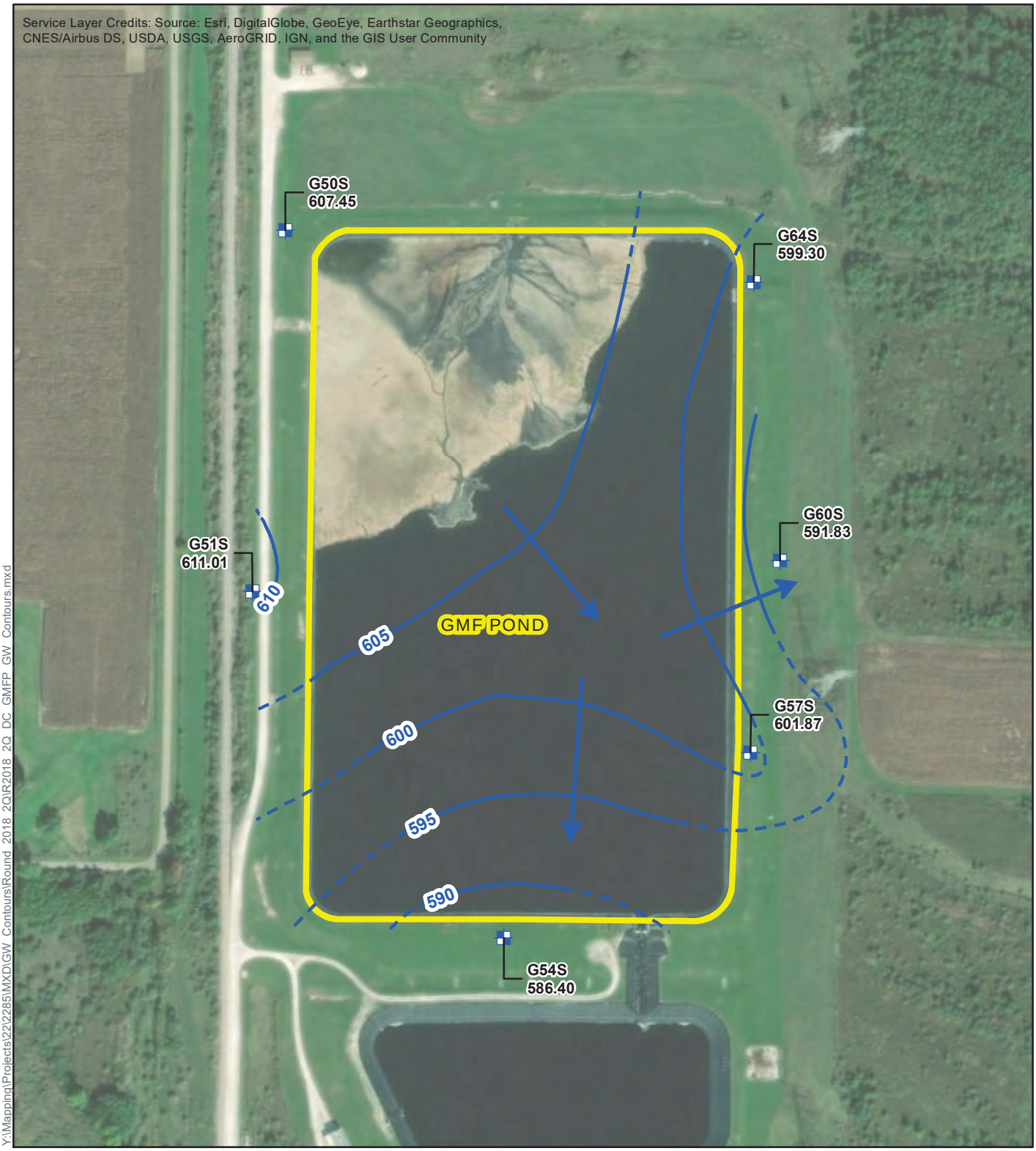
CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Electronic Filing: Received, Clerk's Office 06/20/2024



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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
APRIL 10, 2018

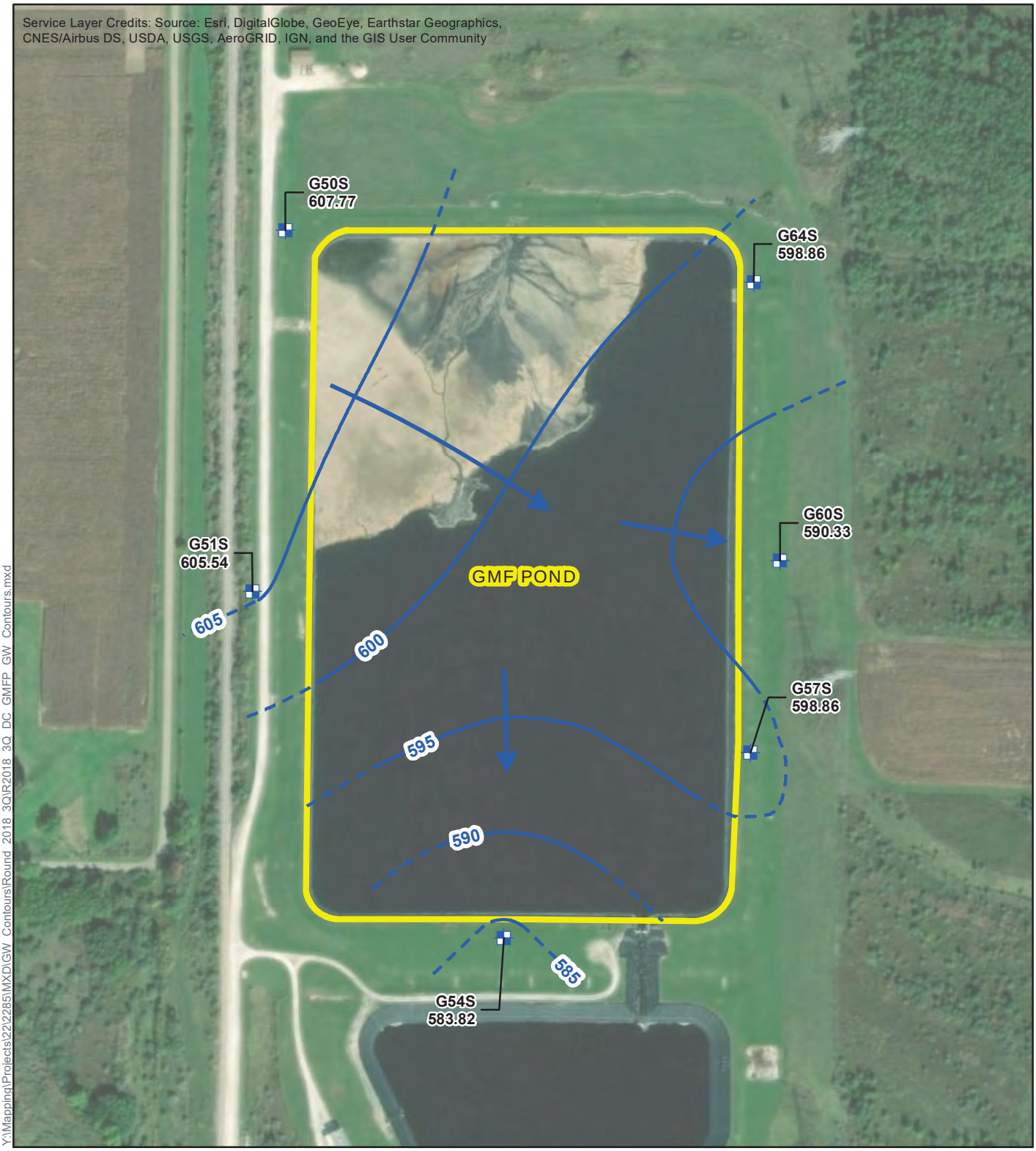
CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Electronic Filing: Received, Clerk's Office 06/20/2024



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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
JULY 2, 2018

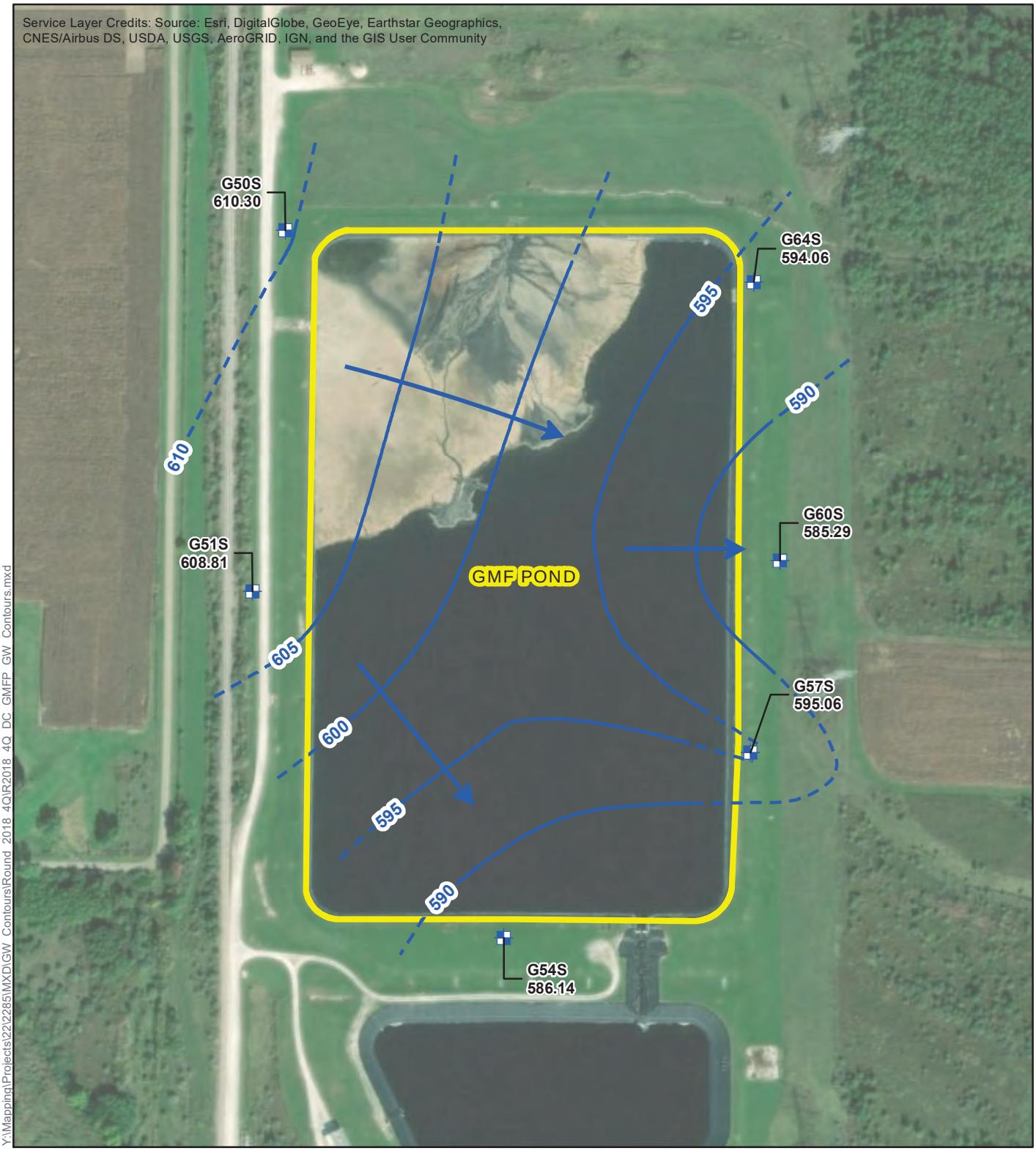
CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Electronic Filing: Received, Clerk's Office 06/20/2024



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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
OCTOBER 2, 2018

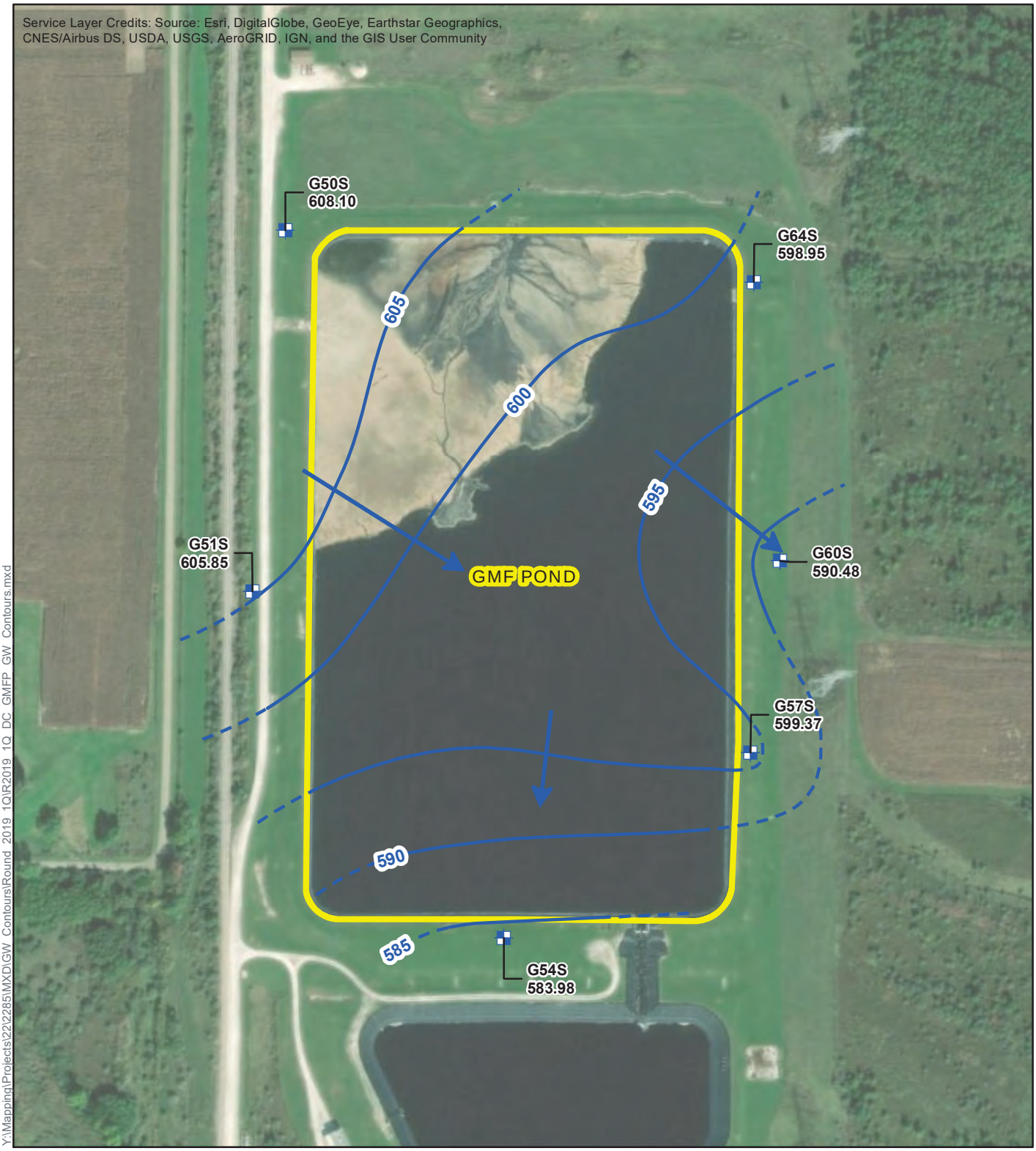
CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Electronic Filing: Received, Clerk's Office 06/20/2024



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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
JANUARY 7, 2019

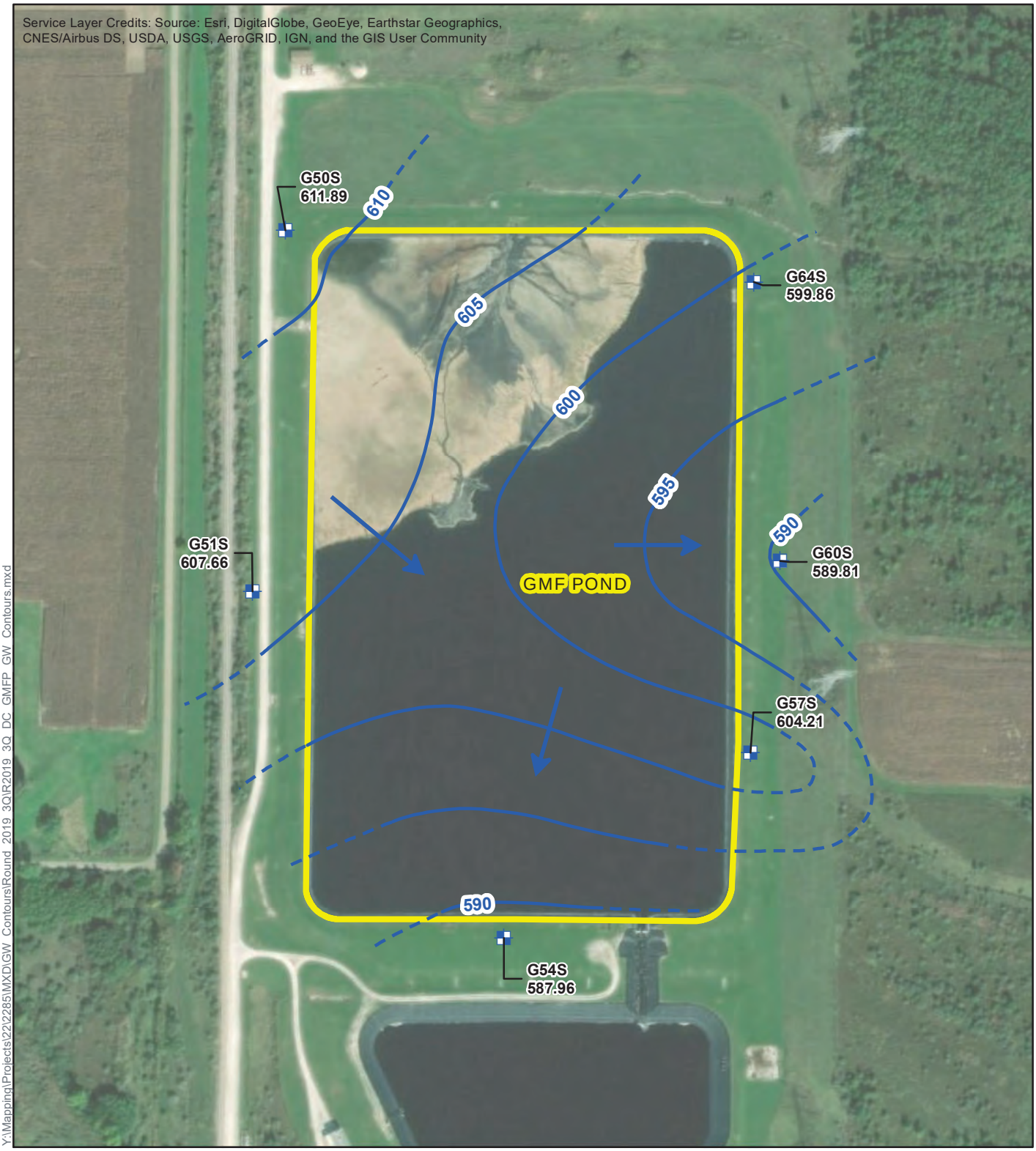
CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Electronic Filing: Received, Clerk's Office 06/20/2024



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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
JULY 1, 2019

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Electronic Filing: Received, Clerk's Office 06/20/2024

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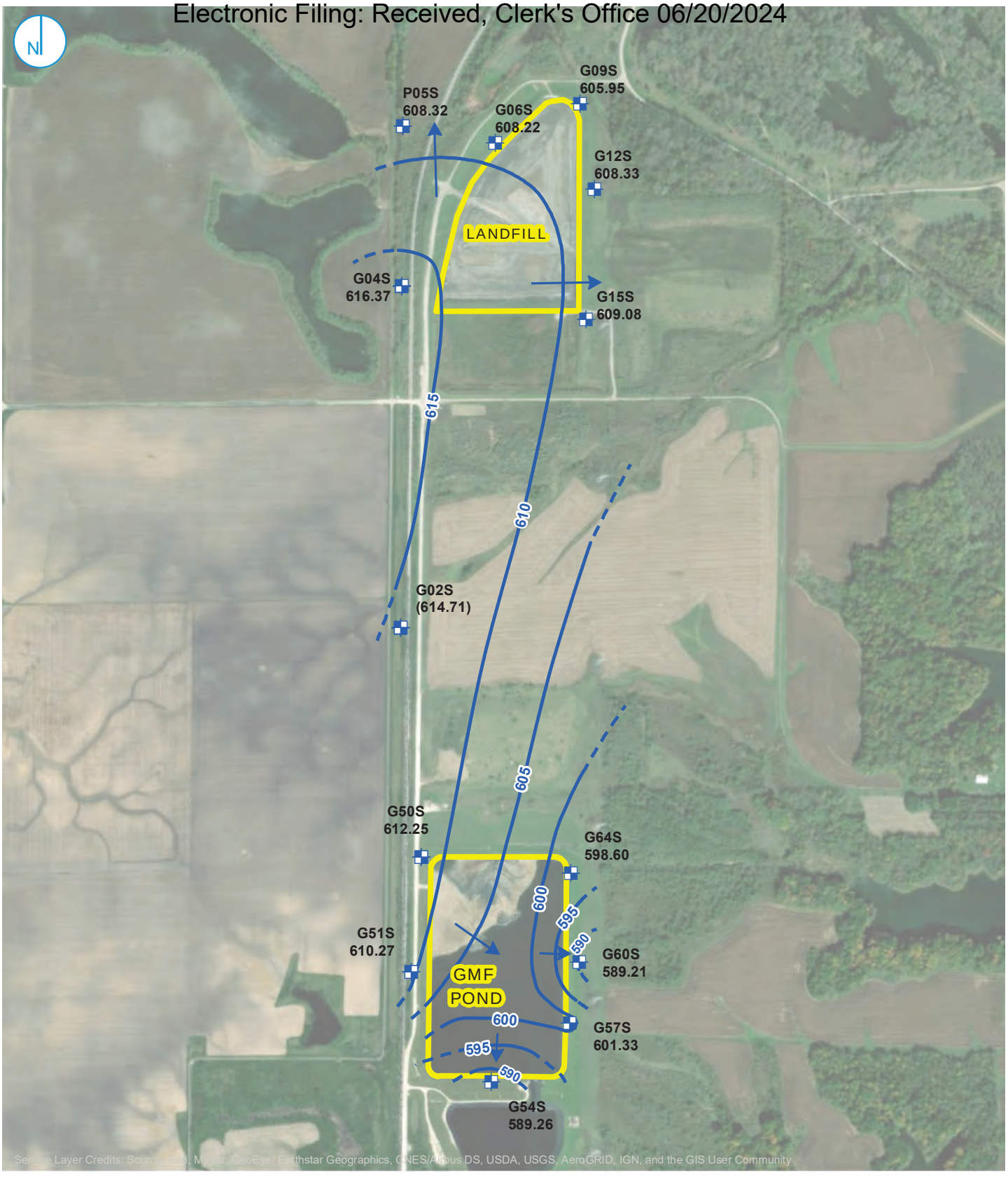


CCR RULE MONITORING WELL

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

0 450 900 Feet

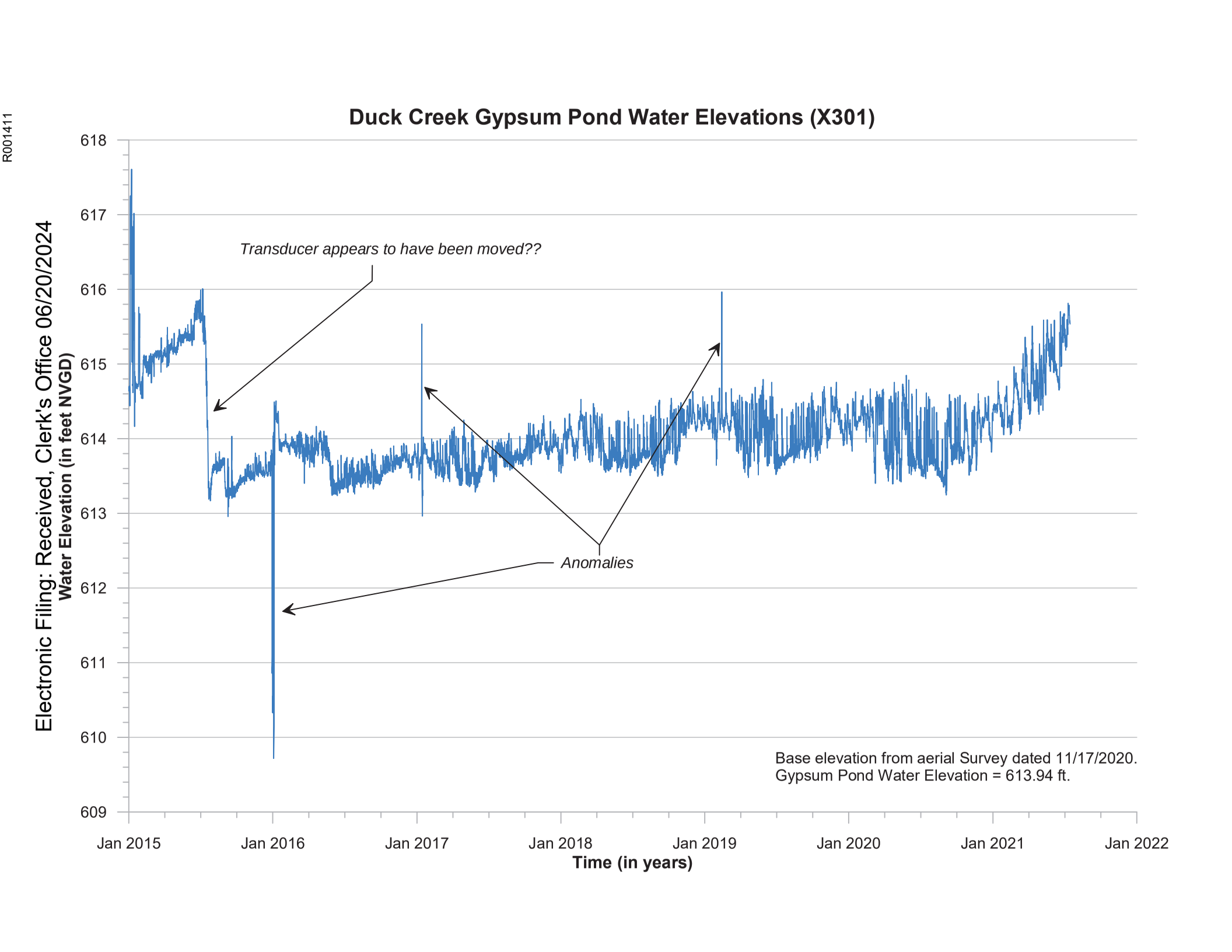
GROUNDWATER ELEVATION CONTOUR MAP
JANUARY 2-3, 2020

DUCK CREEK GMF POND (UNIT ID: 203)
AND LANDFILL (UNIT ID: 204)
VISTRA ENERGY
DUCK CREEK POWER STATION
CANTON, ILLINOIS

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

RAMBOLL

R001411


Duck Creek Gypsum Pond Water Elevations (X301)
Electronic Filing: Received, Clerk's Office 06/20/2024
Water Elevation (in feet NVGD)
618
617
616
615
614
613
612
611
610
609
Transducer appears to have been moved??
Anomalies
Base elevation from aerial Survey dated 11/17/2020.
Gypsum Pond Water Elevation = 613.94 ft.
Jan 2015
Jan 2016
Jan 2017
Jan 2018
Jan 2019
Jan 2020
Jan 2021
Jan 2022
Time (in years)

Electronic Filing: Received, Clerk's Office 06/20/2024

TABLE D-1. GROUNDWATER ELEVATION RESULTS

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G02L	02/18/2021	613.08
G02L	05/10/2021	616.01
G02L	08/05/2021	613.14
G02S	12/02/2015	615.45
G02S	01/25/2016	615.35
G02S	04/18/2016	611.81
G02S	08/09/2016	612.03
G02S	10/14/2016	611.55
G02S	01/09/2017	612.30
G02S	04/02/2017	614.75
G02S	06/28/2017	614.07
G02S	11/10/2017	606.10
G02S	01/17/2018	610.75
G02S	04/10/2018	614.73
G02S	07/02/2018	612.82
G02S	10/02/2018	609.88
G02S	01/07/2019	613.19
G02S	07/01/2019	611.06
G02S	01/03/2020	614.71
G02S	08/06/2020	610.89
G02S	11/16/2020	607.52
G02S	02/18/2021	612.97
G02S	02/19/2021	613.24
G02S	04/14/2021	614.98
G02S	04/28/2021	613.94
G02S	04/29/2021	614.65
G02S	05/10/2021	615.30
G02S	05/12/2021	614.97
G02S	06/01/2021	613.85
G02S	06/10/2021	613.50
G02S	06/15/2021	613.10
G02S	06/21/2021	613.84
G02S	07/12/2021	614.73
G02S	07/26/2021	613.93
G02S	07/28/2021	613.80
G02S	08/05/2021	613.30
G50L	11/18/2020	606.44
G50L	02/18/2021	611.14
G50L	02/19/2021	611.31
G50L	04/14/2021	614.31
G50L	04/28/2021	612.60
G50L	04/29/2021	612.43
G50L	05/10/2021	613.80
G50L	05/13/2021	613.27
G50L	06/01/2021	612.96

Electronic Filing: Received, Clerk's Office 06/20/2024

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G50L	06/10/2021	612.33
G50L	06/21/2021	612.48
G50L	07/12/2021	614.79
G50L	07/13/2021	616.06
G50L	07/26/2021	613.07
G50L	07/28/2021	612.78
G50L	08/05/2021	612.25
G50S	12/02/2015	612.44
G50S	01/25/2016	612.61
G50S	04/18/2016	610.83
G50S	08/09/2016	612.81
G50S	10/14/2016	608.53
G50S	01/09/2017	606.45
G50S	04/02/2017	611.96
G50S	06/28/2017	611.37
G50S	11/08/2017	601.79
G50S	04/10/2018	607.45
G50S	07/02/2018	607.77
G50S	10/02/2018	610.30
G50S	01/07/2019	608.10
G50S	07/01/2019	611.89
G50S	01/02/2020	612.25
G50S	08/06/2020	608.32
G50S	11/16/2020	605.58
G50S	11/18/2020	605.85
G50S	02/18/2021	610.30
G50S	02/19/2021	610.30
G50S	04/14/2021	612.98
G50S	04/28/2021	611.54
G50S	04/29/2021	614.22
G50S	05/10/2021	612.71
G50S	05/13/2021	612.15
G50S	06/01/2021	611.87
G50S	06/10/2021	611.15
G50S	06/21/2021	611.57
G50S	07/12/2021	613.25
G50S	07/13/2021	614.03
G50S	07/26/2021	612.06
G50S	07/28/2021	611.81
G50S	08/05/2021	611.21
G51L	11/18/2020	602.35
G51L	02/18/2021	606.81
G51L	02/19/2021	606.96
G51L	04/14/2021	610.50
G51L	04/28/2021	609.12

Electronic Filing: Received, Clerk's Office 06/20/2024

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G51L	05/10/2021	610.72
G51L	06/01/2021	609.14
G51L	06/10/2021	606.57
G51L	06/21/2021	608.97
G51L	07/12/2021	610.66
G51L	07/26/2021	608.51
G51L	08/05/2021	605.95
G51S	12/02/2015	610.56
G51S	01/25/2016	609.88
G51S	04/18/2016	606.72
G51S	08/09/2016	610.54
G51S	10/14/2016	605.47
G51S	01/09/2017	605.40
G51S	04/02/2017	609.34
G51S	06/28/2017	608.07
G51S	11/08/2017	599.86
G51S	04/10/2018	611.01
G51S	07/02/2018	605.54
G51S	10/02/2018	608.81
G51S	01/07/2019	605.85
G51S	07/01/2019	607.66
G51S	01/02/2020	610.27
G51S	08/06/2020	603.64
G51S	11/16/2020	602.10
G51S	11/18/2020	602.40
G51S	02/18/2021	607.04
G51S	02/19/2021	607.04
G51S	04/14/2021	610.69
G51S	04/28/2021	609.35
G51S	04/29/2021	610.56
G51S	05/10/2021	610.93
G51S	05/13/2021	610.39
G51S	06/01/2021	609.44
G51S	06/10/2021	606.98
G51S	06/15/2021	605.80
G51S	06/21/2021	609.37
G51S	07/12/2021	610.91
G51S	07/26/2021	608.84
G51S	07/27/2021	608.29
G51S	08/05/2021	606.34
G52L	11/18/2020	591.84
G52L	02/18/2021	593.43
G52L	02/19/2021	593.53
G52L	04/14/2021	596.93
G52L	04/28/2021	596.16

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G52L	05/10/2021	596.82
G52L	06/01/2021	597.15
G52L	06/10/2021	596.04
G52L	06/21/2021	595.09
G52L	07/12/2021	597.20
G52L	07/26/2021	596.89
G52L	08/05/2021	595.67
G52S	02/18/2021	589.65
G52S	05/10/2021	596.45
G52S	08/05/2021	589.39
G53L	11/18/2020	605.53
G53L	02/18/2021	607.98
G53L	02/22/2021	608.43
G53L	05/10/2021	613.90
G53L	08/05/2021	612.79
G53S	11/18/2020	603.70
G53S	02/18/2021	606.48
G53S	02/22/2021	606.81
G53S	05/10/2021	610.80
G53S	08/05/2021	610.14
G54C	04/14/2021	581.99
G54C	04/28/2021	581.10
G54C	04/29/2021	580.28
G54C	05/10/2021	580.11
G54C	05/12/2021	580.11
G54C	06/01/2021	581.00
G54C	06/10/2021	580.47
G54C	06/21/2021	579.83
G54C	07/12/2021	582.36
G54C	07/26/2021	581.64
G54C	08/05/2021	578.99
G54L	11/17/2020	592.43
G54L	02/18/2021	591.36
G54L	02/22/2021	591.69
G54L	04/14/2021	591.47
G54L	04/28/2021	591.11
G54L	04/29/2021	591.30
G54L	05/10/2021	591.22
G54L	05/12/2021	591.22
G54L	06/01/2021	591.52
G54L	06/10/2021	591.78
G54L	06/14/2021	591.77
G54L	06/21/2021	592.11
G54L	07/12/2021	592.97
G54L	07/13/2021	594.53

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G54L	07/26/2021	592.50
G54L	07/27/2021	592.51
G54L	08/05/2021	592.79
G54S	12/02/2015	584.98
G54S	01/25/2016	586.07
G54S	04/18/2016	585.51
G54S	08/09/2016	584.36
G54S	10/14/2016	586.39
G54S	01/09/2017	588.77
G54S	04/02/2017	584.50
G54S	06/28/2017	584.39
G54S	11/08/2017	586.48
G54S	01/18/2018	585.43
G54S	04/10/2018	586.40
G54S	07/02/2018	583.82
G54S	10/02/2018	586.14
G54S	01/07/2019	583.98
G54S	07/01/2019	587.96
G54S	01/02/2020	589.26
G54S	08/06/2020	591.39
G54S	11/16/2020	591.47
G54S	11/17/2020	591.31
G54S	02/18/2021	590.52
G54S	02/22/2021	590.52
G54S	04/14/2021	590.44
G54S	04/28/2021	590.52
G54S	05/10/2021	590.53
G54S	06/01/2021	590.80
G54S	06/10/2021	591.07
G54S	06/21/2021	591.23
G54S	07/12/2021	591.76
G54S	07/26/2021	591.98
G54S	08/05/2021	592.55
G55L	11/17/2020	597.65
G55L	02/18/2021	595.73
G55L	02/22/2021	596.28
G55L	05/10/2021	597.38
G55L	08/05/2021	599.54
G55S	11/17/2020	597.42
G55S	02/18/2021	595.68
G55S	02/22/2021	596.14
G55S	05/10/2021	597.41
G55S	08/05/2021	599.57
G56L	11/17/2020	598.87
G56L	02/18/2021	597.50

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G56L	02/22/2021	598.01
G56L	04/14/2021	602.88
G56L	04/28/2021	603.24
G56L	05/10/2021	603.44
G56L	06/01/2021	602.48
G56L	06/10/2021	604.14
G56L	06/21/2021	603.64
G56L	07/12/2021	605.23
G56L	07/26/2021	605.31
G56L	08/05/2021	604.62
G56S	11/17/2020	598.37
G56S	02/18/2021	598.06
G56S	02/22/2021	598.38
G56S	05/10/2021	603.62
G56S	08/05/2021	604.42
G57L	11/17/2020	596.17
G57L	02/18/2021	595.73
G57L	02/22/2021	595.88
G57L	04/14/2021	603.07
G57L	04/28/2021	602.15
G57L	05/10/2021	604.41
G57L	06/01/2021	603.88
G57L	06/10/2021	603.17
G57L	06/21/2021	602.45
G57L	07/12/2021	604.81
G57L	07/26/2021	604.43
G57L	08/05/2021	603.00
G57S	12/02/2015	596.98
G57S	01/25/2016	601.68
G57S	04/18/2016	600.90
G57S	08/09/2016	602.06
G57S	10/14/2016	602.36
G57S	01/09/2017	598.83
G57S	04/02/2017	600.87
G57S	06/28/2017	600.77
G57S	11/08/2017	594.76
G57S	01/18/2018	602.07
G57S	04/10/2018	601.87
G57S	07/02/2018	598.86
G57S	10/02/2018	595.06
G57S	01/07/2019	599.37
G57S	07/01/2019	604.21
G57S	01/02/2020	601.33
G57S	08/06/2020	600.65
G57S	11/16/2020	596.28

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G57S	11/17/2020	596.21
G57S	02/18/2021	596.21
G57S	02/22/2021	596.21
G57S	04/14/2021	601.83
G57S	04/28/2021	601.99
G57S	05/10/2021	602.61
G57S	06/01/2021	603.89
G57S	06/10/2021	603.20
G57S	06/21/2021	602.52
G57S	07/12/2021	604.68
G57S	07/26/2021	604.41
G57S	08/05/2021	603.51
G58L	11/18/2020	591.87
G58L	02/18/2021	591.24
G58L	02/22/2021	591.55
G58L	05/10/2021	597.62
G58L	08/05/2021	598.92
G58S	11/18/2020	591.87
G58S	02/18/2021	591.54
G58S	02/22/2021	592.02
G58S	05/10/2021	597.67
G58S	08/05/2021	598.87
G59L	11/18/2020	590.59
G59L	02/18/2021	588.96
G59L	02/22/2021	589.09
G59L	05/10/2021	599.77
G59L	08/05/2021	601.28
G59S	11/18/2020	587.04
G59S	02/18/2021	586.43
G59S	02/22/2021	586.88
G59S	05/10/2021	588.40
G59S	08/05/2021	598.43
G60L	11/17/2020	593.09
G60L	02/18/2021	593.56
G60L	02/23/2021	594.34
G60L	04/14/2021	606.78
G60L	04/28/2021	603.75
G60L	04/29/2021	604.10
G60L	05/10/2021	606.16
G60L	05/13/2021	605.30
G60L	06/01/2021	605.20
G60L	06/10/2021	603.76
G60L	06/15/2021	602.71
G60L	06/21/2021	603.43
G60L	07/12/2021	609.27

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G60L	07/26/2021	605.97
G60L	07/28/2021	605.54
G60L	08/05/2021	604.40
G60S	12/02/2015	587.33
G60S	01/25/2016	590.64
G60S	04/18/2016	588.28
G60S	08/09/2016	586.43
G60S	10/14/2016	591.72
G60S	01/09/2017	587.23
G60S	04/02/2017	591.64
G60S	06/29/2017	591.59
G60S	11/08/2017	585.47
G60S	01/19/2018	599.93
G60S	04/10/2018	591.83
G60S	07/02/2018	590.33
G60S	10/02/2018	585.29
G60S	01/07/2019	590.48
G60S	07/01/2019	589.81
G60S	01/02/2020	589.21
G60S	08/06/2020	588.88
G60S	11/16/2020	587.66
G60S	11/17/2020	587.47
G60S	02/18/2021	587.35
G60S	02/23/2021	587.35
G60S	04/14/2021	590.16
G60S	04/28/2021	589.76
G60S	05/10/2021	590.34
G60S	06/01/2021	590.54
G60S	06/10/2021	590.02
G60S	06/21/2021	589.48
G60S	07/12/2021	591.02
G60S	07/26/2021	590.71
G60S	08/05/2021	590.05
G61S	11/18/2020	595.85
G61S	02/18/2021	594.19
G61S	02/23/2021	594.48
G61S	05/10/2021	601.73
G61S	08/05/2021	604.46
G62L	11/18/2020	597.59
G62L	02/18/2021	595.63
G62L	02/24/2021	595.51
G62L	05/10/2021	603.44
G62L	08/05/2021	603.85
G63L	11/18/2020	596.38
G63L	02/18/2021	595.23

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G63L	02/24/2021	595.10
G63L	05/10/2021	599.58
G63L	08/05/2021	600.87
G63S	11/18/2020	595.43
G63S	02/18/2021	595.11
G63S	02/24/2021	595.53
G63S	05/10/2021	599.17
G63S	08/05/2021	601.78
G64L	11/18/2020	596.89
G64L	02/18/2021	596.41
G64L	02/25/2021	596.23
G64L	04/14/2021	600.43
G64L	04/28/2021	600.87
G64L	05/10/2021	601.22
G64L	06/01/2021	602.41
G64L	06/10/2021	601.95
G64L	06/21/2021	601.21
G64L	07/12/2021	602.32
G64L	07/26/2021	602.40
G64L	08/05/2021	601.70
G64S	12/02/2015	596.31
G64S	01/25/2016	598.06
G64S	04/18/2016	597.83
G64S	08/09/2016	598.06
G64S	10/14/2016	598.86
G64S	01/09/2017	596.71
G64S	04/02/2017	599.05
G64S	06/29/2017	598.81
G64S	11/08/2017	594.51
G64S	01/19/2018	600.88
G64S	04/10/2018	599.30
G64S	07/02/2018	598.86
G64S	10/02/2018	594.06
G64S	01/07/2019	598.95
G64S	07/01/2019	599.86
G64S	01/02/2020	598.60
G64S	08/06/2020	598.72
G64S	11/16/2020	596.27
G64S	11/18/2020	596.42
G64S	02/18/2021	596.13
G64S	02/24/2021	596.13
G64S	04/14/2021	599.04
G64S	04/28/2021	599.38
G64S	05/10/2021	599.64
G64S	06/01/2021	600.28

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G64S	06/10/2021	599.97
G64S	06/21/2021	599.51
G64S	07/12/2021	600.50
G64S	07/26/2021	600.60
G64S	08/05/2021	600.04
P60	02/24/2021	591.82
P60	03/24/2021	593.80
P60	05/10/2021	598.86
P60	08/05/2021	601.39
P61	05/10/2021	606.78
P61	08/05/2021	603.86
P62	05/10/2021	602.28
P62	08/05/2021	603.46
P63	05/10/2021	601.64
P63	08/05/2021	601.91
P64	05/10/2021	605.52
P64	08/05/2021	603.10
R61L	11/18/2020	596.19
R61L	02/18/2021	594.59
R61L	02/23/2021	594.27
R61L	05/10/2021	601.43
R61L	08/05/2021	614.47

Notes:
ft NAVD88 = feet relative to the North American Vertical Datum 1988, GEOID 12A

generated 10/06/2021, 3:08:25 PM CDT

Electronic Filing: Received, Clerk's Office 06/20/2024

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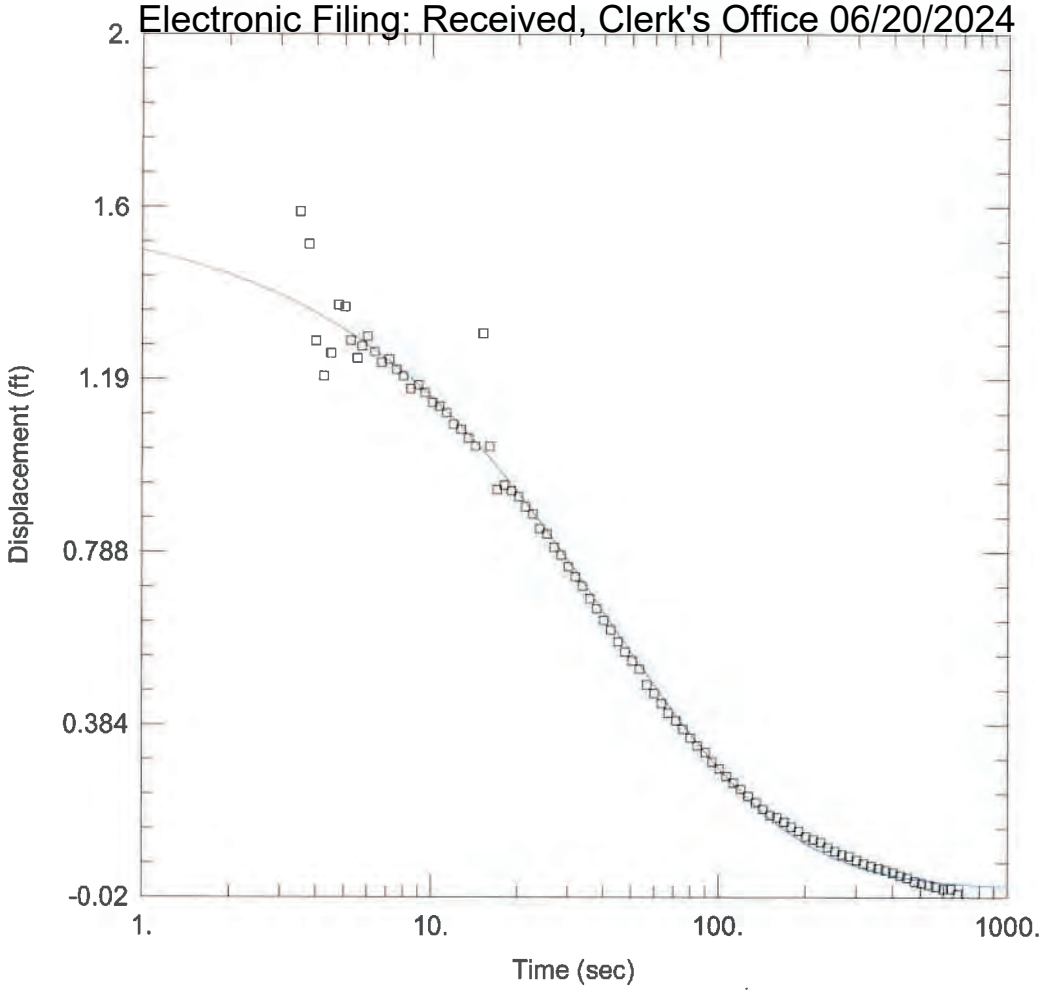
APPENDIX E
HYDRAULIC CONDUCTIVITY TEST DATA

Electronic Filing: Received, Clerk's Office 06/20/2024

Slug Test data summary - Duck Creek Gypsum Management Facility

Well ID	Falling Head k (cm/sec)	Specific Storage (1/ft)	FH Solution	Rising Head k (cm/sec)	Specific Storage (1/ft)	RH Solution	Average	Geo. Mean
G50L	2.30E-03	6.00E-03	KGS Model	2.10E-03	5.00E-03	KGS Model	2.20E-03	2.20E-03
G50S	6.50E-05	7.00E-03	KGS Model	1.50E-04	1.40E-05	KGS Model	1.08E-04	9.87E-05
G51L	3.00E-05	1.10E-03	KGS Model	*No test results*			3.00E-05	3.00E-05
G51S	7.20E-05	n/a	Bouwer-Rice	1.10E-04	1.50E-03	KGS Model	9.10E-05	8.90E-05
G53L	1.10E-04	2.90E-04	KGS Model	1.10E-04	1.10E-03	KGS Model	1.10E-04	1.10E-04
G53S	3.80E-03	2.00E-03	KGS Model	3.20E-03	1.00E-03	KGS Model	3.50E-03	3.49E-03
G54C	1.60E-04	n/a	Hvorslev	1.40E-04	n/a	Hvorslev	1.50E-04	1.50E-04
G54L	4.90E-05	n/a	Bouwer-Rice	2.20E-04	n/a	Bouwer-Rice	1.35E-04	1.04E-04
G54S	1.20E-04	n/a	Bouwer-Rice	2.10E-04	n/a	Bouwer-Rice	1.65E-04	1.59E-04
G57S	2.60E-03	7.00E-05	KGS Model	6.80E-04	2.20E-03	KGS Model	1.64E-03	1.33E-03
G60L	2.30E-04	6.00E-02	KGS Model	2.60E-04	3.50E-02	KGS Model	2.45E-04	2.45E-04
G60S	3.90E-03	7.10E-06	KGS Model	3.50E-03	7.00E-05	KGS Model	3.70E-03	3.69E-03
G63S	3.00E-04	2.00E-02	KGS Model	2.90E-04	2.00E-02	KGS Model	2.95E-04	2.95E-04

Electronic Filing: Received, Clerk's Office 06/20/2024



G50L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50L-fh.aqt
Date: 06/02/21 Time: 16:26:20

AQUIFER DATA

Saturated Thickness: 5.04 ft

WELL DATA (G50L)

Initial Displacement: 1.6 ft
Total Well Penetration Depth: 7.64 ft
Casing Radius: 0.08333 ft

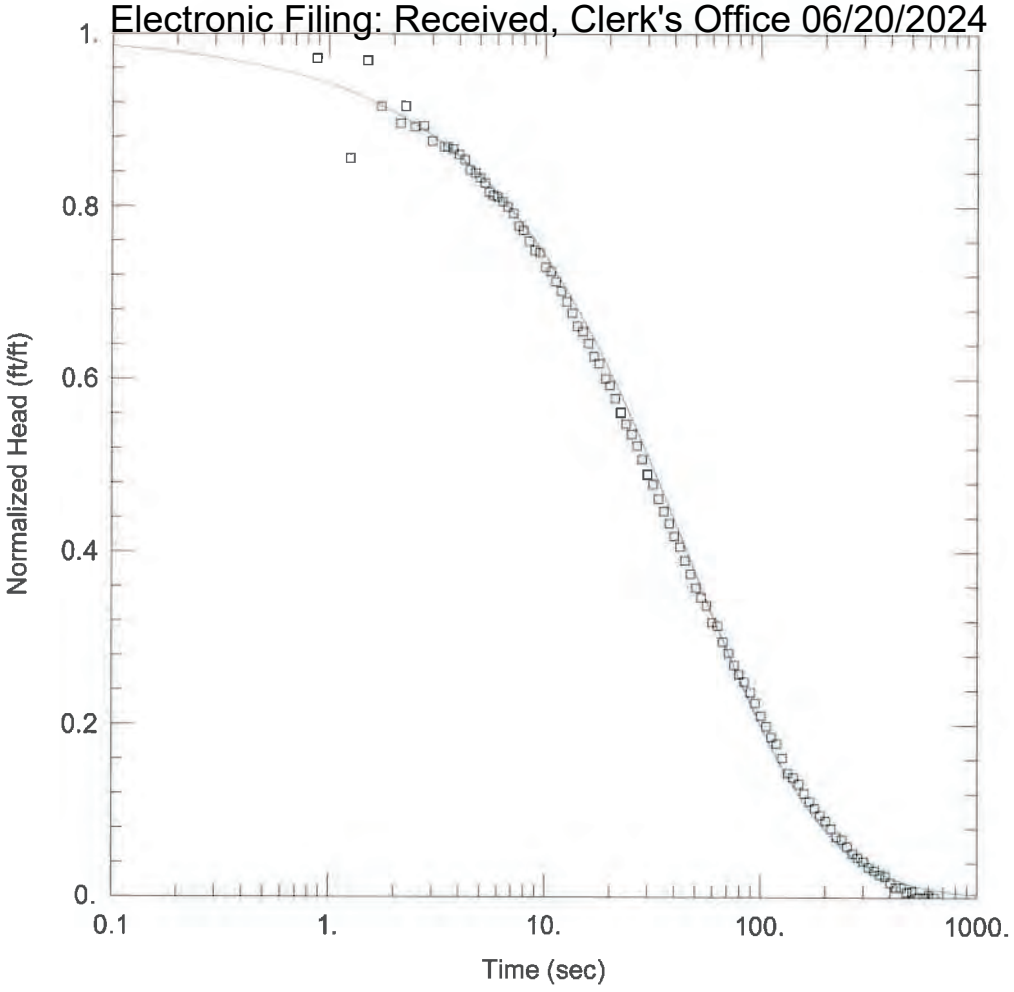
Static Water Column Height: 5.04 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Kr = 0.0023 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.006 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G50L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50L-rh.aqt
Date: 06/02/21 Time: 16:26:22

AQUIFER DATA

Saturated Thickness: 5.04 ft

WELL DATA (G50L)

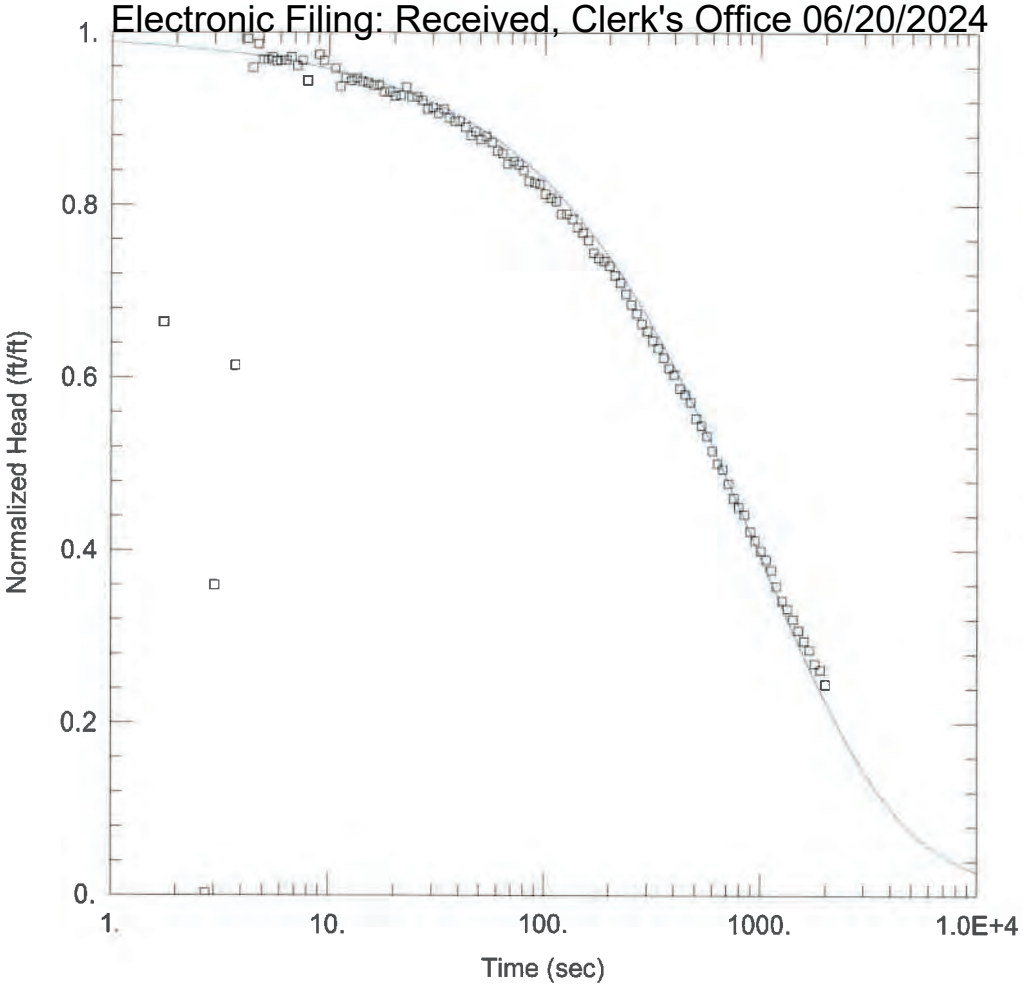
Initial Displacement: 1.625 ft
Total Well Penetration Depth: 7.64 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 5.04 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.0021 cm/sec
Kz/Kr = 1.
Ss = 0.005 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G50S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50S-fh.aqt
Date: 06/02/21 Time: 16:26:23

PROJECT INFORMATION

Client: Duck Creek Power Statin
Project: 20E0111A
Location: Canton, IL
Test Well: G50S
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 4.3 ft

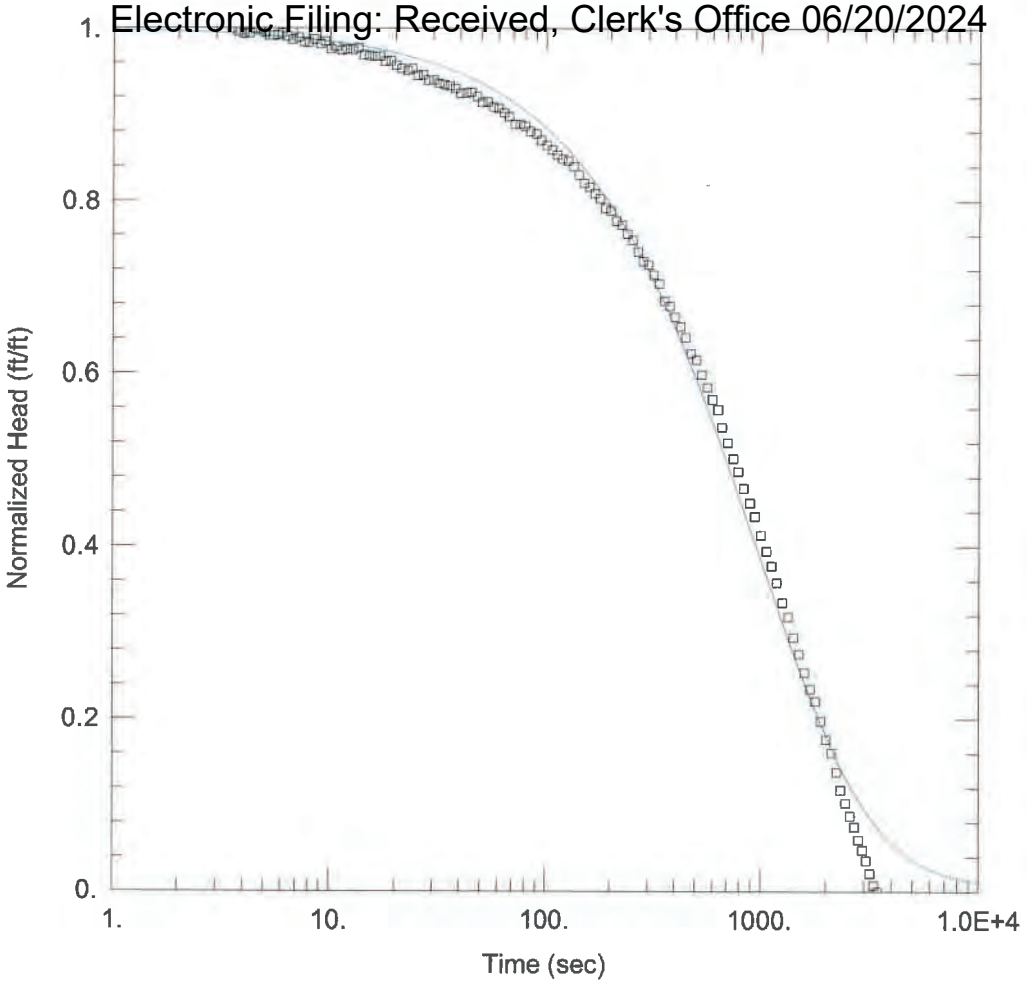
WELL DATA (G50S)

Initial Displacement: 1.07 ft
Total Well Penetration Depth: 22.57 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 20.03 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 6.5E-5 cm/sec
Kz/Kr = 1.
Ss = 0.007 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G50S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50S-rh.aqt
Date: 06/02/21 Time: 16:26:25

AQUIFER DATA

Saturated Thickness: 4.3 ft

WELL DATA (G50S)

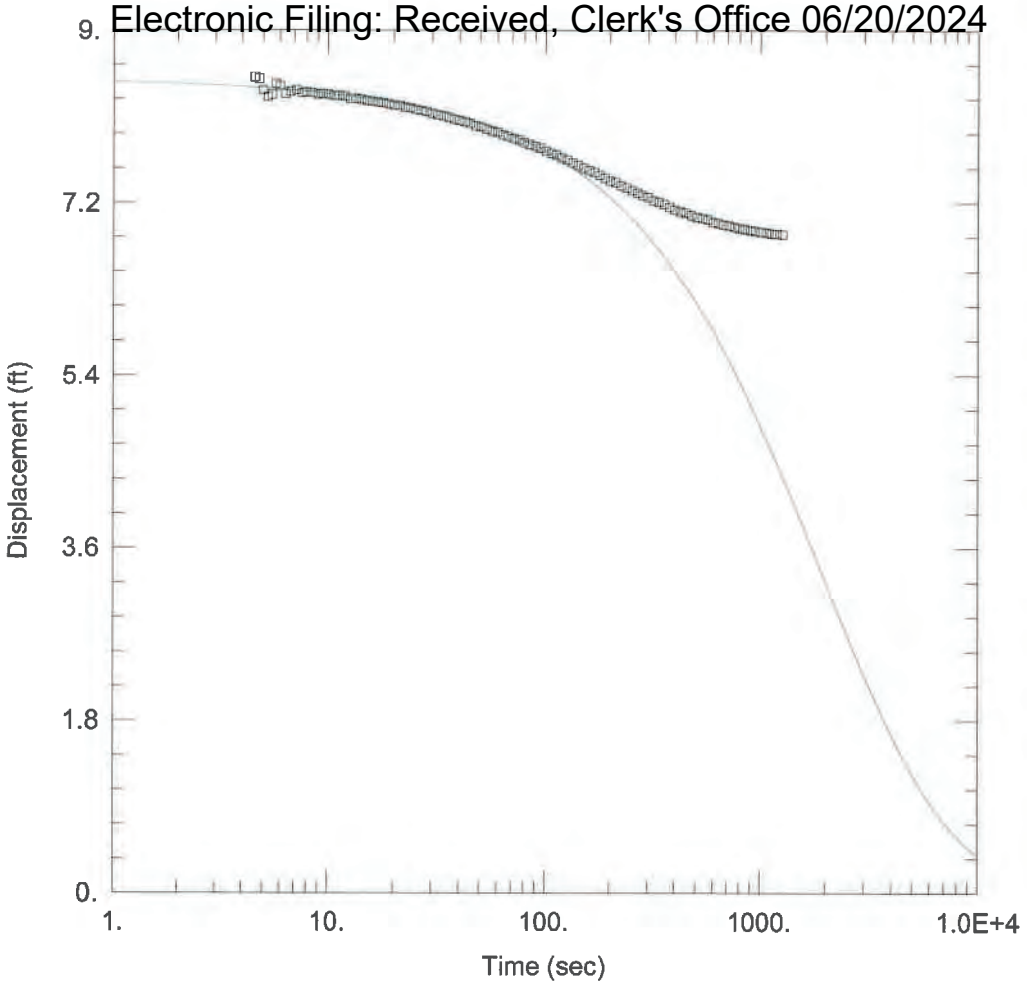
Initial Displacement: 1.35 ft
Total Well Penetration Depth: 22.57 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 20.03 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.00015 cm/sec
Kz/Kr = 1.
Ss = 1.4E-5 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G51L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G51L-fh.aqt
Date: 06/02/21 Time: 16:26:26

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G51L
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 8.5 ft

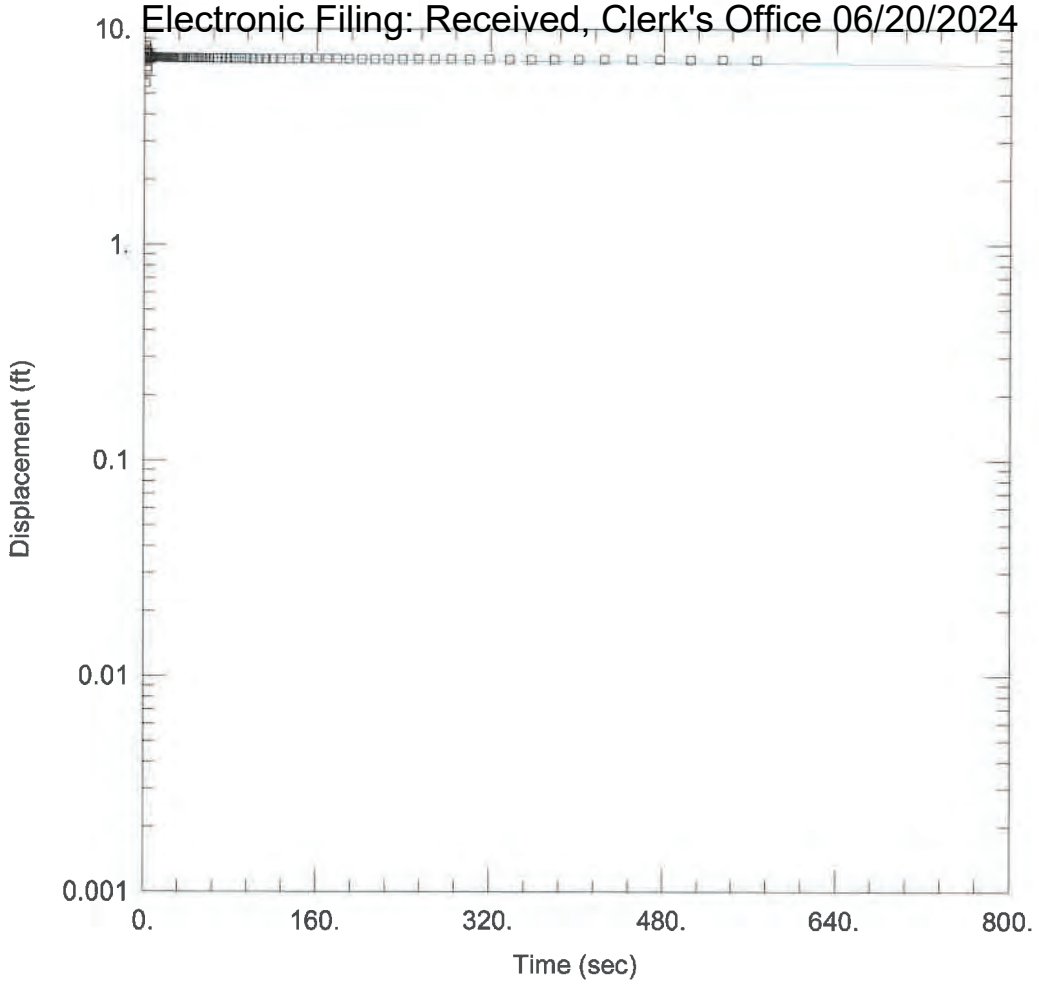
WELL DATA (G51L)

Initial Displacement: 8.5 ft
Total Well Penetration Depth: 14.11 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.32 ft
Screen Length: 4.79 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model
Kr = 3.0E-5 cm/sec
Ss = 0.0011 ft^{-1}
Kz/Kr = 1.

Electronic Filing: Received, Clerk's Office 06/20/2024



G51S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G51S-fh.aqt
Date: 06/02/21 Time: 16:26:27

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G51S
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 0.4 ft
Anisotropy Ratio (Kz/Kr): 1.

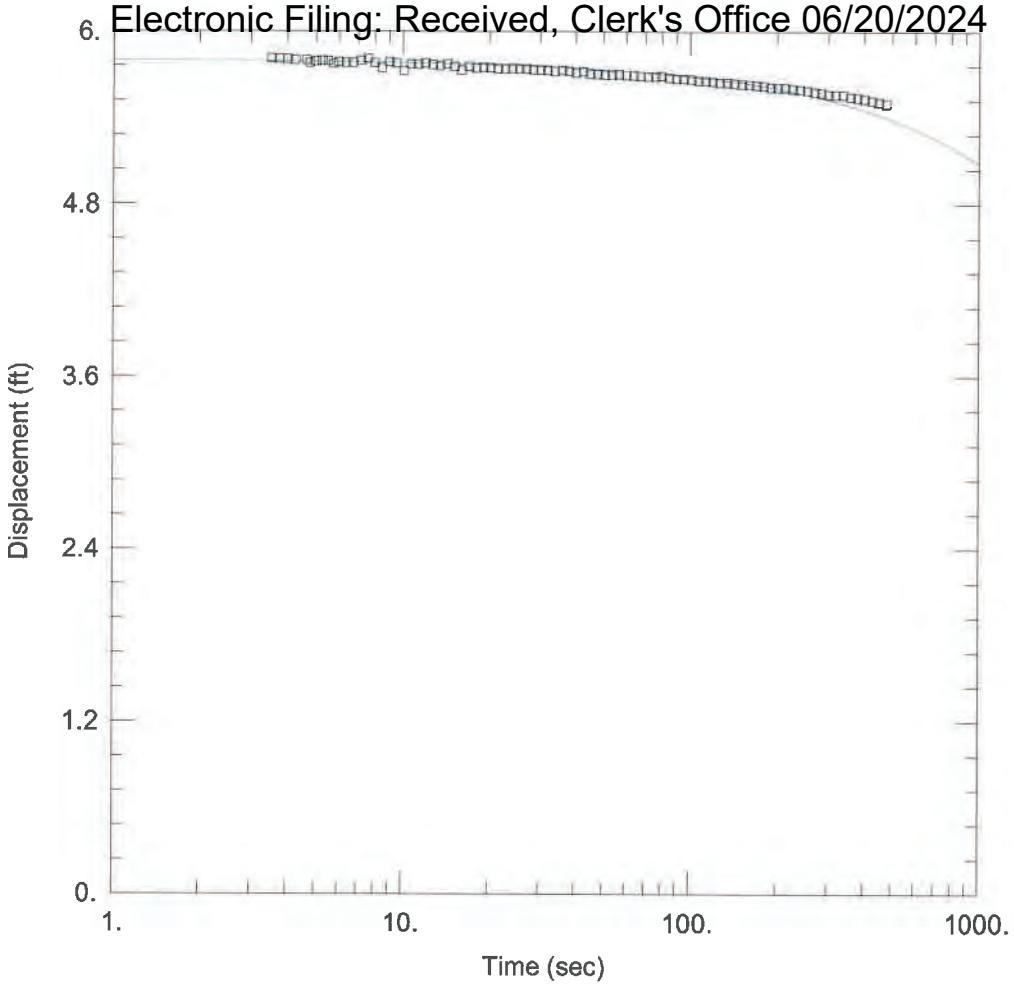
WELL DATA (G51S)

Initial Displacement: 7.4 ft
Total Well Penetration Depth: 20.04 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.4 ft
Screen Length: 4.78 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
K = 7.2E-5 cm/sec
Solution Method: Bouwer-Rice
y0 = 7.35 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G51S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G51S-rh.aqt
Date: 06/02/21 Time: 16:26:29

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G51S
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 0.4 ft

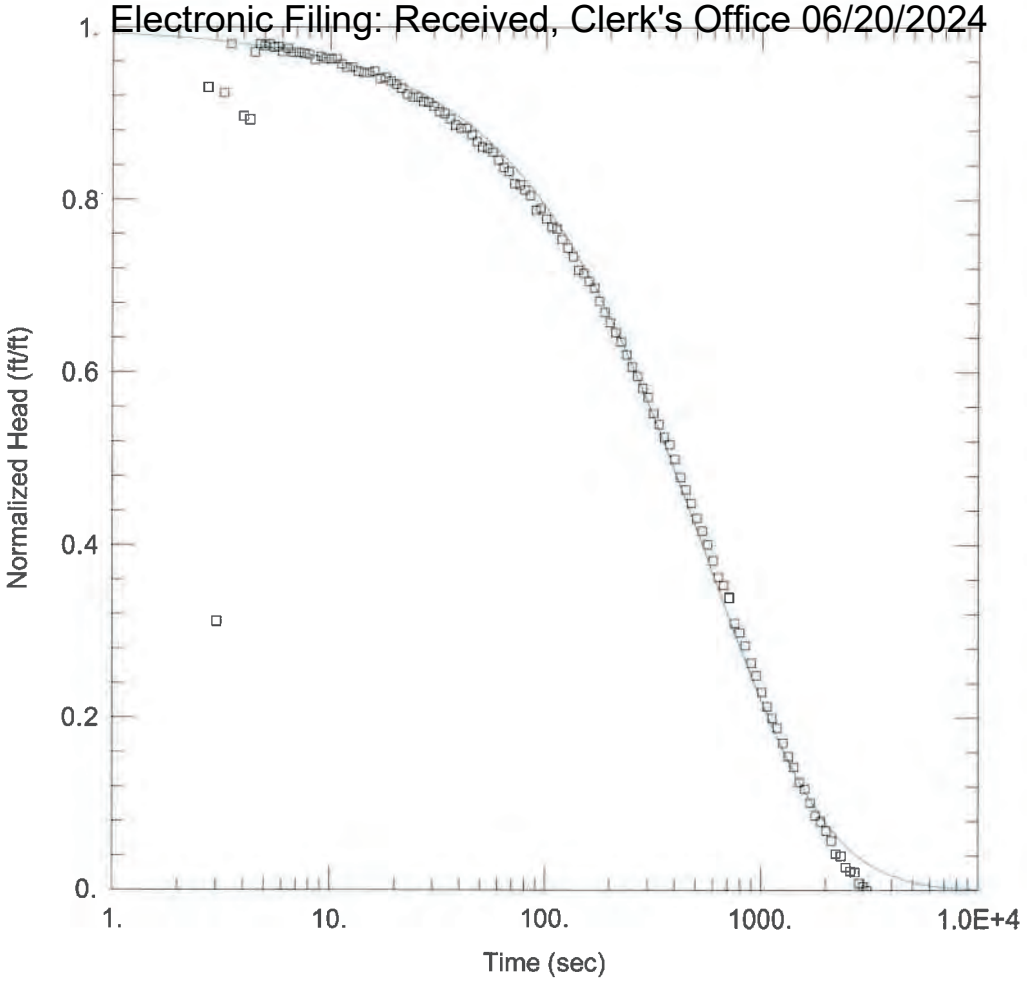
WELL DATA (G51S)

Initial Displacement: 5.8 ft
Total Well Penetration Depth: 20.04 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.4 ft
Screen Length: 4.78 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.00011 cm/sec
Kz/Kr = 1.
Ss = 0.0015 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G53L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53L-fh.aqt
Date: 06/02/21 Time: 16:26:30

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 11.48 ft

WELL DATA (G53L)

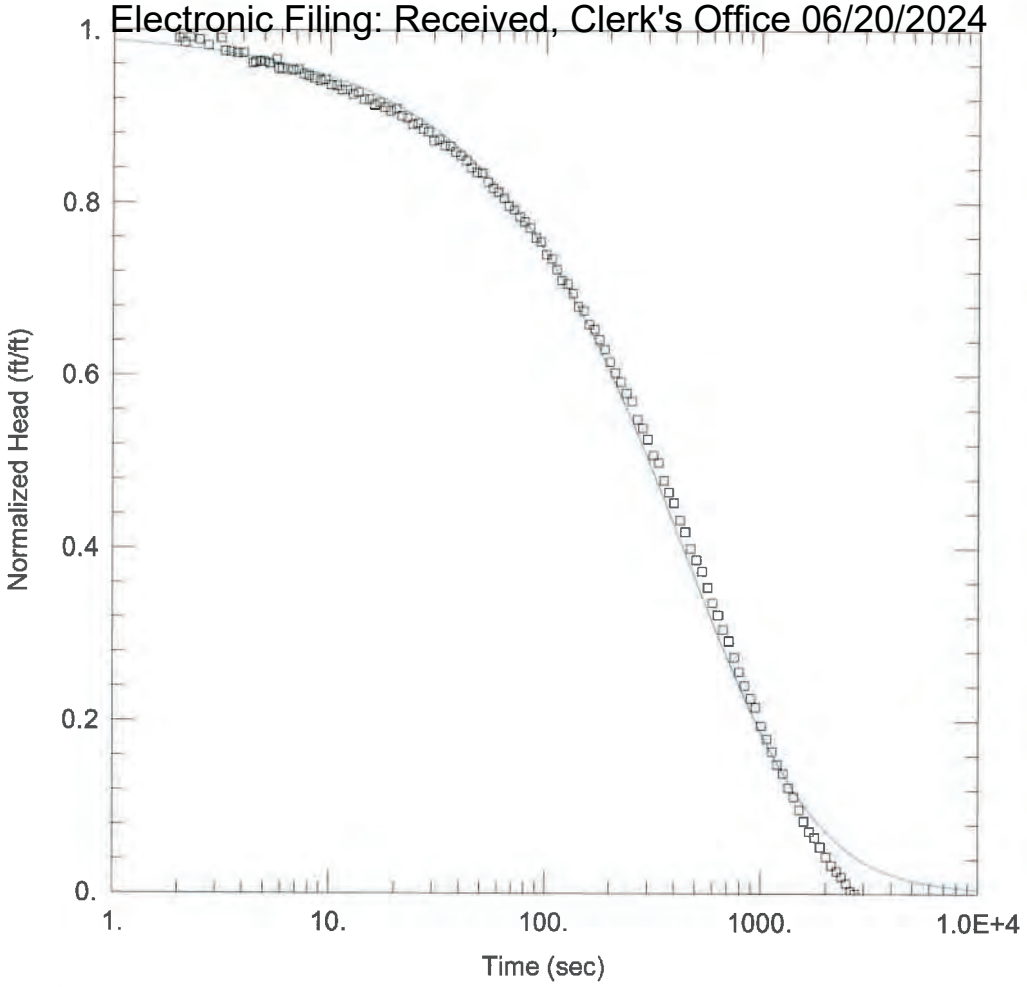
Initial Displacement: 1.4 ft
Total Well Penetration Depth: 14.33 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.48 ft
Screen Length: 9.35 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00011 cm/sec
Kz/Kr = 1.
Ss = 0.00029 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G53L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53L-rh.aqt
Date: 06/02/21 Time: 16:26:32

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 11.48 ft

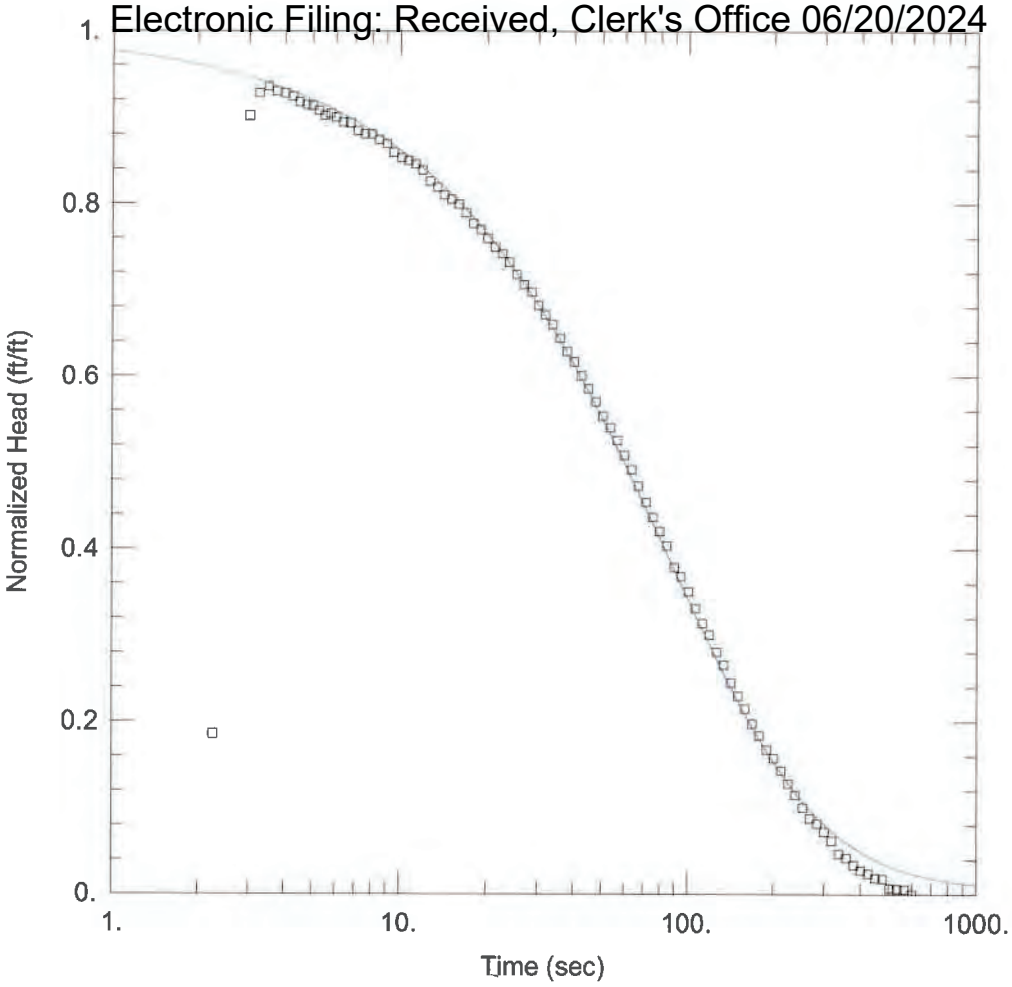
WELL DATA (G53L)

Initial Displacement: 1.5 ft
Total Well Penetration Depth: 14.33 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.48 ft
Screen Length: 9.35 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model
Kr = 0.00011 cm/sec
Kz/Kr = 1.
Ss = 0.0011 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G53S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53S-fh.aqt
Date: 06/02/21 Time: 16:26:33

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.6 ft

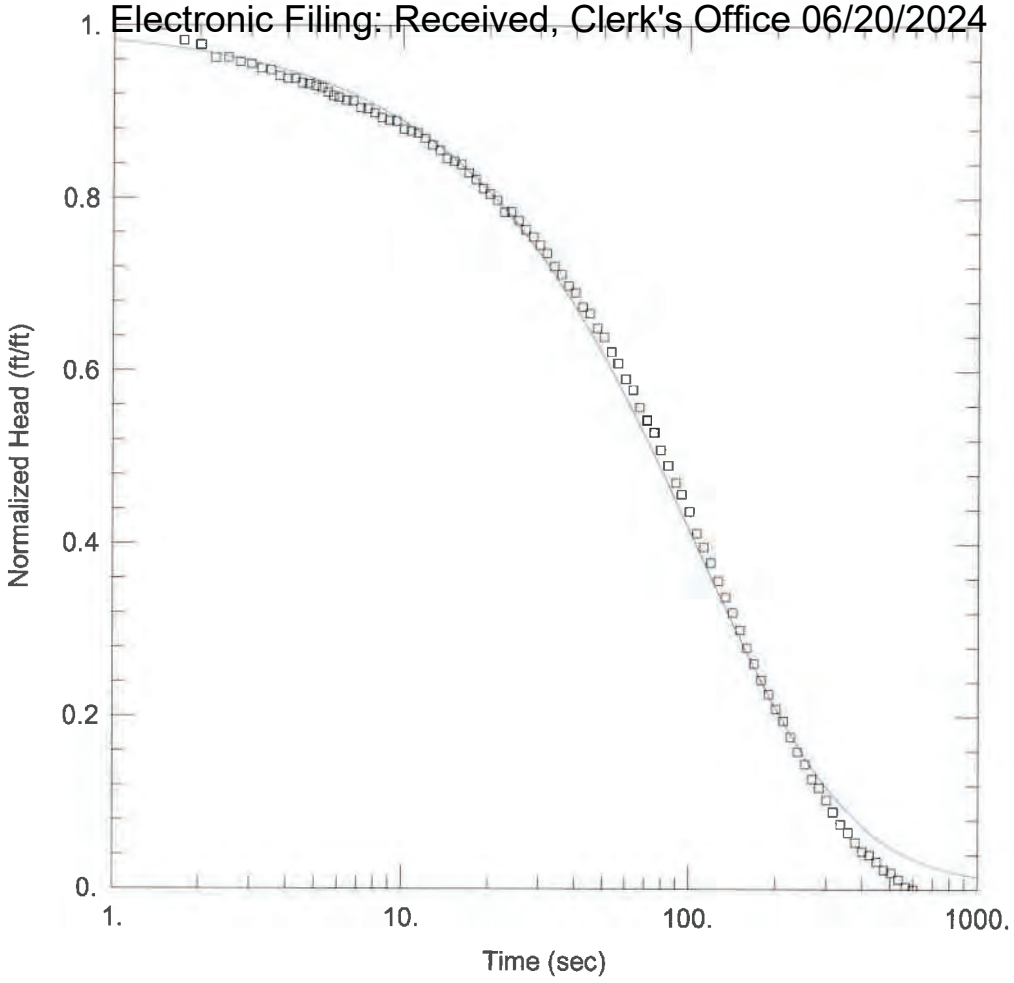
WELL DATA (G53S)

Initial Displacement: 1.6 ft
Total Well Penetration Depth: 21.38 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.77 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.0038 cm/sec
Ss = 0.002 ft^{-1}
Kz/Kr = 1.

Electronic Filing: Received, Clerk's Office 06/20/2024



G53S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53S-rh.aqt
Date: 06/02/21 Time: 16:26:35

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.6 ft

WELL DATA (G53S)

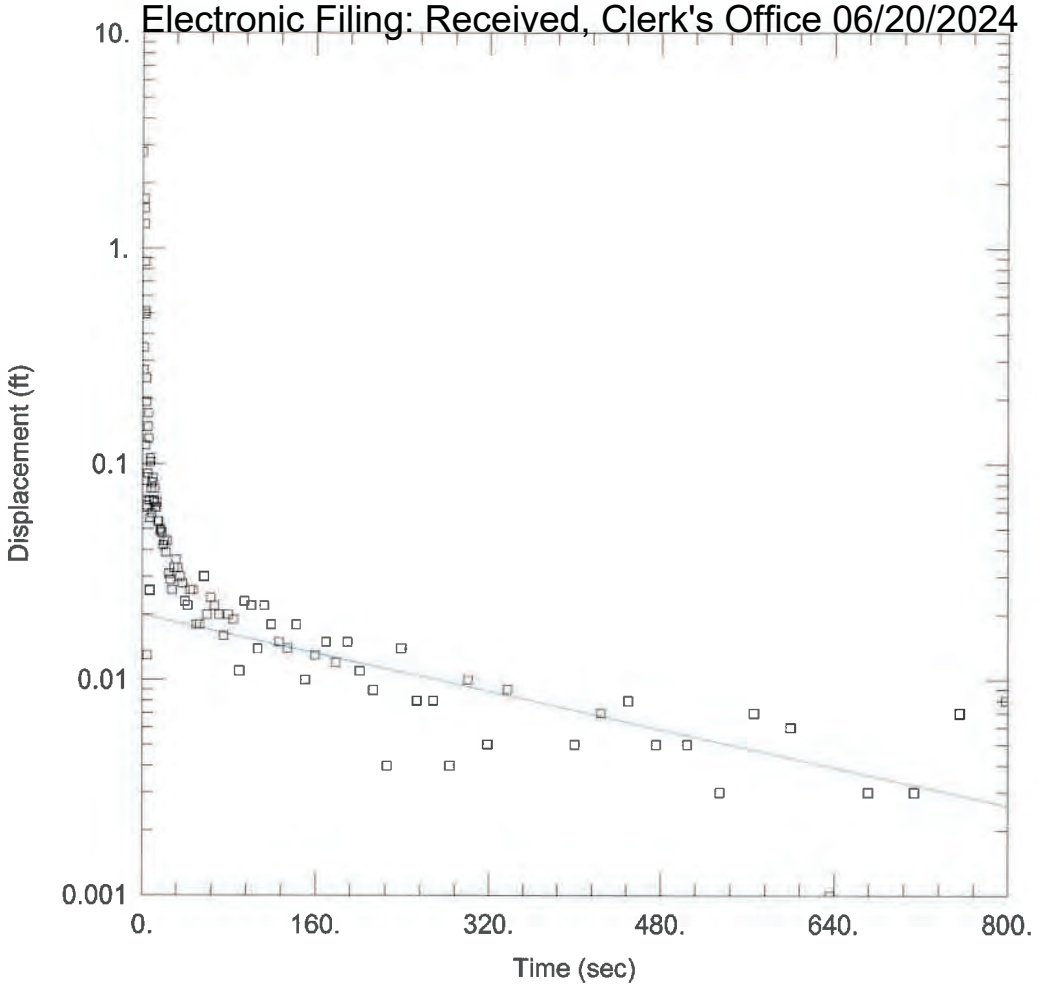
Initial Displacement: 1.75 ft
Total Well Penetration Depth: 21.38 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.77 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.0032 cm/sec
Kz/Kr = 1.
Ss = 0.001 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G54C FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54C-fh.aqt
Date: 06/02/21 Time: 16:26:36

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54C
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 42.2 ft
Anisotropy Ratio (Kz/Kr): 1.

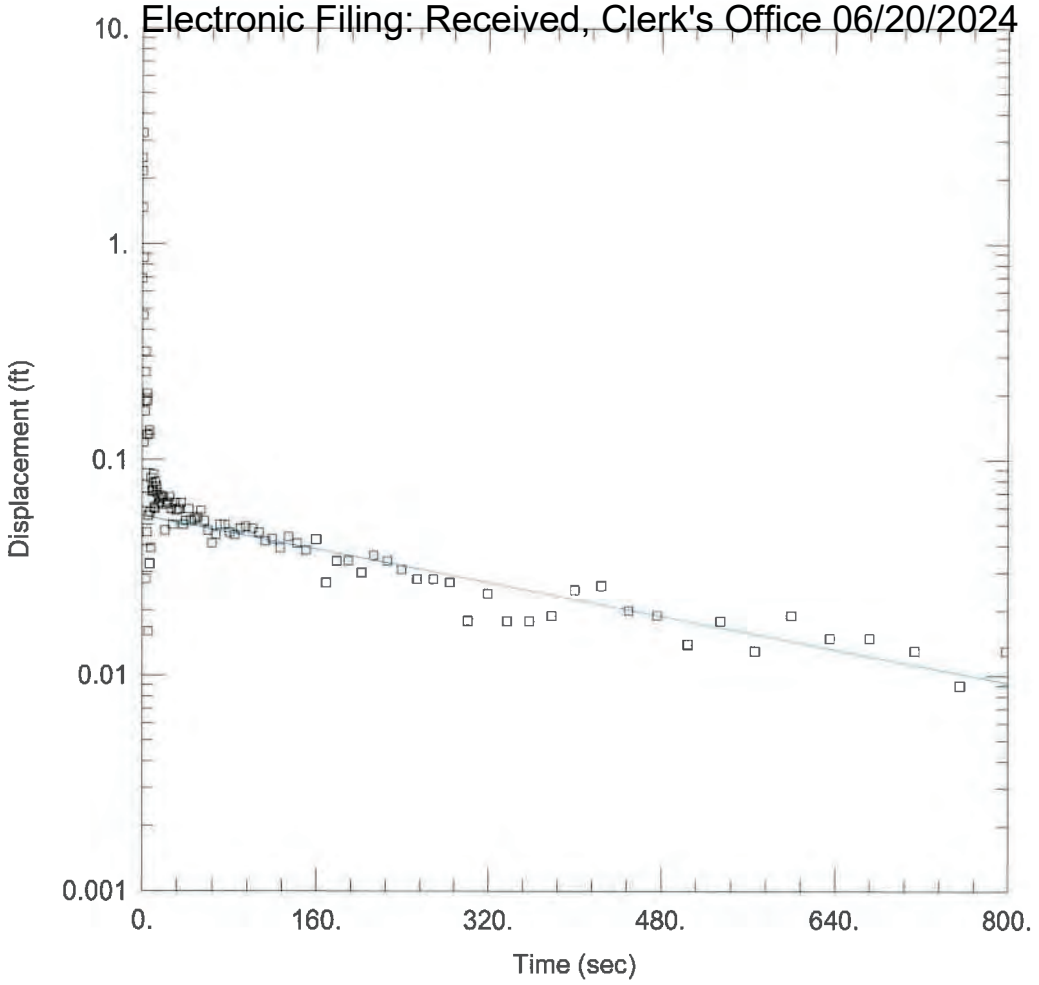
WELL DATA (G54C)

Initial Displacement: 2.8 ft
Total Well Penetration Depth: 44.3 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 42.2 ft
Screen Length: 9.07 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
K = 0.00016 cm/sec
Solution Method: Hvorslev
y0 = 0.02 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54C RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54C-rh.aqt
Date: 06/02/21 Time: 16:26:38

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54C
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 42.2 ft
Anisotropy Ratio (Kz/Kr): 1.

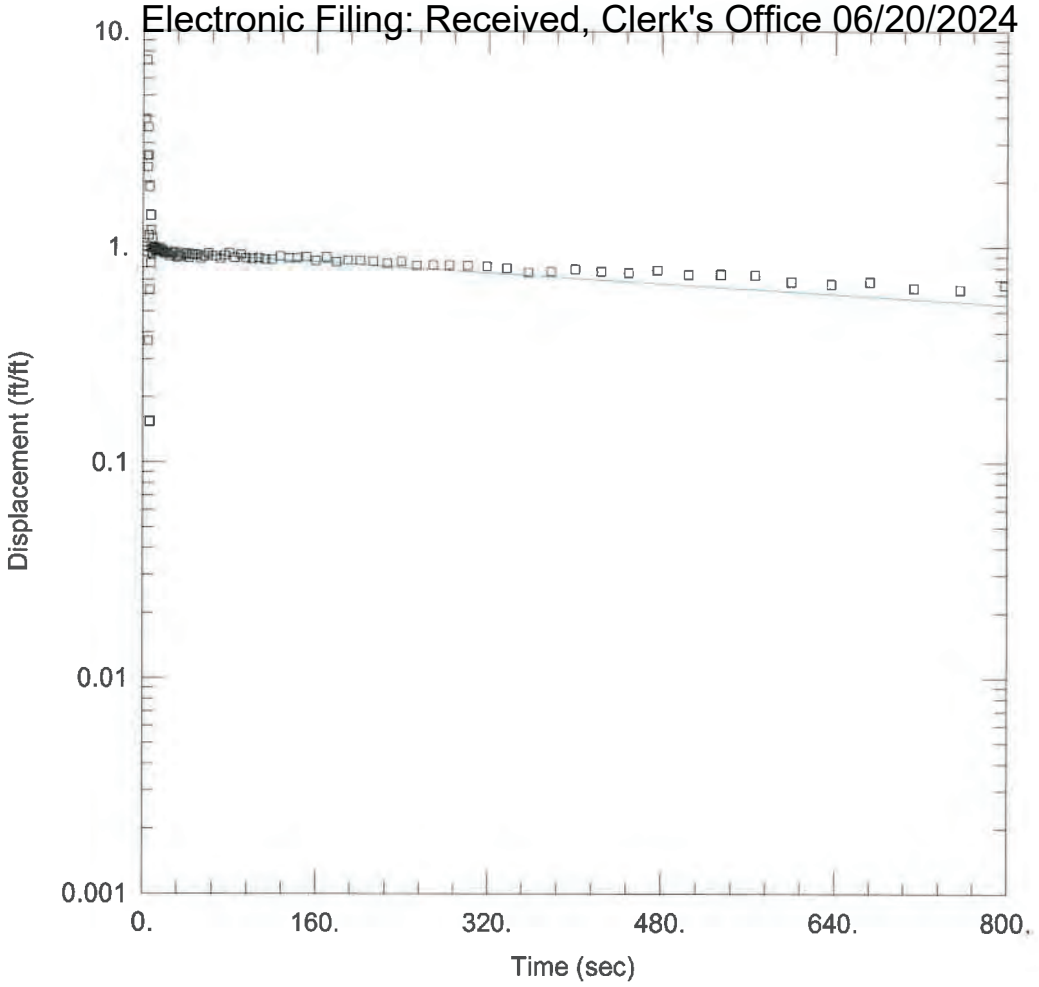
WELL DATA (G54C)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 44.3 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 42.2 ft
Screen Length: 9.07 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
K = 0.00014 cm/sec
Solution Method: Hvorslev
y0 = 0.055 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54L-fh.aqt
Date: 06/02/21 Time: 16:27:18

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54L
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 5.59 ft
Anisotropy Ratio (Kz/Kr): 1.

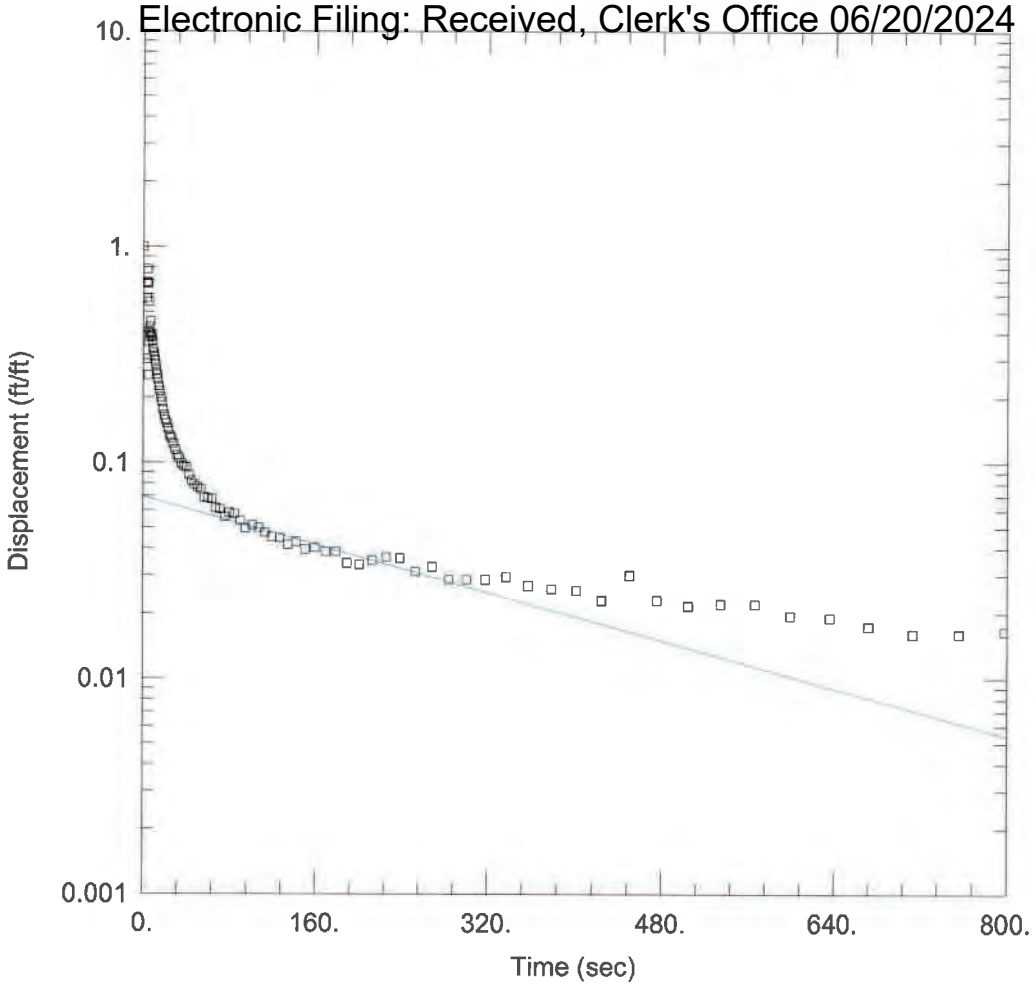
WELL DATA (G54L)

Initial Displacement: 0.2 ft
Total Well Penetration Depth: 10.65 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 5.59 ft
Screen Length: 9.43 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
K = 4.9E-5 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.19 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54L-rh.aqt
Date: 06/02/21 Time: 16:27:20

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54L
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 5.59 ft
Anisotropy Ratio (Kz/Kr): 0.001

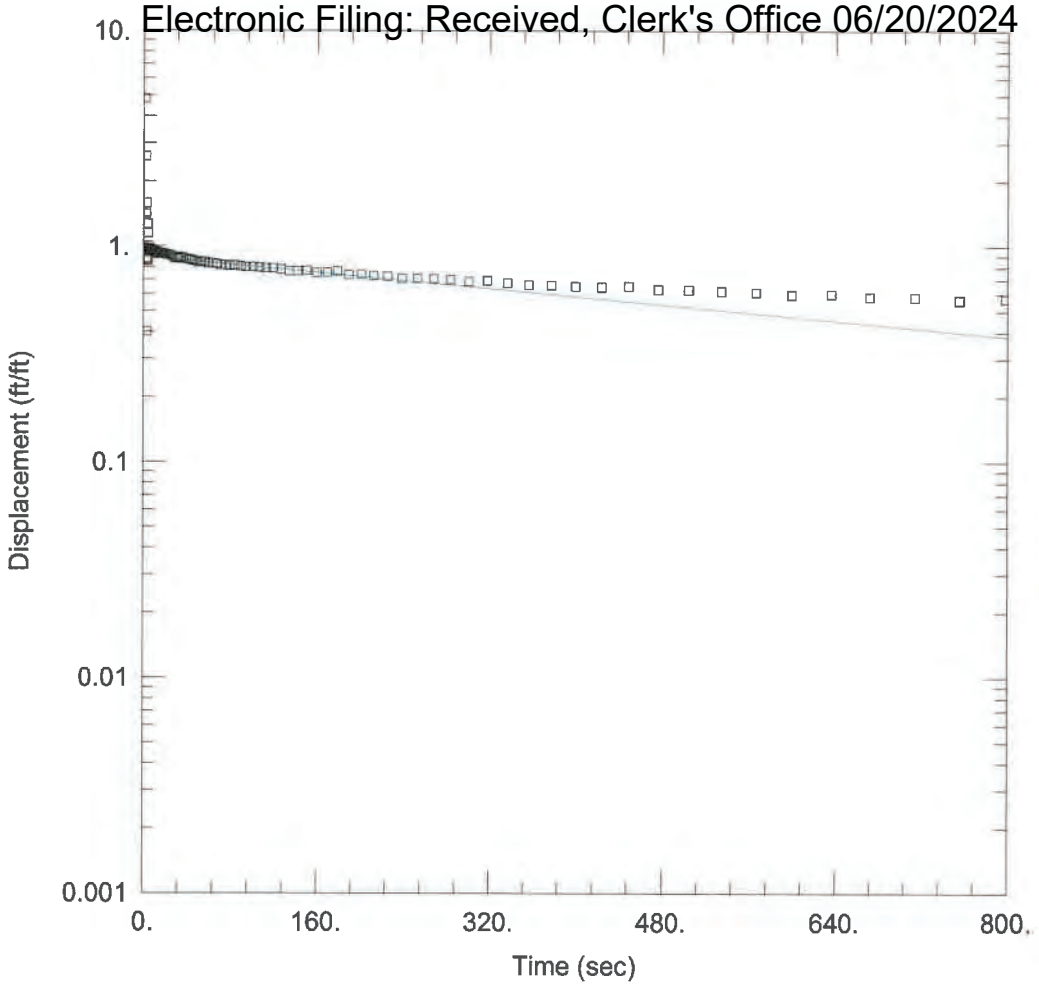
WELL DATA (G54L)

Initial Displacement: 2.3 ft
Total Well Penetration Depth: 10.65 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 5.59 ft
Screen Length: 9.43 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
K = 0.00022 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.16 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54S-fh.aqt
Date: 06/02/21 Time: 16:27:22

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54S
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 3.6 ft
Anisotropy Ratio (Kz/Kr): 0.001

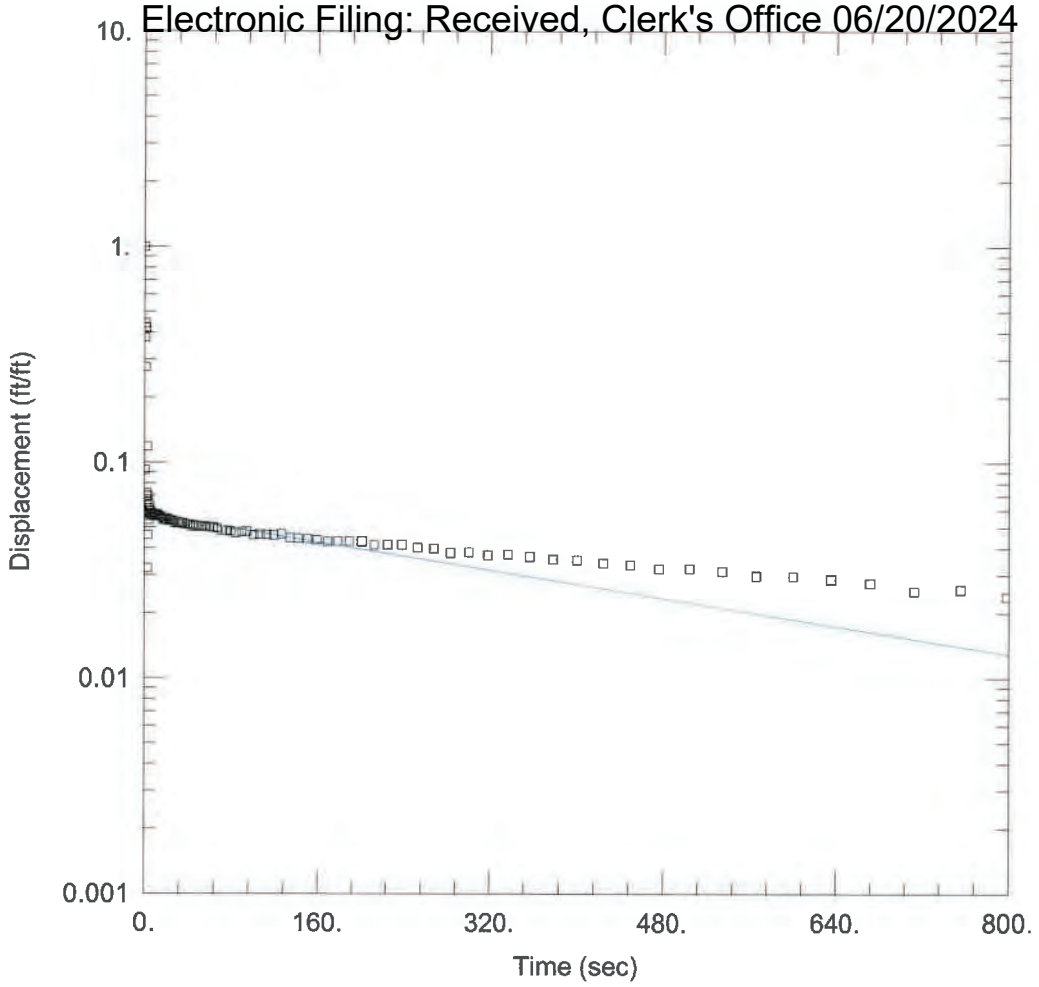
WELL DATA (G54S)

Initial Displacement: 0.525 ft
Total Well Penetration Depth: 17.18 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 14.36 ft
Screen Length: 4.47 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
K = 0.00012 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.47 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54S-rh.aqt
Date: 06/02/21 Time: 16:27:23

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54S
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 3.6 ft
Anisotropy Ratio (Kz/Kr): 1.

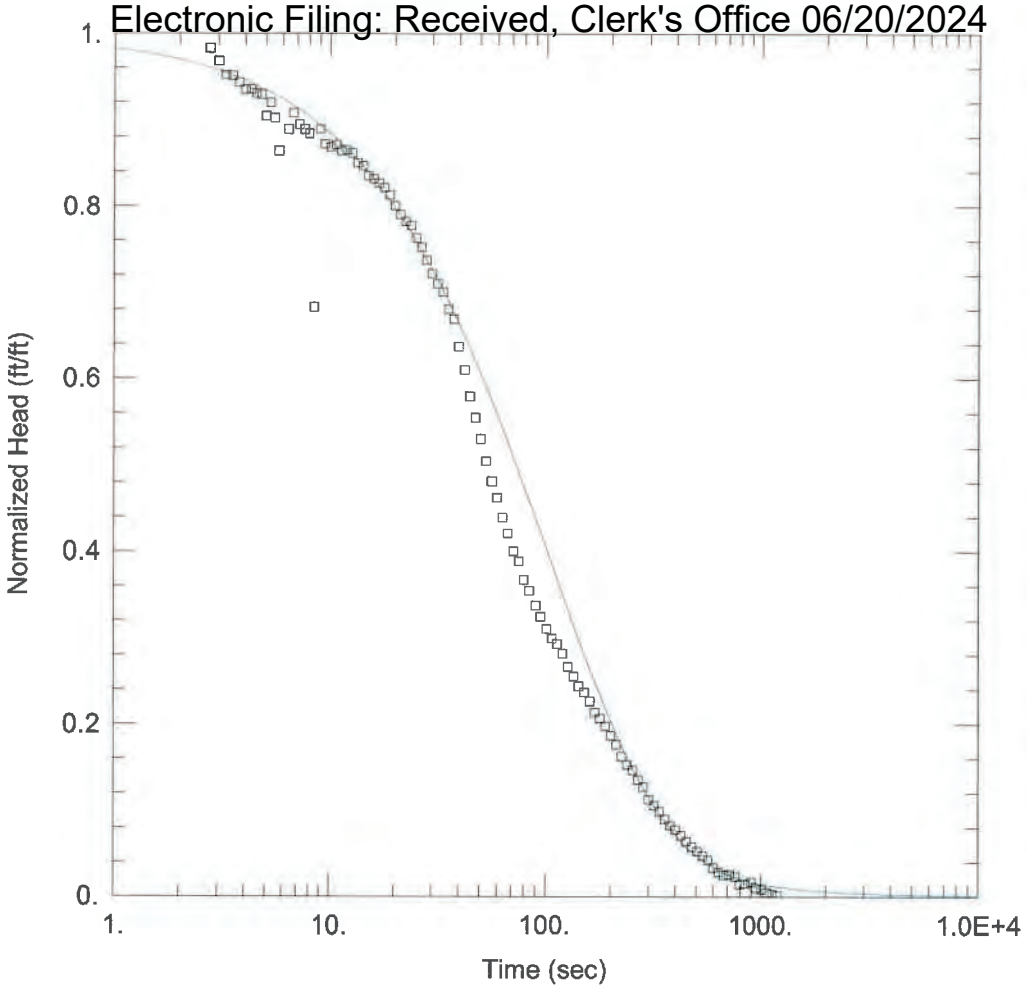
WELL DATA (G54S)

Initial Displacement: 7.8 ft
Total Well Penetration Depth: 17.18 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 14.36 ft
Screen Length: 4.47 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
K = 0.00021 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.45 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G57S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G57S-fh.aqt
Date: 06/02/21 Time: 16:27:25

AQUIFER DATA

Saturated Thickness: 1.9 ft

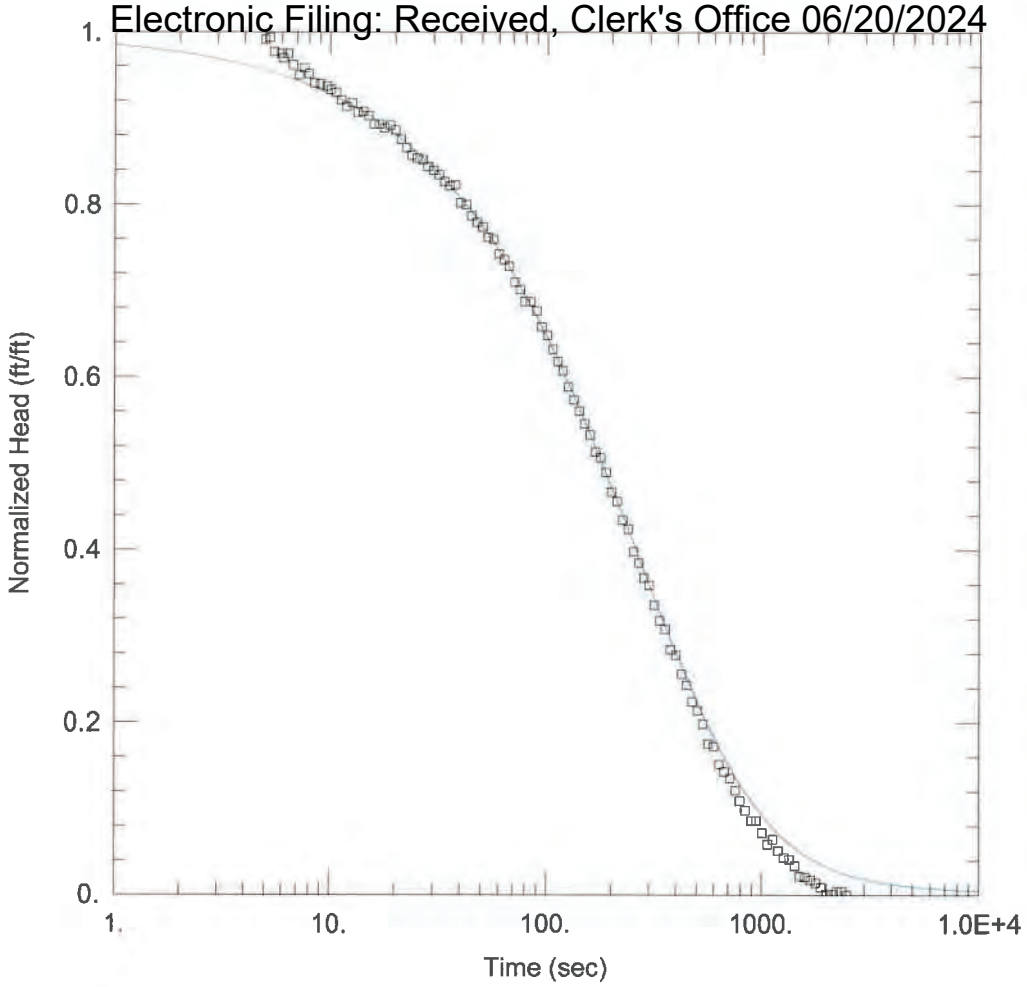
WELL DATA (G57S)

Initial Displacement: 1.55 ft
Total Well Penetration Depth: 10.16 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.62 ft
Screen Length: 4.53 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.0026 cm/sec
Ss = 7.0E-5 ft^{-1}
Kz/Kr = 1.

Electronic Filing: Received, Clerk's Office 06/20/2024



G57S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G57S-rh.aqt
Date: 06/02/21 Time: 16:27:26

AQUIFER DATA

Saturated Thickness: 1.9 ft

WELL DATA (G57S)

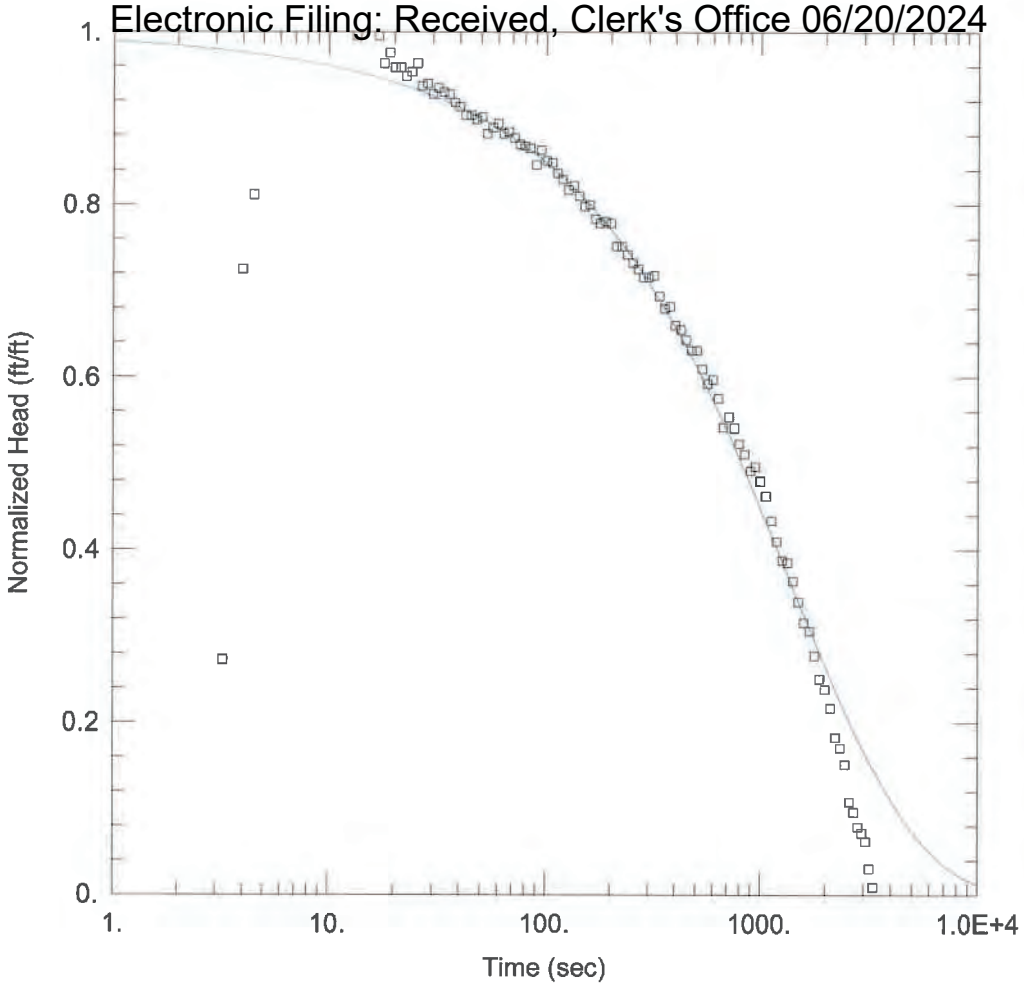
Initial Displacement: 0.925 ft
Total Well Penetration Depth: 10.16 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.62 ft
Screen Length: 4.53 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.00068 cm/sec
Kz/Kr = 0.001
Ss = 0.0022 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60L-fh.aqt
Date: 06/02/21 Time: 16:27:28

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.04 ft

WELL DATA (G60L)

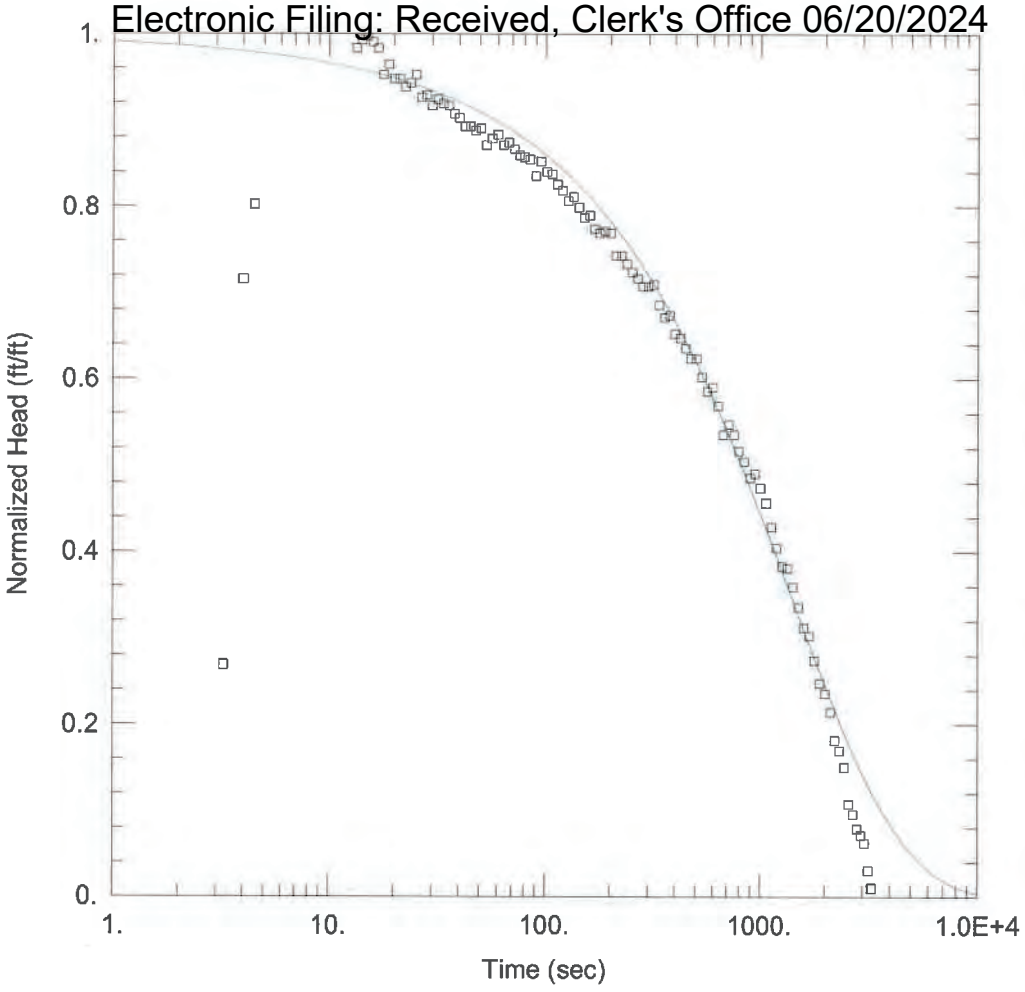
Initial Displacement: 0.415 ft
Total Well Penetration Depth: 5.4 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 1.04 ft
Screen Length: 4.74 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00023 cm/sec
Kz/Kr = 1.
Ss = 0.06 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60L-rh.aqt
Date: 06/02/21 Time: 16:27:30

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.04 ft

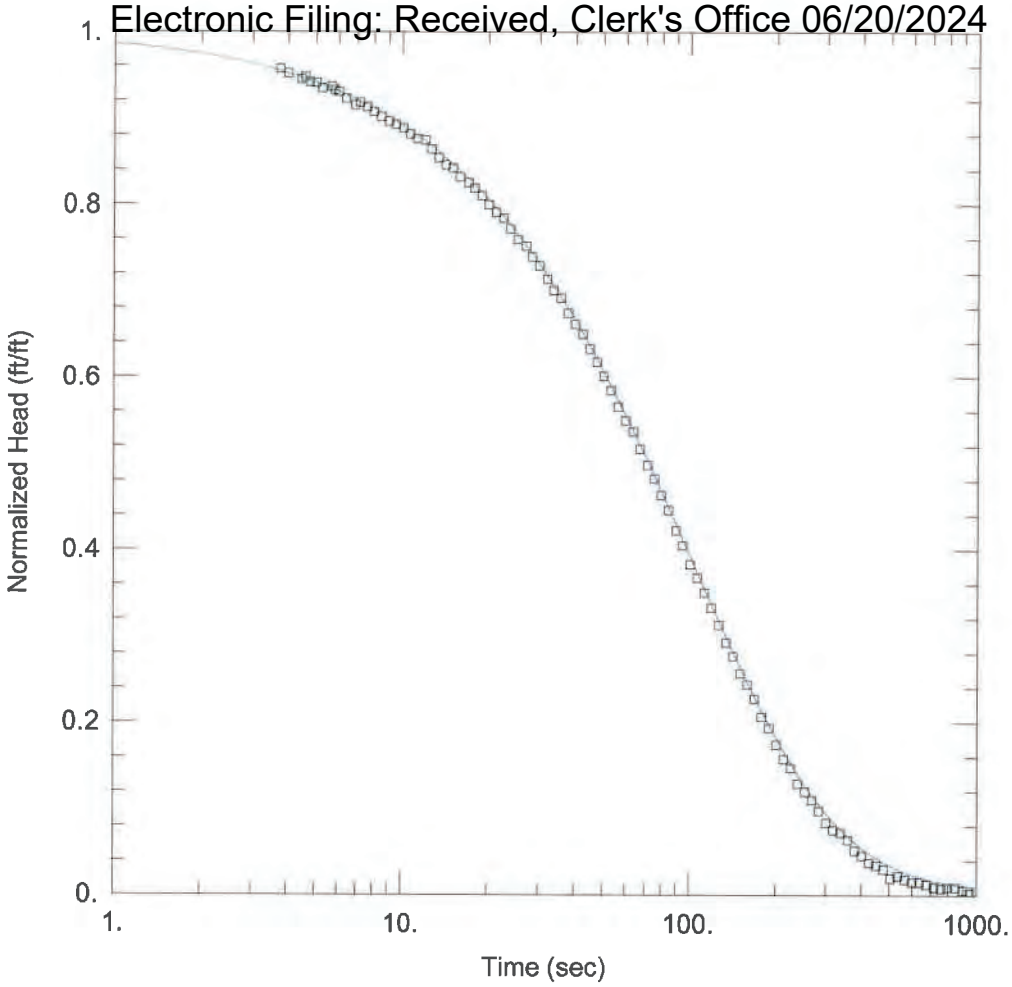
WELL DATA (G60L)

Initial Displacement: 0.42 ft
Total Well Penetration Depth: 5.4 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 1.04 ft
Screen Length: 4.74 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model
Kr = 0.00026 cm/sec
Kz/Kr = 1.
Ss = 0.035 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60S-fh.aqt
Date: 06/02/21 Time: 16:27:31

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.9 ft

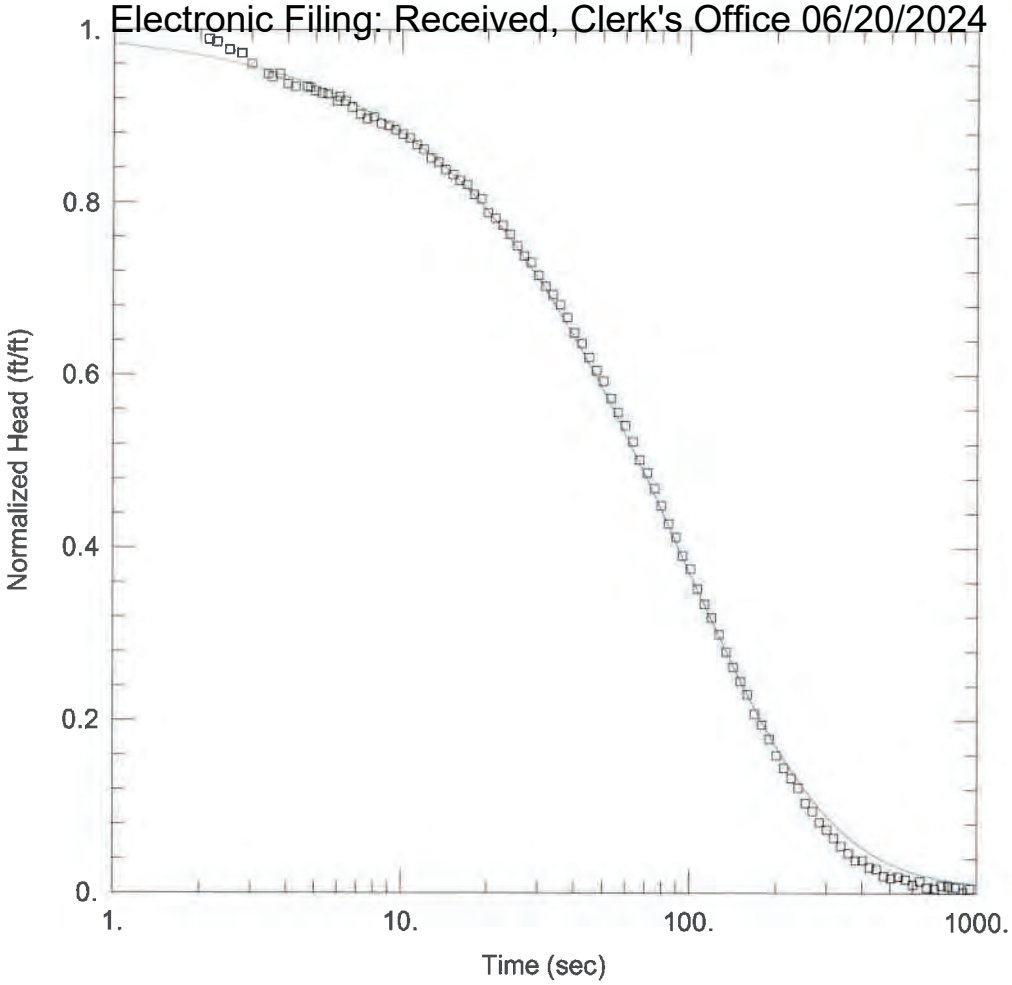
WELL DATA (G60S)

Initial Displacement: 1.55 ft
Total Well Penetration Depth: 7.23 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 3.91 ft
Screen Length: 3.95 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.0039 cm/sec
Kz/Kr = 1.
Ss = 7.1E-6 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60S-rh.aqt
Date: 06/02/21 Time: 16:27:33

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.9 ft

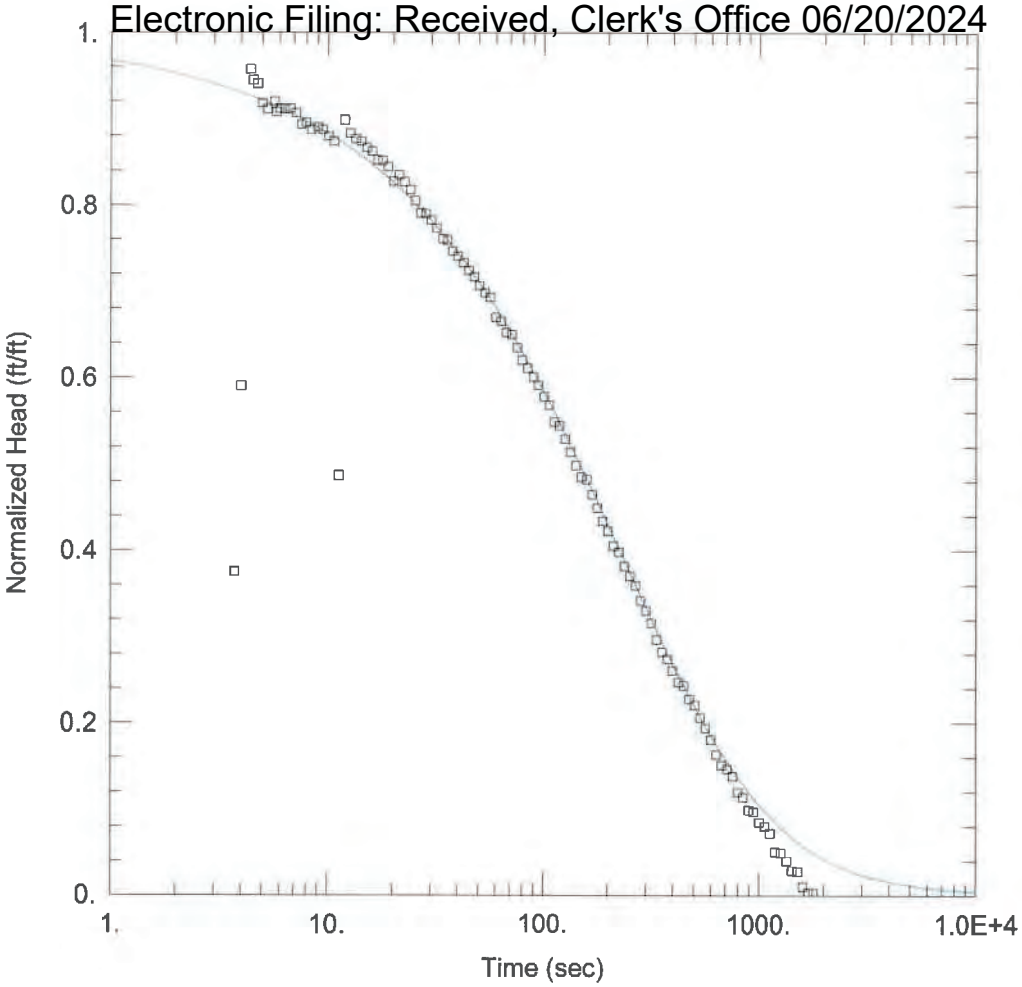
WELL DATA (G60S)

Initial Displacement: 1.85 ft
Total Well Penetration Depth: 7.23 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 3.91 ft
Screen Length: 3.95 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.0035 cm/sec
Ss = 7.0E-5 ft^{-1}
Kz/Kr = 1.

Electronic Filing: Received, Clerk's Office 06/20/2024



G63S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G63S-fh.aqt
Date: 06/02/21 Time: 16:27:35

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G63L
Test Date: 5 May 2021

AQUIFER DATA

Saturated Thickness: 10.8 ft

WELL DATA (G63S)

Initial Displacement: 0.975 ft
Total Well Penetration Depth: 13.54 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.84 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.0003 cm/sec
Kz/Kr = 1.
Ss = 0.02 ft^{-1}

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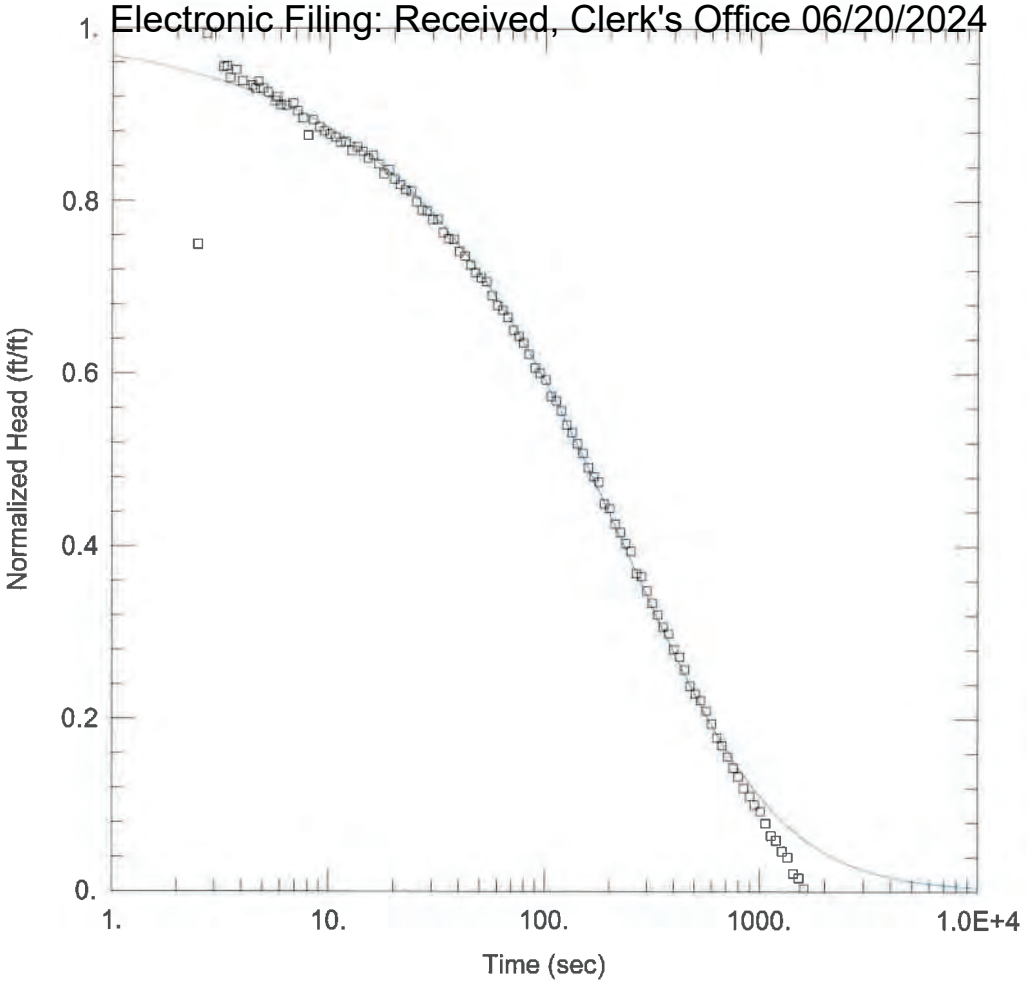

G63S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G63S-rh.aqt
Date: 06/02/21 Time: 16:27:37

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G63S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 10.8 ft

WELL DATA (G63S)

Initial Displacement: 1.15 ft
Total Well Penetration Depth: 13.54 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.84 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.00029 cm/sec
Kz/Kr = 1.
Ss = 0.02 ft^{-1}

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APPENDIX F
FEMA FLOOD HAZARD MAP

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NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or flood plain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or flood plain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

In the State of Illinois, any portion of a stream or watercourse that lies within the **floodway fringe** of a studied (AE) stream may have a state regulated floodway. The FIRM may not depict these state regulated floodways.

Floodways restricted by anthropogenic features such as bridges and culverts are drawn to reflect natural conditions and may not agree with the model computed widths listed in the Floodway Data table in the Flood Insurance Study report.

Multiple **topographic sources** may have been used in the delineation of Special Flood Hazard Areas. See Flood Insurance Study report for details on source resolution and geographic extent.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 15. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services, NOAA, NNGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey. Digital orthoimagery with a spatial resolution of 0.5 meter ground sample distance were photogrammetrically compiled from aerial photography acquired during the leaf-off period of spring 2005.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The Special Flood Hazard Areas and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

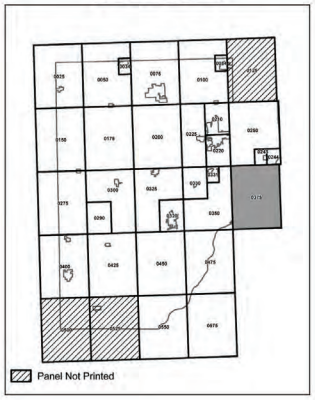
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

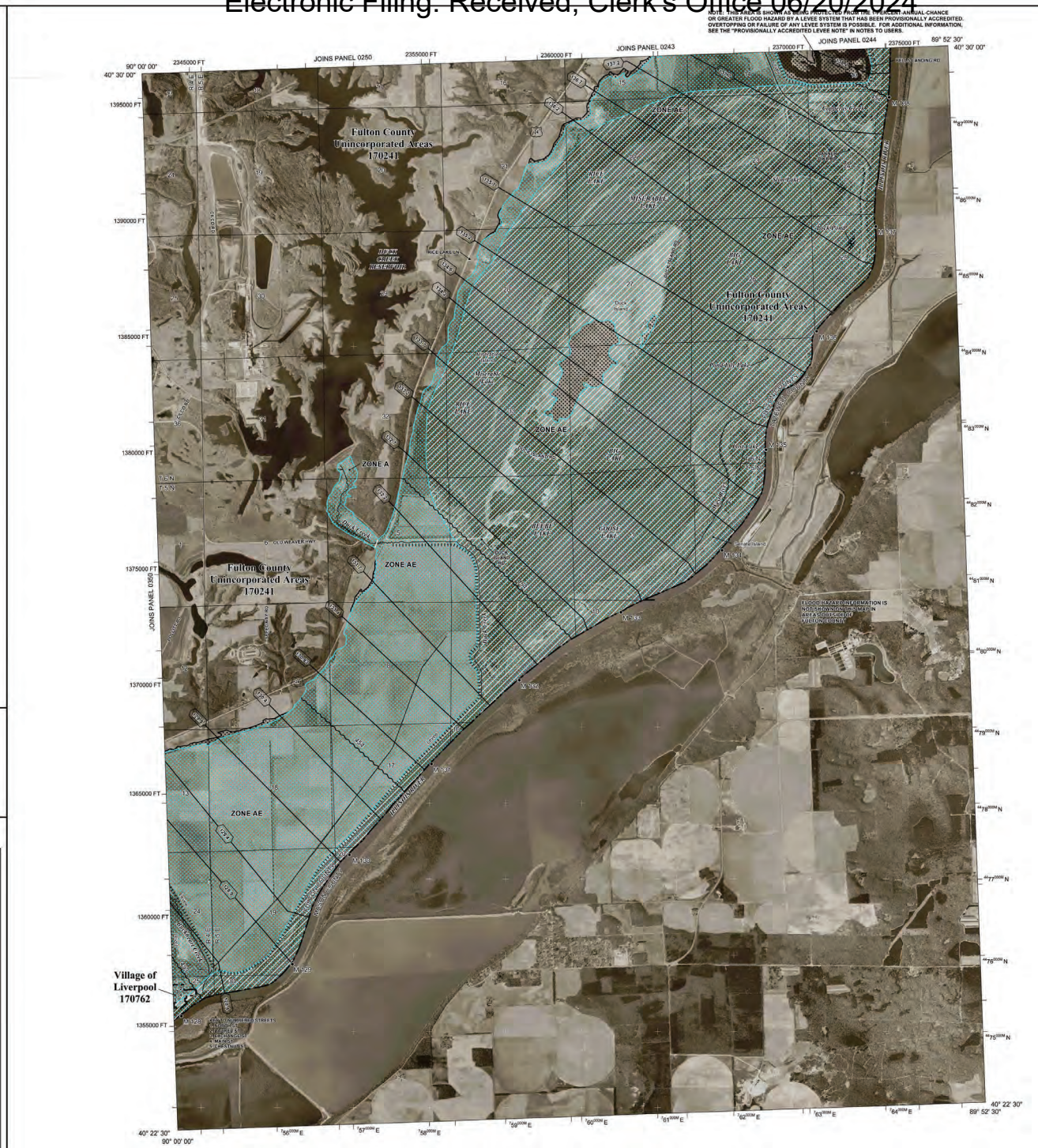
For information on available products associated with this FIRM visit the Map Service Center (MSC) website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

Provisionally Accredited Levee Notes to Users: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations by December 31, 2010. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicate the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA website at http://www.fema.gov/business/nfip/index.shtm.

PANEL INDEX





LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equalled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- A — A — Cross section line
- 23 — 23 — Transect line
- 45° 02' 08", 93° 02' 12" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4980000 N — 1000-meter Universal Transverse Mercator grid values, zone 15
- 1565000 FT — 5000-foot grid tick: Illinois State Plane West Coordinate System, 3801 zone (FIPSZONE 1202) Transverse Mercator
- DX5510$_X$ — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
FEBRUARY 4, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

PANEL 0375E

FIRM

FLOOD INSURANCE RATE MAP

FULTON COUNTY, ILLINOIS AND INCORPORATED AREAS

PANEL 375 OF 575

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FULTON COUNTY	170241	0375	E
LIVERPOOL, VILLAGE OF	170762	0375	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
17057C0375E

EFFECTIVE DATE
FEBRUARY 4, 2011

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

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ATTACHMENT I

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Intended for

LL

Date

Project No.

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S A A E E T A L T

EE E LA T

A T LL S

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GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND

Project Name	**Duck Creek Power Plant Gypsum Management Facility Pond**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Groundwater Monitoring Plan**
Revision	**FINAL**
Date	**October 25, 2021**

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Nathaniel R. Keller
Senior Hydrogeologist

Chase J. Christenson, PG
Hydrogeologist

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LICENSED PROFESSIONAL CERTIFICATIONS

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Duck Creek Power Plant Gypsum Management Facility Pond), has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).



Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Duck Creek Power Plant Gypsum Management Facility Pond), has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).



Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

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Table A	IEPA Groundwater Monitoring Program Parameters
Table B	40 C.F.R. § 257 Groundwater Monitoring Program Parameters
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TABLES (ATTACHED)

Table 1-1	Part 845 Requirements Checklist
Table 2-1	Monitoring Well Locations and Construction Details
Table 3-1	Background Groundwater Quality and Standards
Table 4-1	Sampling and Analysis Summary
Table 4-2	Detection and Reporting Limits for Part 845 Parameters

FIGURES (ATTACHED)

Figure 1-1	Site Location Map
Figure 1-2	Site Map
Figure 1-3	Uppermost Aquifer Groundwater Elevation Contours, April 14, 2021
Figure 2-1	IEPA Monitoring Program Well Network
Figure 2-2	Proposed Part 845 Groundwater Monitoring Well Network

APPENDICES

Appendix A	Statistical Analysis Plan

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ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
ASD	Alternate Source Demonstration
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
CSM	conceptual site model
DCPP	Duck Creek Power Plant
GMF Pond	Gypsum Management Facility Pond
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard
HCR	Hydrogeologic Site Characterization Report
HDPE	high-density polyethylene
ID	identification
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
mg/L	milligrams per liter
mil	millimeter
msl	mean sea level
NA	not applicable
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
NRT/OBG	Natural Resource Technology, an OBG Company
oz/yd^2	ounces per square yard
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
PMP	potential migration pathway
QA/QC	quality assurance/quality control
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RL	reporting limit
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency
WLO	water level only
WPCP	Water Pollution Control Permit

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (SIs): Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845) (Illinois Environmental Protection Agency [IEPA], April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Monitoring Plan (GMP) on behalf of Duck Creek Power Plant (DCPP), operated by Illinois Power Resources Generating, LLC (IPRG). This report will apply specifically to the CCR Unit referred to as the Gypsum Management Facility Pond (GMF Pond) (Vistra identification [ID] number [No.] 203, IEPA ID No. W0578010001-04, and National Inventory of Dams [NID] No. IL50573). This GMP includes Part 845 content requirements specific to 35 I.A.C. § 845.630 (Groundwater Monitoring System), 35 I.A.C. § 845.640 (Groundwater Sampling and Analysis), and 35 I.A.C. § 845.650 (Groundwater Monitoring Program) for the GMF Pond at the DCPP.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650 is included in **Table 1-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650.

1.2 Site Location and Background

The DCPP is located in Fulton County, Illinois, approximately six miles southeast of the town of Canton, Illinois. The GMF Pond is located north of the DCPP within Section 18, Township 6 North, Range 5 East (**Figure 1-1**). Prior to construction of the DCPP and associated facilities, strip mining of coal took place within the current property boundary. Currently, land use adjacent to the DCPP is primarily agriculture, pasture, and forested land with minimal development.

The GMF Pond is a 1,500-foot by 900-foot earthen berm double-lined CCR SI located north of the former DCPP. The GMF Pond decant water discharges to the lined GMF Recycle Pond located to the south of the GMF Pond (**Figure 1-2**). In addition to the GMF Pond, several other CCR units are located on the DCPP property, including the Landfill located due north of the GMF Pond; the closed units Ash Pond No. 1 and Ash Pond No. 2 located south of the GMF Pond; and the Bottom Ash Basin located between the former DCPP and the closed Ash Pond No. 1 and Ash Pond No. 2.

The GMF Pond, also referred to as the gypsum stack/management system, operates under IEPA Water Pollution Control Permit (WPCP) No. 2017-E0-62640, issued in December 2017. It consists of 1,500-foot by 900-foot earthen berm with 3.5:1 side slopes, a maximum elevation of 620 feet above mean sea level, a double geomembrane liner consisting of a 60-millimeter (mil) high-density polyethylene (HPDE) geomembrane liner, 12 inches of clay cushion, 4 ounces per square yard (oz/yd^2) non-woven geotextile filter fabric, 12 inches highly permeable granular drainage (sand), 10 oz/yd^2 non-woven geotextile filter fabric, 60-mil HPDE geomembrane liner, reinforced bentonite mat, 36 inches compacted clay all installed over in-situ foundation soil, and all pipes, pumps, and appurtenances necessary for the storage of approximately 3.6 million tons of gypsum at a maximum elevation of 715 feet above mean sea level with discharge to the Recycle Pond. The GMF Recycle Pond is lined with a 60-mil HDPE geomembrane liner, reinforced bentonite mat, and 36 inches of compacted clay.

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) coal unit at some portions of the DCPP property. Previous investigations completed outside of the GMF Pond indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to and downgradient of several former large surface mining areas.

1.3 Conceptual Model

Significant site investigation has been completed at the DCPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, the GMF Pond has been well characterized and detailed in the Hydrogeologic Site Characterization Report (HCR; Ramboll, 2021); included in the Operating Permit to which this Plan is attached). A conceptual site model (CSM) has been developed and is discussed below.

The three distinct hydrostratigraphic units summarized below have been identified at the GMF Pond based on stratigraphic relationships and common hydrogeologic characteristics:

- **Uppermost Aquifer:** At the GMF Pond, this unit includes the Peoria/Roxana Loess, the upper Radnor Till, and the shallow sands. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (Natural Resource Technology, an OBG Company [NRT/OBG], 2017a). The shallow sands are laterally extensive across the GMF Pond, vary in thickness from less than one to 18 feet, and are generally located at an elevation of 570 to 590 feet above mean sea level (msl). Sand was completely removed where it was encountered during construction of the GMF Pond, putting the base of liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place. While the primary migration pathway is the shallow sand of the uppermost aquifer, the groundwater within the overlying Peoria/Roxanna Loess has the potential to be impacted and is considered a potential migration pathway (PMP).
- **Lower Radnor Till/Lower Confining Unit**: Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick. Previous hydrogeologic studies indicate discontinuous sand lenses observed within the till are not hydraulically connected to the shallow sand unit (NRT/OBG, 2017a).
- **Bedrock Confining Unit**: The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet.

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow in the sands is generally in a northwest to southeast direction (**Figure 1-3**). Seasonal variation of groundwater levels at the GMF Pond are present and may fluctuate approximately one to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond associated with the elevation changes. Groundwater flows toward the Duck Creek Cooling Pond located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Duck Creek Cooling Pond is estimated from 562.5 to 565 feet North American Vertical Datum of 1988 (NAVD88). Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond.

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Part 845 parameters were monitored in the uppermost aquifer and PMP monitoring wells at the GMF Pond as part of the Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257 monitoring program beginning in 2015. These data were supplemented with sampling of additional locations in 2021. The results indicate that the following parameters were detected at concentrations or measurements greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs) and are considered potential exceedances:

- Antimony, arsenic, cobalt, lead, pH, sulfate, and thallium were detected at least once at concentrations or measurements greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). Lead, mercury, pH, and thallium were detected at concentrations or measurements greater than the GWPS in upgradient uppermost aquifer wells. Radium 226 and 228 combined was detected once at concentrations greater than the GWPS in the bedrock confining unit well.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPS, without an evaluation of background concentrations. Evaluation of background groundwater quality has been completed as part of this GMP, and compliance with Part 845 will be determined following the first round of groundwater sampling. The first round of groundwater sampling for compliance will be completed the quarter following issuance of the Operating Permit and in accordance with this GMP.

2. GROUNDWATER MONITORING SYSTEMS

2.1 Existing Monitoring Well Network and Analysis

This GMP is being provided to propose a groundwater monitoring network and monitoring program specific to the GMF Pond that will comply with Part 845. Monitoring networks and programs that apply to other units are not discussed in this GMP. Those programs will continue to be performed as specified in IEPA approvals. Any future modifications will be proposed and submitted to IEPA for approval in a separate document. The remaining discussion in this document will include only these networks and monitoring programs that are applicable and specific to the GMF Pond, specifically the IEPA WPCP monitoring network, the 40 C.F.R. § 257 monitoring network and the proposed Part 845 monitoring network.

2.1.1 IEPA Monitoring Program

Routine quarterly groundwater monitoring is completed at GMF Pond wells G50L/S, G51L/S, G52L/S, G53L/S, G54L/S, G55L/S, G56L/S, G57L/S, G58L/S, G59L/S, G60L/S, R61L/G61S, G62L, G63L/S, and G64L/S in accordance with the IEPA WPCP No. 2017-E0-62640. This permit also requires sampling G65L/S, G66L/S, G67L/S, G70L, G71L/S, and G72L/R72S at the GMF Recycle Pond. The boring logs, well construction forms, and other related monitoring well forms for the GMF Pond well network are included in Appendix B of the HCR (included in the Operating Permit to which this Plan is attached). The location of all IEPA monitoring wells is illustrated in **Figure 2-1**. Groundwater samples are collected quarterly and annually and are analyzed for the laboratory and field parameters listed in **Table A** below.

Table A. IEPA Groundwater Monitoring Program Parameters

Field Parameters			
pH	Temperature	Specific Conductance	
Groundwater Elevation	Depth to Water (bmp)	Bottom of Well Elevation	
Quarterly Parameters (Dissolved)			
Arsenic	Cadmium	Lead	Sulfate
Boron	Chloride	Manganese	Total Dissolved Solids (TDS)
Annual Parameters (Dissolved)			
Alkalinity, bicarbonate	Chromium	Mercury	Selenium
Alkalinity, carbonate	Cobalt	Nickel	Sodium
Ammonia as Nitrogen	Iron	Nitrate nitrogen	Zinc
Calcium	Magnesium	Potassium	

2.1.2 40 C.F.R. § 257 Monitoring Program

The 40 C.F.R. § 257 well network for the GMF Pond consists of seven monitoring wells installed nearby or adjacent to the GMF Pond in the uppermost aquifer. The GMF Pond 40 C.F.R. § 257 well network consists of three background monitoring wells (G02S, G50S, and G51S) and four compliance monitoring wells (G54S, G57S, G60S, and G64S). The boring logs, well construction forms, and other related monitoring well forms are available in the Operating Records as required by 40 C.F.R. § 257.91 for each monitored CCR Unit or CCR Multi-Unit, and are included in Appendix B of the HCR (included in the Operating Permit to which this Plan is attached).

Groundwater is being monitored at the GMF Pond in accordance with the Detection Monitoring Program requirements specified in 40 C.F.R. § 257.94. Details on the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the Sampling and Analysis Plan for the GMF Pond (NRT/OBG, 2017b).

Groundwater samples are collected semiannually and analyzed for the laboratory and field parameters from Appendix III of 40 C.F.R. § 257, summarized in **Table B** below.

Table B. 40 C.F.R. § 257 Groundwater Monitoring Program Parameters

Field Parameters[1]		
pH	Groundwater Elevation	
Appendix III Parameters (Total, except TDS)		
Boron	Chloride	Sulfate
Calcium	Fluoride	TDS

[1]Dissolved oxygen, temperature, specific conductance, oxidation/reduction potential, and turbidity were recorded during sample collection.

Results and analysis of groundwater sampling are reported annually by January 31 of the following year and made available on the CCR public website as required by 40 C.F.R. § 257.

2.1.3 Part 845 Well Installation and Monitoring

In 2021, one additional monitoring well (G54C) was installed between the GMF Pond and the GMF Recycle Pond to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet below ground surface (bgs) as specified in 35 I.A.C. § 845.620(b). Additionally, a porewater sample was collected from a temporary leachate monitoring location (XTPW02) installed within the GMF Pond to characterize the CCR materials.

Prospective Part 845 monitoring wells were sampled for eight rounds from February to August 2021 and the results were assessed for selection of the GMF Pond Part 845 monitoring well network. Groundwater samples were collected and analyzed for 35 I.A.C. § 845.600 parameters as summarized in **Table C** below.

Table C. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

Data and results from the Part 845 background monitoring were included in the water quality discussion included in the HCR (included in the Operating Permit to which this Plan is attached). The data collected from background locations during the Part 845 monitoring were used to evaluate and calculate background concentrations for the GMF Pond. The evaluation and discussion are included in **Section 3.2** of this report.

Data collected from the 40 C.F.R. § 257 monitoring network from 2015 to 2021, and from the Part 845 background monitoring were used for selection of the Part 845 monitoring well network proposed in **Section 2.2**.

2.2 Proposed Part 845 Monitoring Well Network

The groundwater monitoring network proposed in this plan will include seven wells screened in the uppermost aquifer (G02S, G50S, G51S, G54S, G57S, G60S, and G64S), three wells screened in the PMP (G54L, G60L, and G64L), and one temporary water level only monitoring point (X301) that is located in a riser along the south end of the pond for monitoring the phreatic surface within the GMF Pond. The proposed network is summarized in **Table D** below and displayed on **Figure 2-2**. Ten wells (three background and seven compliance) will be used to monitor groundwater concentrations within the hydrostratigraphic units.

The groundwater samples collected from the ten wells will be used to monitor and evaluate groundwater quality and demonstrate compliance with the groundwater quality standards listed in 35 I.A.C. § 845.600(a). The proposed monitoring wells will yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 35 I.A.C. § 845.630(a)(2)). Monitoring well depths and construction details are listed in **Table 2-1** and summarized in **Table D** below.

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Table D. Proposed Part 845 Monitoring Well Network

Well ID	Monitored Unit	Well Screen Interval (feet bgs)	Well Type[1]
G02S	UA	23.0 – 28.0	Background
G50S	UA	29.2 – 34.0	Background
G51S	UA	24.0 – 28.8	Background
G54L	PMP	27.3 – 36.8	Compliance
G54S	UA	43.5 – 48.0	Compliance
G57S	UA	29.7 – 34.2	Compliance
G60L	PMP	20.1 – 24.9	Compliance
G60S	UA	31.1 – 35.9	Compliance
G64L	PMP	18.1 – 27.5	Compliance
G64S	UA	34.5 – 39.0	Compliance
X301[2,3]	CCR	NA	WLO

[1] Well Type refers to the role of the well in the monitoring network.
[2] Well is to be used for water level data collection only.
[3] Location is temporary pending implementation of impoundment closure per an approved Construction Permit Application.
NA = not applicable
UA = uppermost aquifer
WLO = water level only

2.3 Well Abandonment

No wells are currently proposed for abandonment.

3. APPLICABLE GROUNDWATER QUALITY STANDARDS

3.1 Groundwater Classification

Groundwater at the GMF Pond meets the definition of Class I – Potable Resource Groundwater (35 I.A.C. § 620.210), based on the following criteria:

- Groundwater in the uppermost aquifer extends ten feet or more below the land surface.
- Field hydraulic conductivity tests performed in the unlithified geologic materials that include loess, shallow sand, and intermediate sand at the GMF Pond resulted in an overall (geometric mean) horizontal hydraulic conductivity exceeding the 1×10^{-4} centimeters per second (cm/s) criterion.

However, background (upgradient) groundwater originates from areas north and west of the GMF Pond that have been surface mined and present a significant alternative source for groundwater impacts.

3.2 Statistical Evaluation of Background Groundwater Data

A Statistical Analysis Plan (**Appendix A**) has been developed to describe procedures that will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring.

In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality was either the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). A comparison of the statistical background concentrations and groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) and the resulting GWPSs are summarized in **Table 3-1**.

3.3 Applicable Groundwater Protection Standards

The applicable GWPSs will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The results of the statistical analysis of background groundwater data (**Table 3-1**) indicate that most background concentrations in the uppermost aquifer are less than the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1). Therefore, for these parameters, the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) will be applied to the results from the proposed groundwater monitoring network. The exception being lead, where the background concentration is greater than the 35 I.A.C. § 845.600(a)(1) standard (0.015 milligrams per liter [mg/L] versus 0.0075 mg/L). In this instance, the GWPS will be the background concentration.

Under most circumstances, the GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Exceptions are when there are high percentages (greater than 50 percent) of non-detects in compliance well data, for which

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a future mean (for 50 to 70 percent non-detects) or median (for greater than 70 percent non-detects) will be compared to the GWPS. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Evaluation of the applicable standards will occur in conjunction with the analysis of groundwater quality results. Background calculations and the resulting concentrations may be updated as appropriate, in accordance with the Statistical Analysis Plan included in **Appendix A.**

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4. GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards included in 40 C.F.R. § 257.94(e), 40 C.F.R. § 257.95(h), and 35 I.A.C. § 845.600(a). The groundwater monitoring program will include sampling and analysis procedures that are consistent and that provide an accurate representation of groundwater quality at the background and compliance wells as required by 35 I.A.C. § 845.630. As discussed in **Section 2**, three monitoring programs specific to the GMF Pond exist: IEPA WPCP monitoring program, the 40 C.F.R. § 257 monitoring program, and the proposed Part 845 monitoring program. These programs will continue to be monitored as specified in IEPA approvals or 40 C.F.R. § 257. Upon approval of the Operating Permit applications (and by extension the GMP) for the GMF Pond, the monitoring program required by IEPA WPCP will be discontinued following approval of a future permit modification submittal and will be replaced by the proposed Part 845 monitoring program. It is expected that upon USEPA approval of Part 845, the 40 C.F.R. § 257 monitoring program and reporting will be eliminated, and the proposed Part 845 monitoring and reporting included in this Plan will continue until requirements of Part 845 have been achieved.

4.1 Monitoring Networks and Parameters

4.1.1 IEPA Groundwater Monitoring

The existing IEPA monitoring program was discussed in detail in **Section 2.1.1**. Monitoring wells are sampled on a quarterly and yearly frequency for the parameters required under IEPA WPCP 2017-EO-62640. Well locations and parameters will continue to be monitored as required by the WPCP until IEPA approves the Operating Permit (and by extension the GMP) for the GMF Pond.

4.1.2 40 C.F.R. § 257 Groundwater Monitoring

The existing 40 C.F.R. § 257 monitoring program was discussed in detail in **Section 2.1.2**. Seven wells (three background and four compliance) are sampled for Appendix III parameters on a semi-annual frequency. No changes are proposed to this monitoring network. Well locations and parameters will continue to be monitored and reported as required by 40 C.F.R. § 257 until USEPA approves Part 845.

4.1.3 Part 845 Groundwater Monitoring

The proposed Part 845 monitoring network will consist of three background monitoring wells (G02S, G50S, and G51S), seven compliance monitoring wells (G54L, G54S, G57S, G60L, G60S, G64L, and G64S), and one temporary water level only monitoring point (X301) to monitor potential impacts from the GMF Pond (**Figure 2-2**). The monitoring wells are screened within the uppermost aquifer (G02S, G50S, G51S, G54S, G57S, G60S, and G64S) and PMP (G54L, G60L, and G64L) along the perimeter of the GMF Pond. Groundwater samples will be collected and analyzed for the laboratory and field parameters in **Table E** below.

Table E. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential will be recorded during sample collection.

All parameters listed above were sampled a minimum of eight times by October 18, 2021 to establish background groundwater quality in accordance with 35 I.A.C. § 845.650 (b)(1)(A). Discussion of background groundwater quality is included in **Section 3.2**.

4.2 Sampling Schedule

Groundwater sampling for the Part 845 monitoring well network will initially be performed quarterly according to the following schedule:

Table F. Part 845 Sampling Schedule

Frequency	Duration
Monthly (groundwater elevations only)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).
Quarterly (groundwater quality)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii), or upon IEPA approval of an alternate schedule as allowed by 35 I.A.C. § 845.650(b)(4).
Semi-annual (groundwater quality)	Begins: Following 5 years of quarterly groundwater monitoring and IEPA approval of a demonstration that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and not exhibiting statistically-significant increasing trends, monitoring effectiveness is not compromised by a semi-annual schedule, and sufficient data has been collected to characterize groundwater.
	Ends: Following detection of a statistically-significant increasing trend in groundwater concentrations or an exceedance of the standards in 35 I.A.C. § 845.600 (quarterly

	monitoring shall be resumed in these circumstances), or following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).

4.3 Groundwater Sample Collection

Groundwater sampling procedures have been developed and the collection of groundwater samples is being implemented to meet the requirements of 35 I.A.C. § 845.640. In addition to groundwater well samples, quality assurance samples will be collected as described in **Section 4.5** (**Table 4-1**).

4.4 Laboratory Analysis

Laboratory analysis will be performed consistent with the requirements of 35 I.A.C. § 845.640(j) by a state-certified laboratory using methods approved by IEPA and USEPA. Laboratory methods may be modified based on laboratory equipment availability or procedures, but the Reporting Limit (RL) for all parameters analyzed, regardless of method, will be lower than the applicable groundwater quality standard. RLs for the applicable parameters are summarized in **Table 4-2**. Concentrations lower than the RL will be reported as less than the RL.

4.5 Quality Assurance Program

Consistent with the requirements of 35 I.A.C. § 845.640(a)(5), the sampling and analysis program includes procedures and techniques for quality assurance/quality control (QA/QC). Additional quality assurance samples to be collected will include the following:

- Field duplicates will be collected at a frequency of one per group of ten or fewer investigative water samples.
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.
- The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:
  - Regular generation of instrument calibration curves to assure instrument reliability
  - Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
  - Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
  - Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
  - Analysis of method blanks to assure that the system is free of contamination

Water quality meters used to measure pH and turbidity will be calibrated according to manufacturer's specifications. At a minimum, it is recommended that calibration of pH occur daily prior to sampling and checked for accuracy at the end of each day. Unusual or suspect pH measurements during sampling events will be flagged, evaluated, and additional calibration may

be performed throughout the sampling events. Turbidity meters will be checked daily, prior to and following sampling. Unusual measurements or erratic meter performance will be flagged and evaluated for overall effects on the data prior to reporting.

4.6 Groundwater Monitoring System Maintenance Plan

Consistent with the requirements of 35 I.A.C. § 845.630(e)(2), maintenance will be performed as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring wells will be inspected during each groundwater sampling event; inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional
- Checks to assure that well caps are intact and vented, unless in flood-prone areas in which case caps will not be vented
- Annual measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well
- Checks to assure that wells are clear of internal obstructions, and flow freely

If maintenance of a monitoring well cannot address an identified deficiency, a replacement well will be installed.

4.7 Statistical Analysis

Statistical analysis will be consistent with procedures listed in 35 I.A.C. § 845.640(f). A Statistical Analysis Plan, provided in **Appendix A**, has been developed to summarize the statistical procedures that will be used to evaluate the groundwater results.

4.8 Data Reporting

Data reporting for the 40 C.F.R. § 257 monitoring program will be consistent with recordkeeping, notification, and internet posting requirements described in 40 C.F.R. § 257.105 through 257.107.

Groundwater monitoring and analysis completed in accordance with the Part 845 monitoring under an approved monitoring program will be reported to IEPA within 60 days after completion of sampling and the data placed in the facility's operating record as required by 35 I.A.C. § 845.610(b)(3)(D). Within 14 days of posting to the operating record, information will be posted to the publicly accessible internet site "Illinois CCR Rule Compliance Data and Information" as required by 35 I.A.C. § 845.810(d). Information will also be submitted to IEPA annually by January 31 as required by 35 I.A.C. § 845.550, for data collected the preceding year. The report will include the status of the groundwater monitoring and any required corrective action plan for the GMF Pond in addition to other requirements detailed in 35 I.A.C. § 845.610(e).

4.9 Compliance with Applicable On-site Groundwater Protection Standards

In accordance with 35 I.A.C. § 845.600(a)(1), the groundwater protection standard at the waste boundary will be the higher of either the 35 I.A.C. § 845.600 standard or the concentration determined by background groundwater monitoring.

As provided in 35 I.A.C. § 845.780(c)(2), at the end of the 30-year post-closure care period, groundwater monitoring will continue to be conducted in post-closure care until the groundwater results show the concentrations are:

- Below the GWPS in 35 I.A.C. § 845.600; and
- Not increasing for those constituents over background, using the statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g), provided that:
  - Concentrations have been reduced to the maximum extent feasible; and
  - Concentrations are protective of human health and the environment.

Following detection of an exceedance of the GWPS, an Alternate Source Demonstration (ASD) will be evaluated as described in **Section 4.10**.

4.10 Alternate Source Demonstrations

As allowed in 35 I.A.C. § 845.650(e), following detection of an exceedance of the GWPS, an ASD will be evaluated and, if completed, submitted to IEPA within 60 days. The ASD will provide lines of evidence that a source other than the GMF Pond caused the contamination and the GMF Pond did not contribute to the contamination, or that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction.

The ASD will include information and analysis that supports the conclusions and a certification of accuracy by a qualified professional engineer. Once the ASD is approved by IEPA, the Part 845 groundwater monitoring will continue as defined in **Section 4.1.3**.

If an ASD is not completed and submitted, or IEPA does not approve the ASD, a notification of the exceedance will be provided to IEPA and placed in the operating record. Additional actions will also be completed as required by 35 I.A.C § 845.650(d)(1) through (3), including initiation of an assessment of corrective measures under 35 I.A.C § 845.660. As allowed in 35 I.A.C § 845.650(e)(7) a petition for review of IEPA's non-concurrence under 35 I.A.C. § 105 may also be filed.

4.11 Assessment of Corrective Measures and Corrective Action

As described in 35 I.A.C. § 845.660, if the ASD summarized in **Section 4.10** has not been approved by IEPA, an assessment of corrective measures will be initiated within 90 days of the detection of a result exceeding 35 I.A.C. § 845.600 standards (*i.e.,* receipt of laboratory data). The assessment of corrective measures will include at least the following (35 I.A.C. § 845.660 (c)):

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- The time required to begin and complete the corrective action plan; and

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- The institutional requirements, such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the corrective action plan.

Within one year of completing the assessment of corrective measures, a corrective action plan will be developed to identify the selected remedy in accordance with 35 I.A.C. § 845.670. If closure of the CCR Unit is required, a closure alternatives analysis will be completed as specified in 35 I.A.C. § 845.710. The analysis and selected alternative will be submitted to IEPA in a Closure Plan as specified by 35 I.A.C. § 845.720. Groundwater monitoring proposed in this Addendum will continue as specified until the post closure care period has expired and IEPA has approved termination of post-closure care.

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5. REFERENCES

Illinois Environmental Protection Agency, 2021. *Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845.* April 15, 2021.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017a. *Hydrogeologic Monitoring Plan, Duck Creek GMF Pond – CCR Unit ID 203 and Duck Creek Landfill – CCR Unit ID 204.* October 17, 2017.

Natural Resource Technology, an OBG Company. (NRT/OBG), 2017b. *Sampling and Analysis Plan, Final, Duck Creek GMF Pond, Duck Creek Power Station, Canton, Illinois, Project No. 2285, Revision 0.* October 17, 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. *Hydrogeologic Site Characterization Report. Gypsum Management Facility Pond. Duck Creek Power Plant*. Canton, Illinois.

United States Environmental Protection Agency (USEPA), March 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance*. Office of Resource Conservation and Recovery, Program Implementation and Information Division, United States Environmental Protection Agency, Washington D.C. EPA/530/R-09/007.

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TABLES

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TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

GMF POND

CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in GMP
845.630	**Groundwater Monitoring Systems**	
845.630(a)(2)	Potential contaminant pathways must be monitored.	Sections 2.2 & 4.1.3 Table 2-1
845.630(a) 845.630(b) 845.630(c)	At least two upgradient wells and four downgradient wells (min. 1 and 3, but requires additional documentation)	Sections 2.2 & 4.1.3 Table 2-1 Figure 2-2
845.630(a) 845.630(b) 845.630(c)	Downgradient Well Density	Figure 2-2
845.630(a)(2)	Downgradient wells at waste boundary	Figure 2-2
845.640	**Groundwater Sampling and Analysis Requirements**	
845.640(a)	Consistent sampling and analysis procedures	Section 4 Tables 4-1 & 4-2
845.640(b)	Methods are appropriate	Section 4 Tables 4-1 & 4-2
845.640(c)	Groundwater elevations must be measured in each well prior to purging, each time groundwater is sampled.	Section 4.3
845.640 (d)(e)(f)(g)(h)	Establishment of background and application of statistical methods	Sections 3 & 4.7 Appendix A
845.640(i)	Analyze total recoverable metals	Section 4.1.3
845.640(j)	Analyze groundwater samples using a certified laboratory	Section 4.4

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TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

GMF POND

CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in GMP
845.650	**Groundwater Monitoring Program**	
845.650(a)	Must include monitoring for all constituents with a groundwater protection standard in Section 845.600(a), calcium, and turbidity	Section 4.1.3
845.650(b)(c)	Groundwater Monitoring Frequency	Sections 4.1.3 & 4.2
845.650(d)(e)	Exceedances of the groundwater protection standard	Sections 4.9, 4.10, & 4.11
845.650(b)(2) and (3)	Staff gauge/ piezometer to monitor head in impoundment	Sections 2.2 & 4.1.3 Figure 2-1 (X301)
NA	Staff gauge/ piezometer to monitor head of neighboring surface water body	NA

[O: CJC 09/17/21; C: LDC 09/20/21]

Notes:

GMP = Groundwater Monitoring Plan

NA = Not Applicable

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TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	Type	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G02S	B	UA	09/29/2003	--	621.66	Top of Disk	619.18	23.00	28.00	596.18	591.18	28.00	589.20	5	2	40.512879	-89.991105
G50S	B	UA	03/13/2007	623.65	623.65	Top of Riser	620.83	29.17	33.98	591.66	586.85	34.30	586.50	4.8	2	40.508672	-89.990607
G51S	B	UA	01/28/2008	619.66	619.66	Top of Riser	616.83	24.01	28.79	592.82	588.04	29.16	587.70	4.8	2	40.50656	-89.990864
G54L	C	UA/PMP	02/12/2009	622.95	622.95	Top of Riser	620.18	27.32	36.75	592.86	583.43	37.22	583.00	9.4	2	40.504524	-89.988927
G54S	C	UA	02/12/2009	622.98	622.98	Top of Riser	620.25	43.50	47.97	576.75	572.28	48.41	571.80	4.5	2	40.504525	-89.98894
G57S	C	UA	01/30/2009	622.76	622.76	Top of Riser	620.20	29.65	34.18	590.55	586.02	34.62	582.20	4.5	2	40.505608	-89.987043
G60L	C	UA/PMP	01/17/2008	615.39	615.39	Top of Riser	612.69	20.12	24.91	592.57	587.78	25.28	587.40	4.8	2	40.506745	-89.986816
G60S	C	UA	01/16/2008	615.03	615.03	Top of Riser	612.33	31.12	35.91	581.21	576.42	36.29	574.30	4.8	2	40.506732	-89.986815
G64L	C	UA/PMP	01/22/2009	622.46	622.46	Top of Riser	620.24	18.12	27.48	602.12	592.76	27.95	592.30	9.4	2	40.508378	-89.987007
G64S	C	UA	01/22/2009	623.06	623.06	Top of Riser	620.25	34.50	38.99	585.75	581.26	39.48	580.30	4.5	2	40.508365	-89.987011
X301	WLO	S	--	--	--	--	--	--	--	--	--	--	--	--	--	40.504777	-89.990046

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
Type refers to the role of the well in the monitoring network: background (B), compliance (C), or water level measurements only (WLO)
WLO wells are temporary pending implementation of impoundment closure per an approved Construction Permit application
-- = data not available
BGS = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
PVC = polyvinyl chloride
S = source water
UA = uppermost aquifer
UA/PMP = uppermost aquifer/potential migration pathway

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TABLE 3-1. BACKGROUND GROUNDWATER QUALITY AND STANDARDS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Parameter	Background Concentration	845 Limit	Groundwater Protection Standard	Unit
Antimony, total	0.003	0.006	0.006	mg/L
Arsenic, total	0.0092	0.010	0.010	mg/L
Barium, total	0.28	2.0	2.0	mg/L
Beryllium, total	0.001	0.004	0.004	mg/L
Boron, total	0.21	2	2	mg/L
Cadmium, total	0.001	0.005	0.005	mg/L
Chloride, total	17	200	200	mg/L
Chromium, total	0.0059	0.1	0.1	mg/L
Cobalt, total	0.002	0.006	0.006	mg/L
Fluoride, total	0.498	4.0	4.0	mg/L
Lead, total	0.015	0.0075	0.015	mg/L
Lithium, total	0.02	0.04	0.04	mg/L
Mercury, total	0.00098	0.002	0.002	mg/L
Molybdenum, total	0.0023	0.1	0.1	mg/L
pH (field)	7.4 / 6.6	9.0 / 6.5	9.0 / 6.5	SU
Radium 226 and 228 combined	2	5	5	pCi/L
Selenium, total	0.0012	0.05	0.05	mg/L
Sulfate, total	55	400	400	mg/L
Thallium, total	0.001	0.002	0.002	mg/L
Total Dissolved Solids	483	1200	1200	mg/L

Notes:
For pH, the values presented are the upper / lower limits
Groundwater protection standards for calcium and turbidity do not apply per 35 I.A.C. § 845.600(b)
mg/L = milligrams per liter
SU = standard units
pCi/L = picocuries per liter

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TABLE 4-1. SAMPLING AND ANALYSIS SUMMARY
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Parameter	Analytical Method [1]	Number of Samples	Field Duplicates [2]	Field Blanks [3]	Equipment Blanks [3]	MS/MSD [4]	Total	Container Type	Minimum Volume [5]	Preservation (Cool to 4 °C for all samples)	Sample Hold Time from Collection Date
Metals											
Metals [6]	6020, Li - EPA 200.7	10	1	0	0	1	12	plastic	600 mL	HNO_3 to pH<2	6 months
Mercury	7470A or 6020	10	1	0	0	1	12	plastic	400 mL	HNO_3 to pH<2	28 days
Inorganic Parameters											
Fluoride	9214 or EPA 300	10	1	0	0	1	12	plastic	300 mL	Cool to 4 °C	28 days
Chloride	9251 or EPA 300	10	1	0	0	1	12	plastic	100 mL	Cool to 4 °C	28 days
Sulfate	9036 or EPA 300	10	1	0	0	1	12	plastic	50 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540 C	10	1	0	0	1	12	plastic	200 mL	Cool to 4 °C	7 days
Radium											
Radium 226	9315 or EPA 903	10	0	0	0	0	10	plastic	1000 mL	HNO_3 to pH<2	6 months
Radium 228	9320 or EPA 904	10	0	0	0	0	10	plastic	1000 mL	HNO_3 to pH<2	6 months
Field Parameters											
pH	SM 4500-H+ B	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Dissolved Oxygen [8]	SM 4500-O/405.1	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Temperature [8]	SM 2550	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential [8]	SM 2580 B	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Specific Conductance [8]	SM 2510 B	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Turbidity [7]	SM 2130 B	10	NA	NA	NA	NA	10	flow-through cell or hand-held turbidity meter	NA	none	immediately

[O: CJC 09/17/21; C: LDC 09/20/21]

Notes:
[1] Analytical method numbers are from SW-846 unless otherwise indicated. Analytical methods may be updated with more recent versions as appropriate.
[2] Field duplicates will be collected at a frequency of one per group of 10 or fewer investigative water samples. Field duplicates will not be collected for radium analysis.
[3] Field blanks will be collected at the discretion of the project manager; Equipment blanks will be collected at a rate of 1 per sampling event if non-dedicated equipment is used.
[4] Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer investigative water samples per CCR unit/multi-unit. Additional volume to be determined by laboratory.
[5] Sample volume is estimated and will be determined by the laboratory.
[6] Metals = antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, lead, lithium, molybdenum, selenium, thallium. Metals may be analyzed via ICP/ ICP-MS USEPA methods 6010 or 6020 depending on laboratory instrument availability
[7] If turbidity exceeds 10 NTUs, a duplicate sample filtered through a .45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
[8] Parameter collected for quality assurance and quality control for field sampling purposes only; not required to be collected or reported under Part 845; collection of parameter may be discontinued without notification.
< = less than
°C = degrees Celsius
GMF = Gypsum Management Facility
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
NTU = nephelometric turbidity unit

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TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

GMF POND

CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Metals							
Antimony	7440-36-0	mg/L	6020	0.006	0.006	0.003	0.00036
Arsenic	7440-38-2	mg/L	6020	0.01	0.01	0.001	0.00013
Barium	7440-39-3	mg/L	6020	2	2	0.001	0.00028
Beryllium	7440-41-7	mg/L	6020	0.004	0.004	0.001	0.000017
Boron	7440-42-8	mg/L	6020	NS	2	0.01	0.0023
Cadmium	7440-43-9	mg/L	6020	0.005	0.005	0.001	0.000042
Calcium	7440-70-2	mg/L	6020	NS	NS	0.15	0.15
Chromium	7440-47-3	mg/L	6020	0.1	0.1	0.004	0.00027
Cobalt	7440-48-4	mg/L	6020	0.006	0.006	0.002	0.000017
Lead	7439-92-1	mg/L	6020	0.015	0.0075	0.001	0.000025
Lithium	7439-93-2	mg/L	6020 or EPA 200.7	0.04	0.04	0.02	0.0001
Mercury	7439-97-6	mg/L	6020 or 7470A	0.002	0.002	0.0002	0.000078
Molybdenum	7439-98-7	mg/L	6020	0.1	0.1	0.001	0.000063
Selenium	7782-49-2	mg/L	6020	0.05	0.05	0.001	0.00032
Thallium	7440-28-0	mg/L	6020	0.002	0.002	0.001	0.000062
Inorganics							
Fluoride	7681	mg/L	9214 or EPA 300	4	4	0.25	0.065
Chloride	16887-00-6	mg/L	9251 or EPA 300	250 [3]	200	1	0.15
Sulfate	18785-72-3	mg/L	9036 or EPA 300	250 [3]	400	1	0.24
Total Dissolved Solids	10052	mg/L	SM 2540C	500 [3]	1200	17	--
Other							
Radium 226 and 228 combined	7440-14-4	pCi/L	9315/9320 or EPA 903/904	5	5	-- [6]	-- [7]

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TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

GMF POND

CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Field							
pH	NA	SU	SM 4500-H+ B	NS	6.5-9.0	NA	NA
Oxidation/Reduction Potential	NA	mV	SM 2580 B	NS	NS	NA	NA
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	NS	NS	NA	NA
Temperature	NA	°C	SM 2550	NS	NS	NA	NA
Specific Conductivity	NA	µS/cm	SM 2510 B	NS	NS	NA	NA
Turbidity	NA	NTU	SM 2130 B	NS	NS	NA	NA

[O: CJC 09/17/21; C: LDC 09/20/21]

Notes:

[1] Analytical method numbers are from SW-846 unless otherwise indicated. Metals will be analyzed via Method 6020 or 6010 depending on laboratory equipment availability. Selected method will ensure reporting limits (RL) are below Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600 groundwater protection standards.

[2] USEPA MCL = United States Environmental Protection Agency Maximum Contaminant Level.

[3] USEPA SMCL = United States Environmental Protection Agency Secondary Maximum Contaminant Level.

[4] RLs will be less than the 35 I.A.C. § 845.600 groundwater protection standards.

[5] RLs and method detection limits (MDL) will vary depending on the laboratory performing the work.

[6] All radium results will be reported (values may be positive or negative) and will include uncertainty and the calculated MDC.

[7] Laboratories calculate a minimum detectable concentration (MDC) based on the sample.

°C = degrees Celsius

µS/cm = microSiemens per centimeter

CAS = Chemical Abstract Number

MDL = Method detection limit as established by the laboratory

mg/L = milligrams per liter

mV = millivolts

NS = No standard

NTU = nephelometric turbidity unit

pCi/L = picoCuries per liter

RL = Reporting limit as established by the laboratory

SM = Standard Methods for the Examination of Water and Wastewater

SU = standard units

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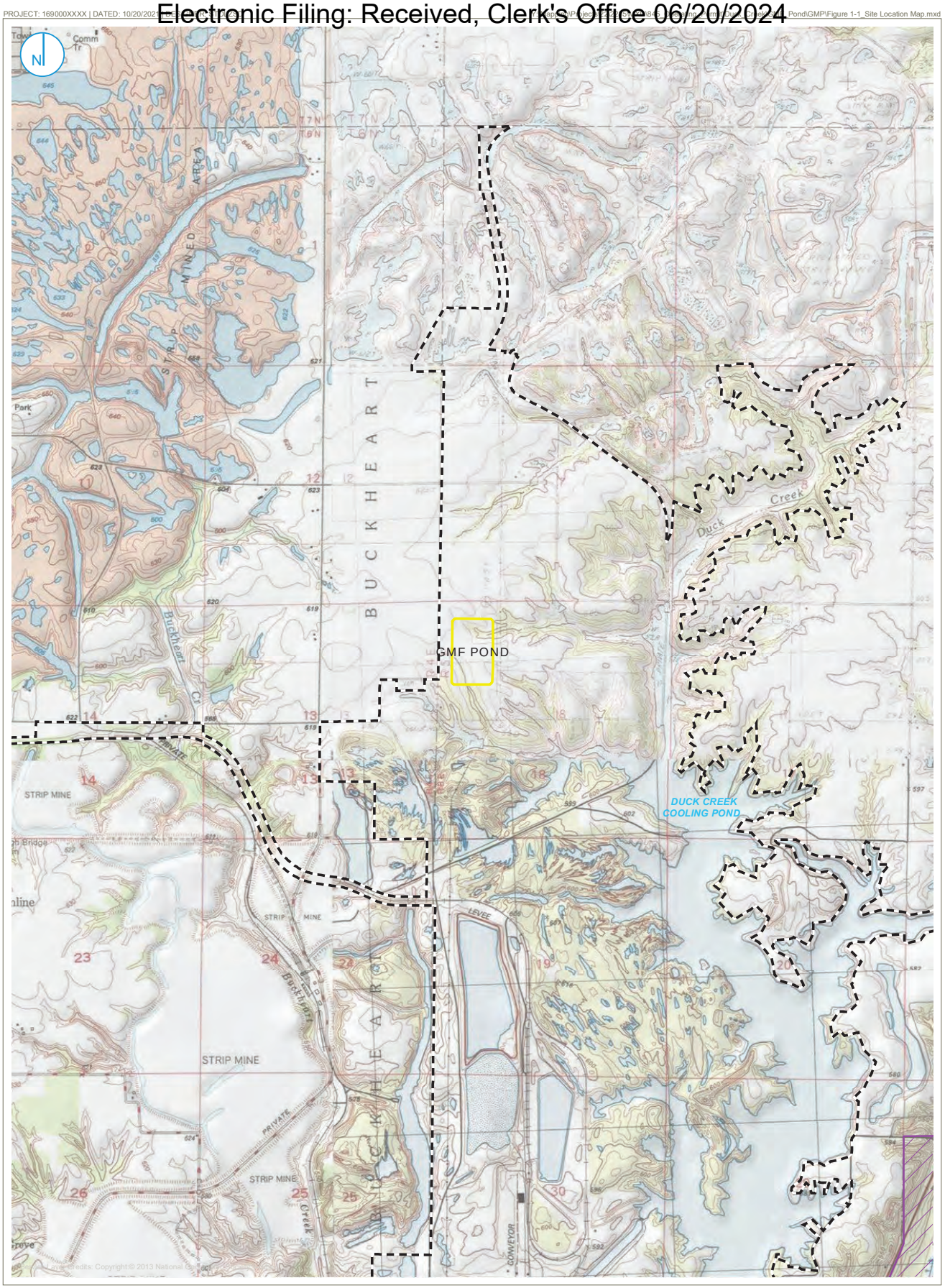
PROJECT: 169000XXXX | DATED: 10/20/2023 | DESIGNED BY: [illegible] | CHECKED BY: [illegible] | G:\Projects\Projects_[illegible]\Duck Creek Pond\GMP\Figure 1-1_Site Location Map.mxd


N
GMF POND
DUCK CREEK COOLING POND
BUCKHEART
STRIP MINE
STRIP MINE
STRIP MINE
LEVEE
CONVEYOR
PRIVATE
Buckheart Ck
Duck Creek
MINED AREA
Park
Comm Tr
Bridge
Creek
Duck
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Buckheart

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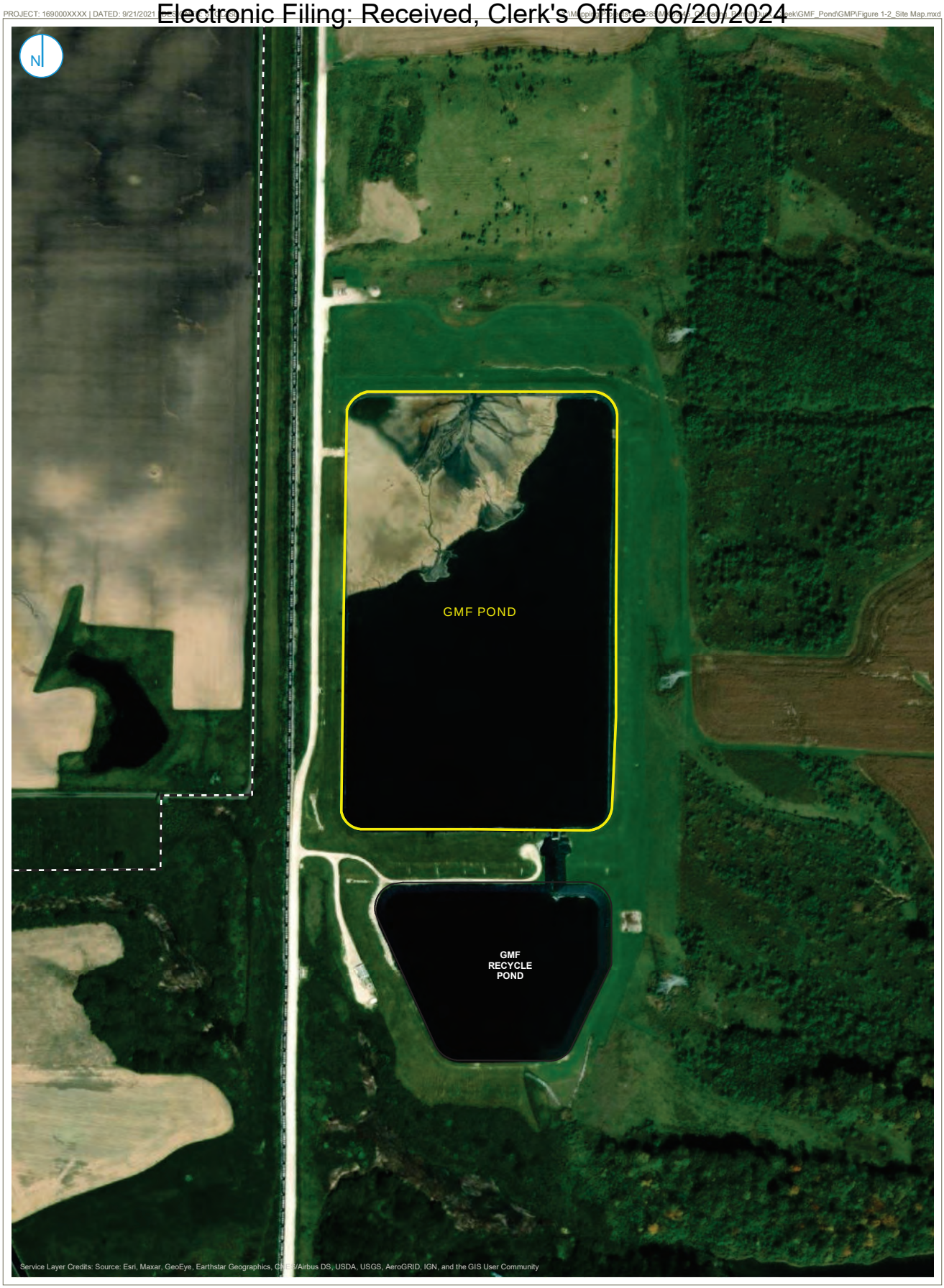
PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGNED BY: CLEAS | A:\Mapping\Projects\169000XXXX\Cleveland_Permit\Duck_Creek\GMF_Pond\GMP\Figure 1-2_Site Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SITE MAP

FIGURE 1-2

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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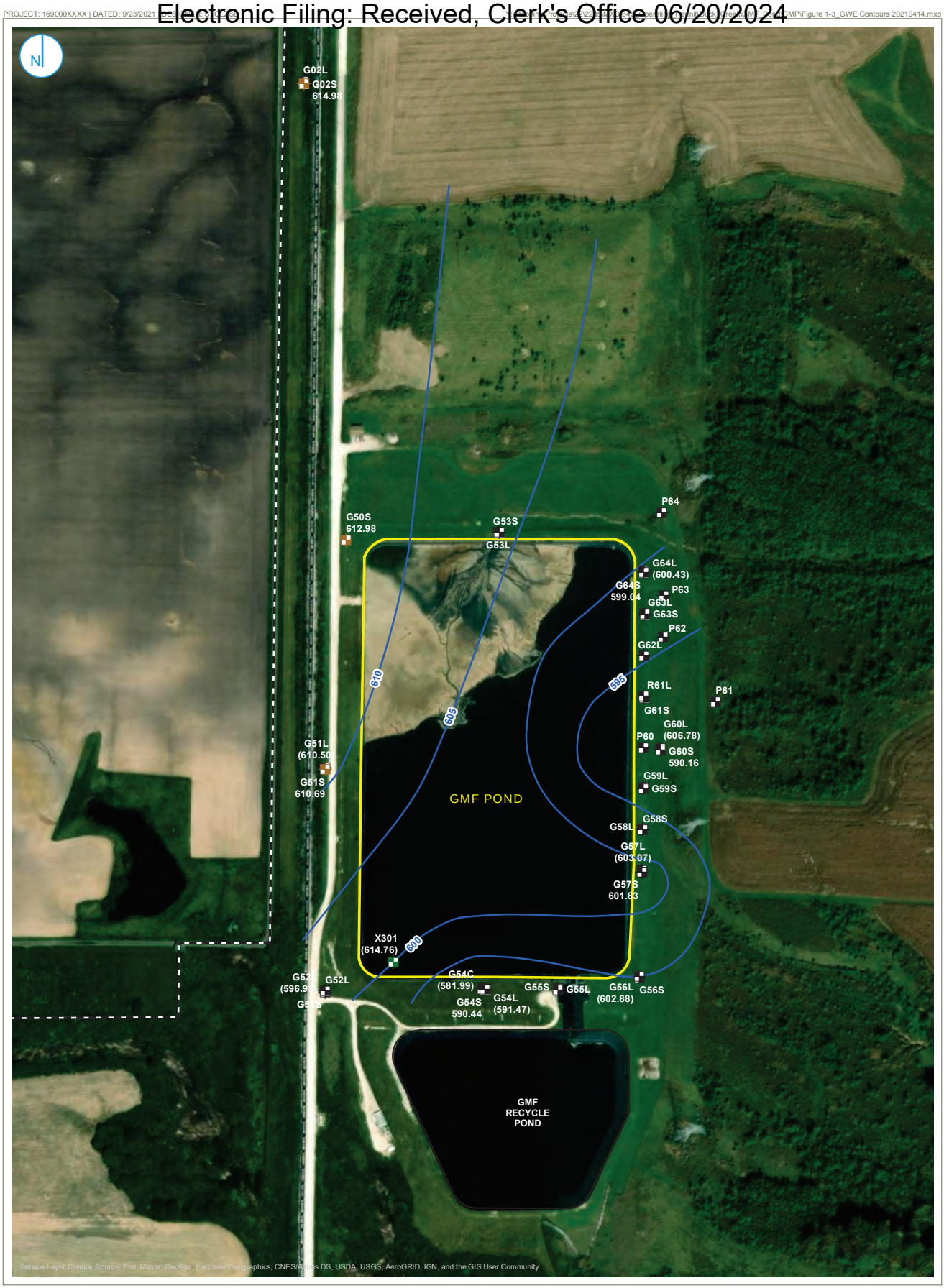
PROJECT: 169000XXXX | DATED: 9/23/2021 | DESIGN: CLERK | Q:\Projects\2021\2100XX\2100XX84\Operating Permit\Duck Creek GMP\Figure 1-3_GWE Contours 20210414.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS APRIL 14, 2021

FIGURE 1-3

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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MONITORING WELL
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

IEPA MONITORING PROGRAM WELL NETWORK

FIGURE 2-1

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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PROJECT: 169000XXXX | DATED: 10/18/2021 | DESIGNED BY: [illegible] | Proposed 845 GW Monitoring Well Network.mxd



BACKGROUND WELL
COMPLIANCE WELL
SOURCE SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

PROPOSED PART 845 GROUNDWATER MONITORING WELL NETWORK

FIGURE 2-2

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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APPENDIX A
STATISTICAL ANALYSIS PLAN

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Prepared for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

STATISTICAL ANALYSIS PLAN

GYPSUM MANAGEMENT FACILITY POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

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STATISTICAL ANALYSIS PLAN
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND

Project Name	**Duck Creek Power Plant Gypsum Management Facility Pond**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Statistical Analysis Plan**
Version	**FINAL**
Date	**October 25, 2021**

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Eric J. Tlachac, PE
Senior Managing Engineer

Rachel A. Banoff, EIT
Project Statistician

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LICENSED PROFESSIONAL CERTIFICATIONS

This certification is based on the description of the statistical methods selected to evaluate groundwater as presented in the following Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond. The procedures described in the plan will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in the United States Environmental Protection Agency (USEPA)'s *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring. In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality will be either the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). Groundwater Protection Standards (GWPS) will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Description of the statistical methods chosen for analysis of groundwater monitoring data and application of these methods for determining exceedances of the GWPS identified in 35 I.A.C. § 845.600(a) is provided in this Statistical Analysis Plan.

35 I.A.C. § 845.640 Statistical Analysis (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the statistical methods summarized above and described in this document (Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.



Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

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35 I.A.C. § 845.640 Statistical Analysis (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.



Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

35 I.A.C. § 845.640 Statistical Analysis

I, Rachel A. Banoff, a qualified professional, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond), are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Rachel A. Banoff, EIT
Project Statistician
Date: October 25, 2021

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TABLES (IN TEXT)

Table A Statistical Calculations Used in Compliance Monitoring Procedures

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ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
ANOVA	analysis of variance
CCR	coal combustion residuals
COC	constituents of concern
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
LTL	lower tolerance limit
MSE	mean squared error
P	probability
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
ROS	regression on order statistics
SI	surface impoundment
SSI	statistically significant increase
SWFPR	site-wide false positive rate
Unified Guidance	*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009)
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

In April 2021, the Illinois Environmental Protection Agency (IEPA) issued a final rule for the regulation and management of Coal Combustion Residuals (CCR) in surface impoundments (SIs) under the Standards for the Disposal of CCR in Surface Impoundments: Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845). Facilities regulated under Part 845 are required to develop and sample a groundwater monitoring well network to evaluate whether impounded CCR materials are impacting downgradient groundwater quality. The groundwater quality evaluation must include selection and certification by a qualified professional engineer of the statistical procedures to be used. The procedures described in the evaluation will be used to establish background conditions and implement compliance and corrective action monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. This Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA's) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance*) (March 2009).

This Statistical Analysis Plan does not include procedures for groundwater sample collection and analysis, as these activities are conducted in accordance with the Sampling and Analysis Plan prepared for each CCR unit in accordance with 35 I.A.C. § 845.640. This Statistical Analysis Plan will be used as the primary reference for evaluating groundwater quality during operation and post-closure care.

1.1 Statistical Analysis Objectives

This Statistical Analysis Plan is intended to provide a logical process and framework for conducting the statistical analyses of data obtained during groundwater monitoring conducted in accordance with the Sampling and Analysis Plan for each CCR unit. The Statistical Analysis Plan will enable a qualified professional engineer to certify that the selected statistical methods are appropriate for evaluating the groundwater monitoring data for the applicable CCR unit(s).

1.2 Statistical Analysis Plan Approach

The main sections of this Statistical Analysis Plan should be viewed as a "generic" outline of statistical methods utilized for each CCR unit and constituent required to be monitored. The statistical analysis of the groundwater monitoring data, however, will be conducted on an individual-constituent or well basis, and may involve the use of appropriate statistical procedures depending on multiple factors such as detection frequency and normality distributions.

The CCR Rule outlines two phases of groundwater monitoring:

- Background Monitoring in accordance with 35 I.A.C. § 845.650(b)(1)
- Compliance Monitoring in accordance with 35 I.A.C. § 845.650

Each phase of the groundwater monitoring program requires specific statistical procedures to accomplish the intended purpose. During the background monitoring phase, background groundwater quality will be established utilizing upgradient and background wells and downgradient groundwater quality data will be collected to facilitate statistics in subsequent phases. Compliance Monitoring is then initiated through the evaluation of the downgradient

groundwater monitoring data for exceedances of the groundwater protection standard (GWPS) established by Part 845 (concentration specified in 35 I.A.C. § 845.600 or an IEPA-approved background concentration). The developed statistical analysis plan will be implemented for each monitoring phase and in accordance with the statistical procedures.

2. BACKGROUND MONITORING AND DATA PREPARATION

The background and compliance monitoring wells were sampled and analyzed for constituents, as listed in Part 845 (antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, pH, radium 226 and 228 combined, selenium, sulfate, thallium, total dissolved solids, and turbidity), during the baseline phase of the groundwater monitoring program.

The background monitoring well(s) were placed upgradient of the CCR unit, or at an alternative background location, where they are not affected by potential leakage from the CCR unit. Compliance monitoring wells were placed at the waste boundary of the CCR unit, along the same groundwater flow path. As 35 I.A.C. § 845.630(a) specifies, the location of these wells ensures that background accurately represents the quality of unaffected groundwater, while compliance wells accurately represent groundwater quality at the waste boundary and monitor all potential contaminant pathways.

As required by 35 I.A.C. § 845.650(a)(1), eight sampling events were completed within 180 days of April 21, 2021. As outlined, groundwater sampling procedures included sampling of the background and compliance wells using low-flow sampling methods, collection of one field quality control sample per event, and groundwater samples were not field filtered before laboratory analysis of total recoverable metals.

Following completion of the eight sampling events, background groundwater quality was established for Part 845 constituents. Groundwater monitoring will be conducted quarterly for at least the first five years. In accordance with 35 I.A.C. § 845.650(b)(4), after the first five years, a request to reduce the monitoring frequency to semiannual may be submitted to IEPA if all of the following can be demonstrated:

- Groundwater monitoring effectiveness will not be compromised by the reduced frequency
- Sufficient data has been collected to characterize groundwater
- Monitoring to date does not show any statistically significant increasing trends
- The concentrations of monitored constituents at the compliance monitoring wells are below the applicable GWPSs established in 35 I.A.C. § 845.600

The following subsections outline the statistical tests and procedures (methods) that will be utilized to evaluate data collected for each constituent in both background and compliance wells for Background and Compliance Monitoring. When necessary and contingent upon equivalent statistical power, an alternative test not included in this Statistical Analysis Plan may be chosen due to site-specific data requirements.

2.1 Sample Independence

Independence of sample results is a major assumption for most statistical analyses. To ensure physical independence of groundwater sampling results, the minimum time between sampling events must be longer than the time required for groundwater to move through the monitoring well. The sampling schedules for both the baseline and compliance monitoring periods are specified in 35 I.A.C. § 845.650(b) and may conflict with the statistical assumption of independence of sample results.

2.2 Non-Detect Data Processing

The reporting limit (RL) will be used as the lower level for the reporting of non-detected groundwater quality data. For all summary statistics (box plots, timeseries, etc.), the RL will be substituted for concentrations reported below the RL, including non-detects. With professional judgement, analytical results between the RL and the method detection limit, *i.e.,* estimated values, typically identified with a "J" flag, may be utilized if provided by the laboratory.

For all statistical test procedures:

- If the frequency of non-detect data are less than or equal to 15 percent, half of the RL will be substituted for these data
- If the non-detect frequency is between 15 percent and 50 percent, either the Kaplan-Meier or robust regression on order statistics (ROS) will be used to estimate the mean and standard deviation adjusted for the presence of left-censored values
- If the non-detect frequency is greater than 50 percent, a non-parametric test will be used
- If only one background result is detected that value will be used as the non-parametric upper prediction limit (UPL)

2.3 Testing for Normality

Many statistical analyses assume that sample data are normally distributed (parametric). However, environmental data are frequently not normally distributed (nonparametric). 35 I.A.C. § 845.640(g) requires the knowledge of the background data distribution for comparison to compliance results. The *Unified Guidance* document recommends the Shapiro-Wilk normality test for sample sizes of 50 or less, and the Shapiro-Francia normality test for sample sizes greater than 50.

When possible, transformation of datasets to achieve normal distributions is preferred.

2.4 Testing for Outliers

Part 845 constituents will be screened for the existence of outliers using a method described by the *Unified Guidance*. Outliers are extreme data points that may represent an anomaly or erroneous data point. To test for outliers, one or more of the following outlier tests will be utilized:

- Dixon's test, for well-constituent pairs with less than 25 samples, assumes normally distributed data.
- Rosner's test, for well-constituent pairs with more than 20 samples, assumes normally distributed data.
- Grubb's test for well-constituent pairs with seven or more samples, assumes normally distributed data.
- Time series, box-whisker plots, and probability plots provide visual tools to identify potential outliers, and evaluation of seasonal, spatial, or temporal variability for both normally and non-normally distributed data.

Data quality control, groundwater geochemistry, and sampling procedures will be evaluated as potential sources of error leading to an outlier result. The outlier tests cannot be used alone to determine whether a value is a true outlier that should be excluded from future statistical

analysis. Corroborating evidence needed to exclude values includes a discrete data reporting or analytical error, or potential laboratory bias. Absent corroborating evidence, the flagged values are considered true, but extreme, values in the data set. Professional judgement will be used to exclude extreme outliers from further statistical analyses. Outliers will be retained in the database.

With professional judgement, a confirmatory sample may be collected to allow for the distinction between an outlier and a true representation of groundwater quality at the monitoring point. If re-sampling is conducted, this sample will be collected within 90 days following outlier identification. If the confirmatory sample indicates the original result as an outlier, it will be reported as such.

2.5 Trend Analysis

Statistical analyses supporting the lack of trend are a fundamental step to confirm the assumption that groundwater quality values are stationary or constant over time at a CCR unit. These analyses allow for evaluation of variation in the background and compliance data for each constituent over time. A statistically significant increasing trend in background data could indicate an existing release from the CCR unit or alternate source, requiring further investigation. In addition, statistically significant trending background data can result in increased standard deviation and, therefore, greater prediction or control limits. Consequently, the increased prediction or control limit will have less power or ability to identify a release from the CCR unit.

A linear regression, coupled with a t-test for slope significance at a 95 percent confidence level (0.05 significance level), may be used on datasets for each constituent with few non-detects and a normally distributed variance of the mean to evaluate time trends. The Theil-Sen trend line, coupled with the Mann-Kendall test for slope significance at a 95 percent confidence level (0.05 significance level), will be used for datasets with frequent non-detects or non-normal variance. Similarly, trend analyses could also be used on compliance data to evaluate a possible release from the CCR unit.

2.6 Spatial Variation

Spatial trends and/or variation between background wells could indicate an existing release from a CCR unit. If the spatial variability is not due to an existing release, intrawell comparisons in compliance wells may be used to account for spatial variability and monitor for a future release. However, the CCR unit being monitored was placed into service prior to the start of groundwater monitoring and it is unknown whether a previous release has occurred. Accordingly, intrawell comparisons in compliance wells cannot be used to determine the occurrence of a future release. Interwell comparisons between compliance wells and background wells will be used.

2.7 Temporal Variation

Time series plots can be used to identify temporal dependence. Potentially significant temporal components of variability can be identified by graphing single constituent data from multiple wells together on a time series plot. With temporal dependence, the time series plot as a pattern of parallel traces, in which the individual wells will tend to rise and fall together across the sequence of sampling dates. Time series plots can be helpful by plotting multiple constituents over time for the same well, or averaging values for each constituent across wells on each sampling event and then plotting the averages over time. In either case, the plots can signify whether the general concentration pattern over time is simultaneously observed for different

constituents. If so, it may indicate that a group of constituents is highly correlated in groundwater or that the same artifacts of sampling and/or lab analysis impacted the results of several monitoring parameters.

Hydrologic factors such as drought, recharge patterns or regular (*e.g.,* seasonal) water table fluctuations may be responsible for the temporal variation. In these cases, it may be useful to test for the presence of a significant temporal effect by first constructing a parallel time series plot and then running a formal one-way analysis of variance (ANOVA) ($\alpha = 0.05$) for temporal effects. A one-way ANOVA for temporal effects considers multiple well data sets for individual sampling events or seasons as the relevant statistical factor. If event-specific analytical differences or seasonality appear to be an important temporal factor, the one-way ANOVA for temporal effects can be used to formally identify seasonality, parallel trends, or changes in lab performance that affect other temporal effects. The one-way ANOVA for temporal effects assumes that the data groups are normally distributed with constant variance. It is also assumed that for each of a series of background wells, measurements are collected at each well on sampling events or dates common to all the wells. Results of the ANOVA can also be used to create temporally stationary residuals, where the temporal effect has been 'subtracted from' the original measurements. These stationary residuals may be used to replace the original data in subsequent statistical testing.

If the data cannot be normalized, a similar test for a temporal or seasonal effect can be performed using the Kruskal-Wallis test ($\alpha = 0.05$). Each sampling event should be treated as a separate 'well,' while each well is treated as a separate 'sampling event.' In this case, no residuals can be computed since the Kruskal-Wallis test employs ranks of the data rather than the measurements themselves.

Where both spatial and temporal variation occur, two-way ANOVA can be considered where both well location and sampling event/season are treated as statistical factors. This procedure is described in Davis (1994).

2.8 Updating Background

Updating the background dataset periodically by adding recent results to an existing background dataset can improve the statistical power and accuracy of the statistical analysis, especially for non-parametric prediction intervals. The *Unified Guidance* recommends updating statistical limits (background) when at least four to eight new measurements (every 1 to 2 years under a quarterly monitoring program), are available for comparison to historical data. Professional judgement will be used to evaluate whether any background data appear to be affected by a release and need to be excluded from a background update. A t-test for equal means (if normal data distribution) or appropriate non-parametric test (if non-normal data distribution) such as a Mann-Whitney (or Wilcoxon) rank-sum or box-whisker plots, will be conducted to evaluate whether the two groups of background sample populations are statistically different prior to updating any background datasets. A 0.05 significance level will be utilized when evaluating the two populations, with the null hypothesis that they are equivalent. In addition, time series graphs or other trend evaluation statistics will be conducted on the new background dataset to verify the absence of a release or changing groundwater quality. If the tests indicate that there are no statistical differences between the two background populations, the new data will be combined with the existing dataset. If the two populations are found to be different, the data will be reviewed to evaluate the cause of the difference. If the differences appear to be caused by a

release (if the new data are significantly higher, or lower for pH), then the previous background dataset may continue to be used. Furthermore, verified outliers will not be added to an existing background dataset. In accordance with the *Unified Guidance*, continual background updates will not be conducted due to the lack of sufficient samples for a statistical comparison.

3. COMPLIANCE MONITORING

Compliance monitoring is designed to monitor groundwater for evidence of a release by comparing Part 845 constituents in compliance wells to both background concentrations and the GWPS. Compliance Monitoring will begin the 1st quarter following approval of this Groundwater Monitoring Plan and issuance of the Operating Permit. The selected Compliance Monitoring statistical method used to compare compliance groundwater quality data for each constituent to the GWPS will provide for adequate statistical power, error levels and individual test false positive rates, and be appropriate for the distribution and detection frequency of the background dataset. Statistical power is the ability of a statistical test to detect a true exceedance.

In accordance with 35 I.A.C. § 845.610(b)(3)(D), compliance monitoring statistical analyses will be completed and submitted to IEPA within 60 days after completion of sampling.

3.1 GWPS Establishment and Exceedance Determination

In accordance with 35 I.A.C. § 845.600(a), the GWPS will be the constituent concentrations specified in 35 I.A.C. § 845.600(a)(1) except for when the background concentration is greater, or no concentration is specified (*i.e.,* for calcium and turbidity), in which case the GWPS will be the background concentration. The GWPS based on background concentration will be calculated using a parametric upper tolerance limit (UTL), a parametric UPL for a future mean, or a non-parametric UPL for a future median.

Statistical calculations that will be utilized in Compliance Monitoring procedures are summarized in **Table A** below and listed in **Sections 3.1.1** through **3.1.7**. Depending on the distribution of the data and the percentage of non-detects, it may be more appropriate to use a parametric model over a non-parametric model. As necessary, other techniques as mentioned in the *Unified Guidance* and/or new methods will be implemented.

Table A. Statistical Calculations Used in Compliance Monitoring Procedures

Compliance Monitoring						
Significant Trend?	Background Data			Compliance Data		
	Percent Non-Detects	Distribution	GWPS Determination	Percent Non-Detects	Distribution	Method to Determine Exceedance
No	0 ≤ 50	Normal	35 I.A.C § 845.600(a)(1) constituent concentration or The Upper Tolerance Limit	≤75	Normal	Parametric Lower Confidence Limit around a Normal Mean
				≤75	Log-Normal	Parametric Lower Confidence Limit around a Lognormal Geometric Mean
				NA	Non-Normal	Non-Parametric Lower Confidence Limit around a Median
				>75	Unknown/ Cannot be determined	
	50 ≤ 70	Normal	The Upper Prediction Limit for a Future Mean	NA	NA	Future mean
	>70	Non-Normal	Upper Prediction Limit for a Future Median	NA	NA	Future median
	100	Non-Normal	Double Quantification Rule	NA	NA	Individual Retesting Values
Yes	0 ≤ 50	Normal	UCL of Confidence Band around Linear Regression	≤75	Residuals after subtracting trend are normal, equal variance	Lower Limit from Confidence Band around Linear Regression
	50 ≤ 100	Non-Normal	UCL of Confidence Band around Thiel-Sen trend line	≤75	Residuals not normal	Lower Limit from Confidence Band around Thiel-Sen

3.1.1 The Upper Tolerance Limit

The UTL will be used to calculate the GWPS when pooled background data are normally distributed, with a non-detect frequency of 50 percent or less. When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects. The *Unified Guidance* recommends 95 percent confidence level and 95 percent coverage (95/95 tolerance interval).

- When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects (simple substitution), and the normal mean and standard deviation will be calculated.

- The Kaplan-Meier or the ROS method will be used when the detection frequency is between 15 percent and 50 percent. The Kaplan-Meier method assesses the linearity of a censored probability plot to determine whether the background sample can be approximately normalized. If so, then the Kaplan-Meier method will be used to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. The Kaplan-Meier or ROS estimate of the mean and standard deviation will be substituted for the sample mean and standard deviation.
- If background normality cannot be achieved, non-parametric UTLs will not be calculated until a minimum of 60 background samples have been collected (to achieve 95 percent coverage).

The parametric UTL on a future mean will be calculated from the background dataset as follows:

$$UTL = \overline{x} + \kappa\,(n, \gamma, \alpha - 1) \cdot s$$

$\overline{x}$ = background sample mean

s = background sample standard deviation

$\kappa\,(n, \gamma, \alpha - 1)$ = one-sided normal tolerance factor based on the chosen coverage (γ) and confidence level (α -1) and the size of the background dataset (n). Values are tabulated in Table 17-3 in Appendix D of the *Unified Guidance*. If exact values are not provided, then κ values can be estimated by linear interpolation.

If the UTL is constructed on the logarithms of original observations to achieve normality, where $\overline{y}$ and s_y are the log-mean and log-standard deviation, the limit will be exponentiated for back-transformation to the concentration scale as follows:

$$UTL = \exp\left[\overline{y} + \kappa\,(n, \gamma, \alpha - 1) \cdot s_y\right]$$

$\overline{y}$ = background sample log-mean

s_y = background sample log-standard deviation

When the GWPS is based on the 35 I.A.C. § 845.600(a)(1) constituent concentrations or a UTL derived from the background dataset, an exceedance in compliance wells relative to the GWPS will be evaluated using confidence intervals. A confidence interval defines the upper and lower bound of the true mean of a constituent concentration in groundwater within a specified confidence range.

- Non-detects in compliance data will be handled similarly to upgradient analyses, with half the RL substituted for non-detects when the frequency is 15 percent or less.
- The Kaplan-Meier, or the ROS method, will be used when the detection frequency is between 15 percent and 50 percent to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. These estimates will then be substituted for the sample mean and standard deviation.

Once the GWPS is established for background data using the UTL, either parametric or non-parametric confidence intervals will be computed for each constituent in compliance wells to identify GWPS exceedances.

3.1.2 Parametric Confidence Intervals around a Mean

If compliance data are approximately normal, one-sided parametric confidence intervals around a sample mean will be constructed for each constituent and well pair. The lower confidence limit (LCL) will be calculated as:

$$LCL_{1-\alpha} = \overline{x} - t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

$\overline{x}$ = compliance sample mean

s = compliance sample standard deviation

n = compliance sample size

$t_{1-\alpha,n-1}$ = obtained from a Student's t-table with (n–1) degrees of freedom (Table 16-1 in Appendix D of the *Unified Guidance*)

The chosen t value will aim to achieve both a low false-positive rate, and high statistical power. Minimum α values are tabulated in Table 22-2 of Appendix D of the *Unified Guidance*. The selected minimum α value, from which the t value will be derived, will have at least 80 percent power (1-β = 0.8) when the underlying mean concentration is twice the GWPS.

If compliance data are distributed lognormally, the LCL will be computed around the lognormal geometric mean as:

$$LCL_{1-\alpha} = \exp\left(\overline{y} - t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

$\overline{y}$ = compliance sample log-mean

s_y = compliance sample log-standard deviation

3.1.3 Non-Parametric Confidence Intervals around a Median

Non-parametric confidence intervals around the median will be computed if the compliance data contain greater than 50 percent non-detects or are not normally distributed. The mathematical algorithm used to construct non-parametric confidence intervals is based on the probability (*P*) that any randomly selected measurement in a sample of n concentration measurements will be less than an unknown *P* x 100th percentile of interest (where *P* is between 0 and 1). Then the probability that the measurement will exceed the *P* x 100th percentile is (1–*P*). The number of sample values falling below the *P* x 100th percentile out of a set of n should follow a binomial distribution with parameters n and success probability *P*, where 'success' is defined as the event that a sample measurement is below the *P* x 100th percentile. The probability that the interval formed by a given pair of order statistics will contain the percentile of interest will then be determined by a cumulative binomial distribution *Bin(x;n,p)*, representing the probability of *x* or fewer successes occurring in *n* trials with success probability p. *P* will be set to 0.50 for an interval around the median.

The sample size n will be ordered from least to greatest. Given *P* = 0.50, candidate interval endpoints will be chosen by ordered data values with ranks close to the product of (n+1) x 0.50. If the result of (n+1) x 0.50 is a fraction (for even-numbered sample sizes), the rank values immediately above and below will be selected as possible candidate endpoints. If the result of (n+1) x 0.50 is an integer (for odd-numbered sample sizes), one will be added to and subtracted

from the result to get the upper and lower candidate endpoints. The ranks of the endpoints will be denoted L* and U*. For a one-sided LCL, the confidence level associated with endpoint L* will be computed as:

$$1 - \alpha = Bin(L^* - 1; n, 0.50) = \sum_{x=L^*}^{n} \binom{n}{x} \left(\frac{1}{2}\right)^n$$

If the candidate endpoint(s) do not achieve the desired confidence level, new candidate endpoints (L*–1) and (U*+1) and achieved confidence levels will be calculated. If one candidate endpoint equals the data minimum or maximum, only the rank of the other endpoint will be changed. Achievable confidence levels are tabulated using these equations in Table 21-11 in Appendix D of the *Unified Guidance*.

Both parametric and non-parametric confidence limits will then be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance monitoring wells. A GWPS exceedance is determined if the LCL exceeds the GWPS.

3.1.4 The Upper Prediction Limit for a Future Mean

The parametric UPL for a future mean will be used to calculate the GWPS if the pooled background data contain 50 to 70 percent non-detects and normality can be achieved. The Kaplan-Meier or ROS methods will be used to estimate the mean and standard deviation. The non-parametric UPL for a future median will be calculated as the GWPS if background samples cannot be normalized or contain greater than 70 percent non-detects. The parametric UPL for a future mean will be calculated from the background dataset at follows:

$$UPL_{1-\alpha} = \overline{x} + \kappa s$$

$\overline{x}$ = background sample mean

s = background standard deviation

κ = multiplier based on the order (p) of the future mean to be predicted, the number of compliance wells to be tested (w), the background sample size (n) the number (c) of constituents of concern (COCs), the “1-of-m” retesting scheme, and the evaluation schedule (annual, semi-annual, quarterly). Values are tabulated in 19-5 to 19-9 in Appendix D of the *Unified Guidance*.

The mean of order p will be computed for each well and compared against the UPL. For any compliance point mean that exceeds the limit, p additional resamples may be collected at that well for a 1-of-2 retesting scheme. Resample means will then be compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when the initial mean and all resample means exceed the UPL.

3.1.5 The Non-Parametric Upper Prediction Limit for a Future Median

The non-parametric UPL for a future median will be used to calculate the GWPS if the pooled background data contain greater than 70 percent non-detects and normality cannot be achieved. Non-parametric methods assume that the data does not have an underlying distribution. To calculate the non-parametric UPL on a future value, the target per-constituent false positive rate (α_{const}) will be determined as follows:

$$\alpha_{const} = 1 - (1 - \alpha)^{1/c}$$

α = the site-wide false positive rate (SWFPR) of 0.10 recommended by the *Unified Guidance*

c = the number of monitoring constituents

The number of yearly statistical evaluation (nE) will be multiplied by the number of compliance wells (w) to determine the look-up table entry, w*. The background sample size (n) and w* will be used to select an achievable per-constituent false positive rate value in Table 19-24 of Appendix D in the *Unified Guidance*. The chosen achievable per-constituent false positive rate value will determine the type of non-parametric prediction limit (maximum or 2nd highest value in background) and a retesting scheme for a future median. The background data will be sorted in ascending order, and the upper prediction limit will be set to the appropriate order statistic previously determined by the achievable per-constituent false positive rate value in Table 19-24. If all constituent measurements in a background sample are non-detect, the Double Quantification rule will be used. The use of the Double Quantification rule in Compliance Monitoring will only be applicable if the RL is above the 35 I.A.C. § 845.600(a)(1) constituent concentration or a constituent concentration is not specified in § 845.600(a)(1). This scenario is highly unlikely. The constituent will also be removed from calculations identifying the target false positive rate.

Two initial measurements per compliance well will be collected. If both do not exceed the upper prediction limit, a third initial measurement will not be collected since the median of order 3 will also not exceed the limit. If both exceed the prediction limit, a third initial measurement will not be collected since the median will also exceed the limit. If one initial measurement is above and one below the limit, a third initial observation may be collected to determine the position of the median relative to the UPL. Up to three resamples will be collected in order to assess the resample median. In all cases, if two or more of the compliance point observations are non-detect, the median will be set equal to the RL. The median value for each compliance well will be compared to the UPL. For the 1-of-2 retesting scheme, if any compliance point median exceeds the limit, up to three additional resamples will may be collected from that well. The resample median will be computed and compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when either the initial median, or both the initial median and resample median exceed the UPL.

If the concentrations of detected constituents are below the established GWPS, Compliance Monitoring will continue.

3.1.6 Parametric Linear Regression and Confidence Band

If the t-test detects a significant trend in the parametric linear regression line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. If this is not accounted for, a wider confidence interval will inevitably be calculated for a given confidence level and sample size (n). A wider confidence interval will result in less statistical power, or ability to demonstrate an exceedance or return to compliance. When a linear trend line has been estimated, a series of confidence intervals is estimated at each point along the trend. This creates a simultaneous confidence band that follows the trend line. As the underlying population mean increases or decreases, the confidence band does also to reflect this change at that point in time.

Linear regression will be used when background or compliance data are approximately normally distributed, with a constant sample variance around the mean, and the frequency of non-detects is low. The linear regression of concentration against sampling date (time) will be computed as follows:

$$\hat{b} = \sum_{i=1}^{n} (t_i - \overline{t}) \cdot x_i / (n-1) \cdot s_t^2$$

x_i = i^{th} concentration value and

t_i = i^{th} sampling date

$\overline{t}$ = sampling mean date

s_t^2 = variance of the sampling dates

This estimate leads to the following regression equation:

$$\hat{x} = \overline{x} + \hat{b} \cdot (\mathrm{t} - \overline{t})$$

$\overline{x}$ = mean concentration level

$\hat{x}$ = estimated mean concentration at time t

The regression residuals will also be computed at each sampling event to ensure uniformity and lack of significant skewness. Regression residuals will be computed at each sampling event as follows:

$$r_i = x_i - \hat{x}_i$$

The estimated variance around the regression line, or mean squared error (MSE) will be computed as follows:

$$s_e^2 = \frac{1}{n-2} \sum_{i=1}^{n} r_i^2$$

The confidence intervals around a linear regression trend line given confidence level (1-α) and a point in time (t_0), will be computed as follows:

$$LCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-1} \cdot \left[\frac{1}{n} + \frac{(t_0 - \overline{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$$UCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-2} \cdot \left[\frac{1}{n} + \frac{(t_0 - \overline{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$\hat{x}_0$ = estimated mean concentration from the regression equation at time t_0

$F_{1-2\alpha,2,\mathrm{n}-2}$ = upper $(1\text{-}2\alpha)^{th}$ percentage point from an F-distribution with 2 and (n-2) degrees of freedom

For background data, the UCL around the linear regression line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the linear regression line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is determined when the LCL based on the trend line first exceeds the GWPS.

3.1.7 Non-Parametric Thiel-Sen Trend Line and Confidence Band

If the Mann-Kendall test detects a significant trend in the non-parametric Thiel-Sen line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. The Thiel-Sen trend line will be used as a non-parametric alternative to linear regression when trend residuals cannot be normalized or if there are a higher percentage of non-detects in either background or compliance data. The Thiel-Sen trend line estimates the median concentration over time by combining the median pairwise slope with the median concentration value and the median sample date. To compute the Thiel-Sen line, the data will first be ordered by sampling event x1, x2, xn. All possible distinct pairs of measurements (x_i, x_j) for j > i will be considered and the simple pairwise slope estimate will be computed for each pair as follows:

$$m_{ij} = (x_j - x_i)/(j - i)$$

With a sample size of n, there will be a total of N = n(n-1)/2 pairwise estimates (m_{ij}). If a given observation is a non-detect, half the RL will be substituted. The N pairwise slope estimates (m_{ij}) will be ordered from least to greatest (renamed m(1), m(2),..m(N)). The Thiel-Sen estimate of slope (Q) will be calculated as the median value of the list depending on whether N is even or odd as follows:

$$Q = \begin{cases} m_{([N+1]/2)} \; if \; N \; is \; odd \\ (m_{(N/2)} + m_{([N+2]/2)})/2 \; if \; N \; is \; even \end{cases}$$

The sample concentration magnitude will be ordered from least to greatest, x(1), x(2), to x(n) and the median concentration will be calculated as follows:

$$\tilde{x} = \begin{cases} x_{([n+1]/2)} \; if \; n \; is \; odd \\ (x_{(n/2)} + x_{([n+2]/2)})/2 \; if \; n \; is \; even \end{cases}$$

The median sampling date ($\tilde{t}$) with ordered times (t(1), t(2), to t(n)) will also be determined in this way. The Thiel-Sen trend line will then be computed for an estimate at any time (t) of the expected median concentration (x) as follows:

$$x = \tilde{x} + Q \cdot (\mathrm{t} - \tilde{t}) = (\tilde{x} - Q \cdot \tilde{t}) + Q \cdot \mathrm{t}$$

To construct a confidence band around the Thiel-Sen line, sample pairs (ti, xi) will be formed with a sample date (ti) and the concentration measurement from that date (xi). Bootstrap samples (B) will be formed by repeatedly sampling n pairs at random with replacement from the original sample pairs. This will be repeated 500 times. For each bootstrap sample, a Thiel-Sen trend line will be constructed using the equation above. A series of equally spaced time points (tj) will be identified along the range of sampling dates represented in the original sample, j =1 to m. The Thiel-Sen trend line associated with each bootstrap replicate will be used to compute an estimated concentration ($\hat{x}_j^B$). An LCL will be constructed for the lower α^{th} percentile $\hat{x}_j^{[\alpha]}$ from the distribution of estimated concentrations at each time point (tj). For a UCL, compute the upper (1-α)th percentile, $\hat{x}_j^{[1-\alpha]}$ at each time point (tj).

For background data, the UCL around the Thiel-Sen trend line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the Thiel-Sen trend line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is confirmed when the LCL based on the trend line first exceeds the GWPS.

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3.2 Determination of Statistically Significant Increases over Background

In accordance with 35 I.A.C. §§ 845.610(b)(3)(B) and 845.640(h), individual monitoring event concentrations for each constituent detected in the compliance monitoring wells during compliance monitoring sampling events will be compared to the background concentration as determined by the methods described above. An exceedance of the background concentration for any constituent measured at any compliance monitoring well, or constituent detection if not detected in the background samples, constitutes a Statistically Significant Increase (SSI). An exception to this method is pH, where two-sided (upper and lower) tolerance limits are established from the distribution of the background groundwater quality data. An exceedance of either the UTL or lower tolerance limit (LTL) would constitute an SSI for pH.

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4. REFERENCES

Davis, C.B., 1994. *Environmental Regulatory Statistics.* In GP Patil & CR Rao (Eds.) *Handbook of Statistics, Volume 12: Environmental Statistics*, Chapter 26. New York: Elsevier Science B.V.

United States Environmental Protection Agency (USEPA), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*. EPA 530-R-09-007. March 2009.

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ATTACHMENT J

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Memorandum

BURNS McDONNELL

Date: 25 October 2021

Subject: IEPA Part 845 – Slope Maintenance Documentation for GMF Pond at Duck Creek Power Plant

Illinois Power resources Generating, LLC operates the coal-fired Duck Creek Power Plant (Plant) located in Fulton County, Illinois. The GMF Pond is an inactive surface impoundment storing coal combustion residuals (CCR). The requirements for the Duck Creek GMF Pond are found in 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845).

Pursuant to Part 845, Section 845.230(d)(2)(F), the initial operating permit application for existing or inactive CCR surface impoundments that have not completed an Agency approved closure before prior to July 30, 2021, must contain documentation that the CCR surface impoundment, if not incised, will be operated, and maintained with one of the forms of slope protection specified in Section 845.430. This statement addresses the requirements of Part 845, Section 845.430 Slope Maintenance, which states:

> *Section 845.430: The slopes and pertinent surrounding areas of the CCR surface impoundment must be designed, constructed, operated, and maintained with one of the forms of slope protection specified in subsection (a) that meets all the performance standards of subsection (b).*
>
> *Section 845.430(a): Slope protection must consist of one of the following: 1) A vegetative cover consisting of grassy vegetation; 2) An engineered cover consisting of a single form or combination of forms of engineered slope protection measures; or 3) A combination of the forms of cover specified in subsections (a)(1) or (a)(2).*
>
> *Section 845.430(b): Any form of cover for slope protection must meet the following performance standards: 1) The cover must be installed and maintained on the slopes and pertinent surrounding areas of the CCR surface impoundment; 2) The cover must provide protection against surface erosion, wave action, and adverse effects of rapid drawdown; 3) The cover must be maintained to allow for the observation of, and access to, the slopes and pertinent surrounding areas during routine and emergency events; 4) Woody vegetation must be removed from the slopes or pertinent surrounding areas. Any removal of woody vegetation with a diameter greater than 1/2 inch must be directed by a person familiar with the design and operation of the CCR surface impoundment and in consideration of the complexities of removal of a tree or a shrubbery, who must ensure the removal does not create a risk of destabilizing the CCR surface impoundment or otherwise adversely affect the stability and safety of the CCR surface impoundment or*

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personnel undertaking the removal; and 5) The height of vegetation must not exceed 12 inches.

Slope protection, consisting of vegetative cover, was installed on the slopes and pertinent surrounding areas of the Duck Creek GMF Pond, and is inspected, maintained and repaired as needed. Based on observations from weekly inspections conducted in accordance with Section 845.540(a), and the 2020 annual inspections conducted by Hanson Professional Services Inc., the vegetative cover is described to be in good working condition with a maximum vegetation height of 12 inches. The owner's Operations and Maintenance Plan (O&M Plan) provides details for maintaining grass and removing woody vegetation and addressing erosion features on the slopes. Based on a review of the documentation described above, the owner is implementing the O&M Plan, including the completion of repairs and maintenance as needed and when issues are identified during weekly and/or annual inspections. The slope maintenance portion of the O&M Plan and the Annual Inspection performed by Hanson in 2020 are included in Attachment J. The surface impoundment slope protection (vegetative cover) installed and maintained on the slopes and pertinent areas around the slopes is depicted in the aerial photograph provided below.



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Excerpt from the Duck Creek Operations and Maintenance Manual

1.1 OPERATION AND MAINTENANCE INSPECTION

"Walk-around" inspections of the dams and appurtenant works are to be made by the dam Operator. During these inspections, a checklist of items to be maintained and items to be observed should be recorded. The checklist provided in Appendix B shall be utilized for these inspections. **If any of the following items are found to be unusual or are cause for concern, Shift Supervisor should be immediately notified.**

Frequency: Weekly. Also, during and after unusual events such as heavy rainfall or after an earthquake.

Inspection Items: During each inspection the following items should be noted.

1. Water Level - Maximum levels because of heavy rainfall should be recorded.

2. Earth Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides, and animal burrows. These are described as follows:

    - Surface Erosion - Removal of vegetative cover by water action or pedestrian or vehicle usage forming deep ruts or gullies.

    - Seepage - The passage of water through and/or underneath the earth embankment abutment and natural groundline or at the contact between the embankment and outlet works. It can be indicated by cattails or other wet environmental vegetation, erosion, channelization, or slumping on the embankment face.

    - Cracks - Deep cracks usually indicate the movement of the dam and/or the foundation and can be in either the longitudinal (along the length of the dam) or transverse (across the dam) directions. Cracking can be an indicator of the beginning of slumps. Shallow cracks may develop during the summer when the surface soils of the embankment become severely dried and are usually of no concern regarding the safety of the dam.

    - Settlement - Settlement is indicated by depressions or low spots and can be signs of consolidation of the dam or foundation or the loss of material beneath the settlement area.

    - Slumps/Slides - A slow or sudden movement of the earth embankment slope on either face toward the toe of the dam.

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- If seepage indicates the presence of soil particles, or if deep cracks, settlement, slumps, or slides are noticed, a qualified engineer should be contacted immediately for consultation.

- Animal Burrows - Animal burrows result in a loss of earth embankment material and can provide seepage paths for water through the embankment.

3. Gypsum Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides, and animal burrows. The descriptions for these are the same as for earth embankment.

4. Vegetation - Grass should be a thick vigorous growth to stabilize the earth embankment soils and prevent erosion from occurring. Note the height of the grass, if greater than 1-foot a mowing of the area should be scheduled before the next inspection. There should be NO trees on the earth embankment and NONE within a minimum of 20 ft of the embankment toes or other structures. The gypsum embankment will not be seeded and is not expected to have any vegetation.

5. Gypsum Stack piezometers should be inspected for any damage or loss of function. Damaged piezometers must be promptly repaired or replaced since their function is critical to ensuring stability of the gypsum stack.

6. The water level in each Gypsum Stack piezometer must be measured and recorded. If the water level in any piezometer is above the "critical elevation" as discussed in Section **Error! Reference source not found.**, Ameren should be notified, and the **design engineer should be immediately consulted for guidance on an appropriate course of action**.

7. Gypsum Stack LD/LCRS Drains - The change in location or amount of flow discharging from the Leak Detection/Leachate Collection Recovery System (LD/LCRS) should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

8. Gypsum Stack Ring Drains - The change in location or amount of flow discharging from the Ring Drains should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

9. Gypsum Stack Fixed Decant – Check the alignment and supports for the pipe. Record the amount of flow discharging from the pipe and any erosion or scour around the discharge point.

10. Gypsum Stack Perimeter Ditch – The perimeter ditch should have a consistent prismatic shape for the entire length. Inspect the perimeter ditch for evidence of erosion, sediment deposition and irregularity in channel geometry, especially in the vicinity of siphon, decant or ring drain outfall structures. If irregularities are noted, repairs should be scheduled and completed.

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11. Stop Logs - Check to make sure that the stop logs in the transfer ditch are undamaged, and, if installed, are operating well, and allowing for the free flow of water over them.

12. Transfer Channel - Check for any debris or other obstructions which may block or restrict the free flow of water. Check for any pools or undulation of the floor of the channel.

13. Recycle Pond Decant - Check for any debris or other obstructions around the Recycle Pond decant which may block or restrict the free flow of water. The emergency dewatering valve should be lubricated. If there is no return water in the pipe, the emergency dewatering valve should be exercised. Record the physical and operating conditions of the system.

14. Recycle Pond Drop Inlet Spillways - Check for any debris or other obstructions around the inlet crest and at the bottom of the drop inlet which may block or restrict the free flow of water. Check for the development of any rusty areas on the concrete, and seepage, cracking, breaking, or spalling of the concrete. Check for settlement or cracking of the crest. Check for any debris in the pipes which may restrict the flow of water. Check for any tears or leaks in the HDPE liner covering the concrete.

15. Recycle Pond Rip Rap Basin - Check for any debris or other obstructions in the riprap basin which may block or restrict the free flow of water. Check to make sure that the rip rap is remaining in a uniform position. Freeze/thaw action or flow over the rip rap may tend to lift or fracture, thus requiring replacement or leveling to maintain the necessary level of protection. NO trees or woody vegetation should be growing through the rip rap.

16. Fences - Check for damage, accumulated debris, operation of gates and locks, and adequacy of locations (this may change with time as people access the area or development occurs in the area).

17. Perimeter - Check the perimeter of the dams for a distance of at least 100 ft beyond the toe for signs of seepage or boils.

18. HDPE Liner – Wherever exposed, the HDPE Liner should be inspected for tears, gouges, protrusions under the liner and abrasion.

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Dam Inspection Report

Name of Dam: Duck Creek GMF Gypsum Stack Dam ID No.: IL 50573

Permit Number: DS2014020 Class of Dam: III

Location: _____ Section: 18 Township: 6N Range: 5E

Owner: Dynegy Midwest Generation (Name) 309-633-2836 (Telephone Number (Day))

17751 North Cilco Road (Street) 309-633-2836 (Telephone Number (Night))

Canton (City) 61520 (Zip Code) County: Fulton

Type of Dam: Earth embankment with geosynthetic liner

Type of Spillway: Overflow

Date(s) Inspected: 10-Nov-20

Weather When Inspected: Cloudy

Temperature When Inspected: 50 F

Pool Elevation When Inspected: 614.7

Tailwater Elevation When Inspected: NA

LICENSED PROFESSIONAL ENGINEER
JAMES P. KNUTELSKI
062-054206
OF ILLINOIS

12/31/2020

Professional Engineer's Seal

Exp 11/30/21

Inspection Personnel:

Name	Title
James P. Knutelski, P.E.	Geotechnical Engineer
Jason Campbell, P.E.	Dynegy Dam Safety
Daryl Johnson	Dynegy Plant
Paul Mauer	IDNR-OWR

The Department of Nautural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5. Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 3702.160 of the "Rules for Construction and Maintenance of Dams".

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CONDITION CODES

NE - No evidence of a problem

GC - Good condition

MM - Item needing minor maintenance and/or repairs within the year, the safety or integrity of the item is not yet imperiled

IM - Item needing immediate maintenance to restore or ensure its safety or integrity

EC - Emergency condition which if not immediately repaired or other appropriate measures taken could lead to failure of the dam

OB - Condition requires regular observation to ensure that the condition does not become worse

NA - Not applicable to this dam

NI - Not inspected - list the reason for non-inspection under deficiencies

R001521

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EARTH EMBANKMENT

ITEM	CONDITION CODE	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES AND IMPLEMENTATION SCHEDULE
Surface Cracks	NE		
Vertical and Horizontal Alignment of Crest	GC		
Unusual Movement or Cracking At or Beyond Toe	NE		
Sloughing or Erosion of Embankment and Abutment Slopes	NE		
Upstream Face Slope Protection	GC		Note: Liner weld at anchor trench on both sides of spillway incomplete in small area approximately 2 inches in length was observed. Not a dam safety issue.
Seepage	NE		
Filter and Filter Drains	NA		

R001522

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EARTH EMBANKMENT

(Continued)

ITEM	CONDITION CODE	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES AND IMPLEMENTATION SCHEDULE
Animal Damage	NE		
Embankment Drainage Ditches	GC		
Vegetative Cover	GC		
Unwanted Vegetation	NE		
Other			
Other			
Other			

R001523

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PRINCIPAL SPILLWAY

(Continued)

☐ Drop Inlet Spillway X Overflow Spillway Structure ☐ Gated

ITEM	CONDITION CODE	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES AND IMPLEMENTATION SCHEDULE
Alignment of Abutment Walls	GC		
Construction Joints	NE		
Filter and Filter Drains	NA		
Trash Racks	NA		
Bridge and Piers	NA		
Differential Settlement	NE		
Outlet Channel	GC		

IF THE SPILLWAY IS GATED FILL OUT THE GATES SECTION

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SUMMARY OF MAINTENANCE DONE AND/OR

REPAIRS MADE SINCE THE LAST INSPECTION

DATE OF PRESENT INSPECTION 10-Nov-20

DATE OF LAST INSPECTION 5-Nov-19

1. EARTH EMBANKMENT DAMS
   Mowed.

2. CONCRETE MASONRY DAMS
   NA

3. PRINCIPAL SPILLWAY
   None

4. OUTLET WORKS
   NA

5. EMERGENCY SPILLWAY
   NA

R001525

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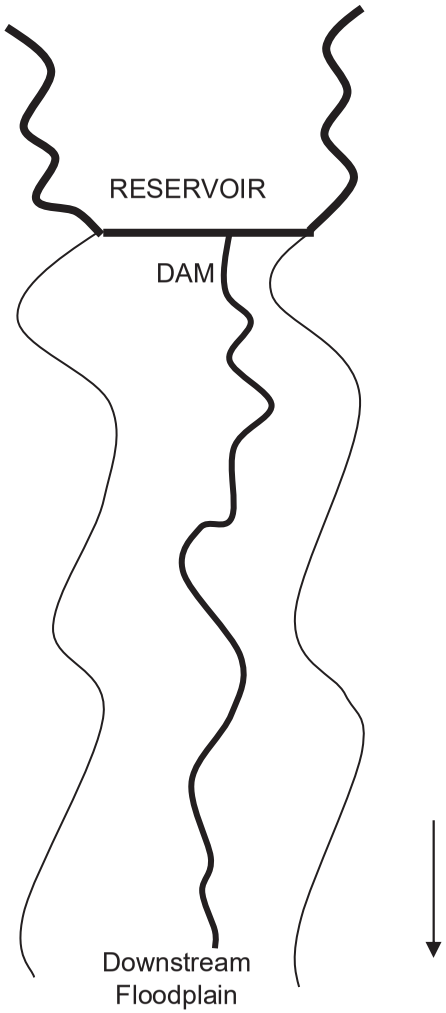
DOWNSTREAM DEVELOPMENT
APPROXIMATE WIDTH OF AFFECTED FLOODPLAIN _____ MILES

MILES DOWNSTREAM FROM DAM	DOWNSTREAM DEVELOPMENT												Loss of Life Potential			Economic Loss Potential		
	OCCUPIED HOMES	UNOCCUPIED HOMES	AGRICULTURAL BUILDINGS	INDUSTRIAL BUILDINGS	COMMERCIAL BUILDINGS	SCHOOLS	HOSPITALS	ROADS & BRIDGES	DAMS	OVERHEAD UTILITIES	OTHER DEVELOPMENT (Name	OTHER DEVELOPMENT (Name	NONE	1 TO 10	OVER 10	MINIMAL EXPECTED	APPRECIABLE EXPECTED	EXCESSIVE EXPECTED
0 to 1/4	0	0	0	0	0	0	0	0	0	0	0	0	X			X		
1/4 to 1/2																		
1/2 to 3/4																		
3/4 to 1																		
1 to 1-1/4																		
1-1/4 to 1-1/2																		
1-1/2 to 1-3/4																		
1-3/4 to 2																		
OVER 2																		

SKETCH IN DEVELOPMENTS DOWNSTREAM OF THE DAM



The number of homes, buildings, or other items in the floodplain downstream of the dam should be placed in the appropriate row and column to designate their location.

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Owner's Maintenance Statement

I, _____, owner of Duck Creek Gypsum Stack

Dam Identification Number IL 50573, in Fulton County,

am maintaining the dam in accordance with the accepted maintenance plan which is part of

Permit Number DS2014020.

_____
Signature

_____
Date

Owner's Operation and Maintenance Plan Statement

I, _____, owner of Duck Creek Gyp. Stack dam,

Dam Identification Number IL 50573, in Fulton County,

have reviewed the operation and maintenance plan including the Emergency Action Plan (EAP),

which is part of, Permit Number DS2014020.

I _____ have enclosed the appropriate revisions or

_____ have determined that no revisions to the plan are necessary.

_____
Signature

_____
Date

The Department of Nautural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5. Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 3702.160 of the "Rules for Construction and Maintenance of Dams".

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Pond north side interior



North side

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East side crest



East side interior slope

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East side exterior



South side

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West side exterior



Outlet structure

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Outlet channel

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ATTACHMENT K

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POST-CLOSURE PLAN FOR EXISTING CCR SURFACE IMPOUNDMENT
40 C.F.R. § 257.104 and 35 I.A.C. 845.780
REV 0 – 10/30/2021

SITE INFORMATION

Site Name / Address	Duck Creek Power Plant / 17751 North Cilco Road, Canton, IL 62234		
Owner Name / Address	Illinois Power Generating Company / 6555 Sierra Drive Irving, Texas 75039		
CCR Unit	GMF Pond	Closure Method and Final Cover Type	Close In-Place Geomembrane with Soil and Vegetation Cover

POST-CLOSURE PLAN DESCRIPTION

40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1) – Length of post-closure care period.	Post-closure care will be conducted for a period of 30 years as required by 40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1), except as provided by 40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2).
40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2) - Circumstances extending the post closure care period.	If at the end of the post-closure care period the CCR unit is operating under assessment monitoring in accordance with §257.95, the post-closure care as described in this plan will continue until returning to detection monitoring in accordance with §257.95. Under 35 I.A.C. 845.780(c)(2), the post-closure care period will be extended until groundwater monitoring data demonstrate that concentrations are below the groundwater protection standards in Section 845.600 and are not increasing for those constituents over background, using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that concentrations have been reduced to the maximum extent feasible and concentrations are protective of human health and the environment.
40 C.F.R. § 257.104(d)(1)(i) and 35 I.A.C. 845.780(d)(1)(A) – A description of the monitoring and maintenance activities required in 40 C.F.R. § 257.104(b) and 845.780(b), and the frequency at which these activities will be performed, to maintain the integrity and effectiveness of the final cover system, maintain the groundwater monitoring system and monitor the groundwater.	Pursuant to § 257.104(b)(1) and 35 I.A.C. 845.780(b)(1), throughout the post-closure care period, periodic visual observations of the final cover system and stormwater management system will be performed at least annually for evidence of settlement, subsidence, erosion, or other damage that may adversely affect the integrity and effectiveness of the final cover system. When practical, visual observations of the final cover will be made concurrent with groundwater monitoring activities. Noted evidence of damage, such as damage to the geosynthetic components, rills, surface cracks and settlement, will be repaired to maintain the integrity and effectiveness of the final cover system. Vegetation will be established and maintained on the final cover system, including storm drainage areas, where appropriate, to provide long-term erosion control. Established vegetation and the slope design of the final cover system will prevent potential erosion and damage

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	that may be caused by run-on and run-off. Repair activities may include, but are not limited to, repairing, or replacing damaged geosynthetic components, replacing and compacting soil cover, repairing drainage channels that have been eroded, filling in depressions with soil, regrading, and reseeding areas of failed vegetation, as necessary. Pursuant to § 257.104(b)(3) and 35 I.A.C. 845.780(b)(3), the groundwater monitoring system will be maintained, and groundwater will be monitored as required by 40 C.F.R. § 257.90 through 40 C.F.R. § 257.98 and 35 I.A.C. 845.600 through 35 I.A.C. 845.680. Monitoring wells will be inspected during each groundwater sampling event. Monitoring wells and associated instrumentation will be maintained so that they perform to the design specifications throughout the life of the monitoring program. Groundwater monitoring frequency will be at least quarterly, except as provided in 40 C.F.R. § 257.94(d), 257.94(c), and 35 I.A.C. 845.650(b)(4).
40 C.F.R. § 257.104(d)(1)(ii) and 35 I.A.C. 845.780(d)(1)(B) – The name, address, telephone number and email address of the person or office to contact about the facility during the post-closure care period.	Illinois Power Generating Company 6555 Sierra Drive Irving, Texas 75039 800.633.4704 ccr@dynegy.com
40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) – A description of the planned uses of the property during the post-closure period.	The CCR unit is located at a retired electric generation facility. Planned uses of the property during the post-closure period are currently unknown, except for post-closure care of the CCR unit. Post-closure use of the property will not disturb the integrity of the final cover system or other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements of 40 C.F.R. Part § 257, Subpart D and 35 I.A.C. Part 845. Any other disturbance will be conducted following a demonstration that it will not increase the potential threat to human health or the environment, as required by 40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780 (d)(1)(C). The demonstration will be certified by a qualified professional engineer and submitted to the Illinois Environmental Protection Agency (IEPA). Per 40 C.F.R. § 257.104(d)(1)(iii) notification shall be provided to the State Director that the demonstration has been placed in the operating record and on the owners or operator's publicly accessible internet site. Following closure of the CCR unit, a notation on the deed to the property, or some other instrument that is normally examined during title search, will be recorded in accordance with 40 C.F.R. § 257.102(i) and 35 I.A.C. 845.760(h). The notation will notify potential purchasers of the property that the land has been used as a CCR unit and its use is restricted under the post-closure care requirements in 40 C.F.R. 40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) or groundwater monitoring requirements per 35 I.A.C. 845.740(b). Within 30 days of recording the deed notation, a notification stating that the notation has been recorded will be submitted to the IEPA and placed in the facility's operating record per 845.760(h)(3). The notification will be placed on

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	the owner or operator's publicly accessible CCR Web site in accordance with 40 C.F.R. § 257.107(i)(9) and 35 I.A.C. 845.810(e) and placed in the facility's operating record as required by 35 I.A.C. 845.800(d)(26) and §257.105(i)(9).
40 C.F.R. § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3)– Amendments to the initial or subsequent written post-closure plan.	Pursuant to 40 C.F.R. § 257.104(d), the initial post closure care plan for the Duck Creek GMF Pond was prepared on October 17, 2016. That plan is being amended pursuant to 40 C.F.R. § 257.104(d)(3)(i). This plan also serves as the initial post-closure care plan, prepared in accordance with 35 I.A.C. 845.780(d). Pursuant to § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3), an operating permit modification application to amend the initial or any subsequent written post-closure care plan developed under 35 I.A.C. 845.780 (d)(1) and § 257.104(d)(1) will be submitted to IEPA. The written post-closure care plan will be amended whenever there is a change in the operation of the CCR surface impoundment that would substantially affect the written post-closure care plan in effect; or unanticipated events necessitate a revision of the written post-closure care plan, after post-closure activities have started. The written post-closure care plan will be amended at least 60 days before a planned change in the operation of the facility or CCR surface impoundment, or within 60 days after an unanticipated event requires the need to revise the existing plan. If the plan is revised after post-closure activities have started, a request to modify the operating permit, including an amended written post-closure care plan, will be submitted to the IEPA within 30 days following the triggering event.
40 C.F.R. § 257.104(d)(4) and 35 I.A.C. 845.780(d)(4) – Qualified professional engineering certification.	Certification by a qualified professional engineer will be appended to this plan and any amendment of this plan.
35 I.A.C. 845.780(e) – Termination of post-closure care.	Upon completion of the post-closure period, a request to terminate post-closure care will be submitted to the IEPA. The request will include a certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the post-closure care plan specified in 35 I.A.C. 845.780(d) and the requirements of 35 I.A.C. 845.780.
40 C.F.R. § 257.104(e) and 35 I.A.C. 845.780(f) – Notification of completion of the post-closure care period.	A notification of completion of post-closure care will be prepared and placed in the facility's operating record within 30 days after IEPA approval of the request to terminate post-closure care. The notification will be placed in the facility's operating record in accordance with 35 I.A.C. 845.800(d)(31) and § 257.105(i)(13). The notification will be placed on the owner or operator's publicly accessible CCR Internet site in accordance with the requirements of § 257.107(i)(13) and 35 I.A.C. 845.810(e). The IEPA will be notified when the notification has been placed in the operating record and on the owner or operator's publicly accessible Internet site in accordance with the requirements of § 257.106(i)(13).

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Certification Statement 40 C.F.R. § 257.104 (d)(4) and 35 I.A.C. 845.780(d)(4) – Amended/Initial Written Post Closure Plan for a CCR Surface Impoundment

CCR Unit: Illinois Power Resources Generating, LLC; Duck Creek Power Plant; GMF Pond

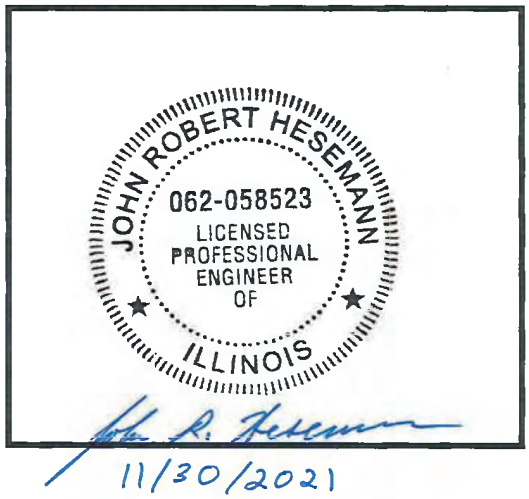
I, John R. Hesemann, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above referenced CCR Unit, that the information contained in the amended/initial written post closure plan, dated October 30, 2021, meets the requirements of 40 C.F.R. § 257.104 and 35 I.A.C. 845.780.

John R. Hesemann

Printed Name

9/28/2021

Date



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ATTACHMENT L

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Date: 25 October 2021

Subject: 35 Ill. Admin. Code Part 845 – CCR Liner Design Criteria Demonstration for GMF Pond at Duck Creek Power Plant

Illinois Power Resources Generating, LLC is the owner of the inactive coal-fired Duck Creek Power Plant (Plant) located in Fulton County, Illinois. The GMF Pond is an inactive surface impoundment storing coal combustion residuals (CCR). The requirements for the GMF Pond are found in 35 Ill. Admin. Code (I.A.C.) Part 845 (Part 845).

This liner design criteria demonstration addresses the requirements of Section 845.400 Liner Design Criteria for Existing CCR Surface Impoundments, which states.

Section 845.400 Liner Design Criteria for Existing CCR Surface Impoundments

a) *An existing CCR surface impoundment is considered to be an existing lined surface impoundment if it has been constructed with either a composite liner that meets the requirements of subsection (b) or an alternative composite liner that meets the requirements of subsection (c).*

b) *Composite Liner*

1) *A composite liner must consist of two components: the upper component consisting of, at a minimum, a 30-mil geomembrane liner, and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1 x 10−7 centimeters per second (cm/sec). The geomembrane liner components consisting of high-density polyethylene (HDPE) must be at least 60 mil. The geomembrane liner or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component.*

2) *The composite liner must be:*

A) *Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;*

B) *Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component, including on slopes;*

C) *Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and*

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D) *Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.*

c) *Alternative Composite Liner*

1) *An alternative composite liner must consist of two components: the upper component consisting of, at a minimum, a 30-mil geomembrane liner, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than 1 x 10−7 cm/sec. The geomembrane liner components consisting of high-density polyethylene (HDPE) must be at least 60 mil. If the lower component of the alternative liner is compacted soil, the geomembrane liner must be installed in direct and uniform contact with the compacted soil.*

2) *The liquid flow rate through the lower component of the alternative composite liner must be no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1 x 10−7 cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison must be no greater than 1 x 10−7 cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods.*

3) *The liquid flow rate comparison must be made using the following equation, which is derived from Darcy's Law for gravity flow through porous media.*

$$Q/A = q = k((h/t)+1)$$

Where:
Q = flow rate (cubic centimeters/second)
A = Surface area of the liner (squared centimeters)
q = flow rate per unit area (cubic centimeters/ second/squared centimeter)
k = hydraulic conductivity of the liner (centimeters /second)
h = hydraulic head above the liner (centimeters); and
t = thickness of the liner (centimeters)

4) *The alternative composite liner must meet the requirements specified in subsection (b).*

d) *The hydraulic conductivity of the compacted soil must be determined using recognized and generally accepted methods.*

e) *The owner or operator of an existing CCR surface impoundment that has not completed an Agency approved closure before July 30, 2021 must submit an initial operating permit application under Section 845.230 that demonstrates whether the CCR surface impoundment was constructed with either of the following:*

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1) A composite liner that meets the requirements of subsection (b); or

2) An alternative composite liner that meets the requirements of subsection (c).

h) The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer attesting that the CCR surface impoundment meets the requirements of subsection (a) and submit the certification to the Agency in the facility's initial operating permit application.

A liner evaluation was conducted for the Duck Creek Power Plant GMF Pond in 2016 to evaluate conformance with liner design criteria set forth in 40 C.F.R. § 257.71 and 257.70 (as referenced in 257.71). The evaluation included a review of design drawings, laboratory test data, field test data, construction records and other available information. The evaluation results were documented in the *Liner Evaluation Report – Duck Creek GMF Pond*, prepared by Hanson Professional Services Inc. in October 2016. The report demonstrates that the Duck Creek Power Plant GMF Pond was constructed with an alternative composite liner, as defined in 40 C.F.R. § 257.70(c)(1), that meets the design criteria set forth in 40 C.F.R. § 257.71 and 257.70 (as referenced in 257.71). The report includes a certification from a qualified professional engineer licensed in the State of Illinois stating that the Duck Creek Power Plant GMF Pond meets the applicable requirements set forth in 40 C.F.R. § 257.71 and 257.70.

Because the liner design criteria set forth in Section 845.400 are nearly identical to those presented in 40 C.F.R. § 257.71 and 257.70, the previous liner evaluation report and associated certification demonstrate that the Duck Creek Power Plant GMF Pond meets the design criteria for an alternative composite liner set forth in Section 845.400(c). The previous liner evaluation report and associated certification are provided in Attachment L.

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I, John R. Hesemann, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that, based on the information provided in the Duck Creek Power Plant GMF Pond Liner Evaluation Report prepared by Hanson Professional Services Inc., the Duck Creek Power Plant GMF Pond Liner meets the design criteria set forth in 35 I.A.C.845.400(a).

John R. Hesemann

Printed Name

10/18/2021

Date



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Liner Evaluation Report
Duck Creek GMF Pond

Illinois Power Resources Generating, LLC
Duck Creek Power Station
Fulton County, Illinois

October 2016

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DUCK CREEK GMF POND
ILLINOIS POWER RESOURCES GENERATING, LLC
LICENSED PROFESSIONAL ENGINEER CERTIFICATION

As a Qualified Professional Engineer as defined by 40 CFR 257.53 and being a Professional Engineer licensed in the State of Illinois, I certify that I have personally examined and am familiar with the information in the Duck Creek GMF Pond Liner Evaluation Report and the Duck Creek GMF Pond Liner Documentation Report in the operating record and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete.

As required by 40 CFR 257.71(b), the Duck Creek GMF Pond Liner Evaluation Report and the Duck Creek GMF Pond Liner Documentation Report in the operating record are accurate, and the **Duck Creek GMF Pond** meets the requirements set forth in 40 CFR 257.71(a)(iii) as published on April 17, 2015. As required by 40 CFR 257.70(c)(2), the **Duck Creek GMF Pond** meets the requirements in 40 CFR 257.70(c)(2).

Steven M. Bishoff, P.E.
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, IL 62703-2886
(217) 788-2450
Registration No. 062-040449

Seal:



Signature: _____

Date: 10-10-2016

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1. Summary

The Duck Creek GMF Pond (GMF Pond) was constructed to retain wet-sluiced gypsum produced in the flue-gas scrubber at the Duck Creek Power Station. Construction of the GMF Pond began in 2007 with excavation of the site. Construction of the liner components began in April 2008 and was completed in February 2009. The GMF Pond encompasses about 30.0 acres within Section 18, Township 6 North, Range 5 East of the Fourth Principal Meridian, just north of the Duck Creek Power Station.

The composite liner system in the GMF Pond was designed to exceed compliance with Illinois Environmental Protection Agency rules for solid waste landfills by having a double HDPE geomembrane. Basic liner system performance criteria is contained in 35 Illinois Administrative Code (IAC) Part 811 as follows:

35 IAC 811.306 Liner Systems

d) Compacted Earth Liner Standards

1) The minimum allowable thickness shall be 1.52 meters (5 feet).

2) The liner shall be compacted to achieve a maximum hydraulic conductivity of $1X10^{-7}$ centimeters per second.

3) The construction and compaction of the liner shall be carried out in accordance with the construction quality assurance procedures of Subpart E so as to reduce void spaces and allow the liner to support the loadings imposed by the waste disposal operation without settling that causes or contributes to the failure of the leachate collection system.

4) The liner shall be constructed from materials whose properties are not affected by contact with the constituents of the leachate expected to be produced.

5) Alternative specifications, using standard construction techniques, for hydraulic conductivity and liner thickness may be utilized under the following conditions:

A) The liner thickness shall be no less than 1.52 meter (5 feet) unless a composite liner consisting of a geomembrane immediately overlying a compacted earth liner is installed. The following minimum standards shall apply for a composite liner:

i) the geomembrane shall be no less than 60 mils in thickness and meet the requirements of subsection (e); and

ii) the compacted earth liner shall be no less than 0.91 meter in thickness (3 feet) and meet the requirements of subsection (d)(2) through (d)(4).

B) The modified liner shall operate in conjunction with a leachate drainage and collection system to achieve equivalent or superior performance to the requirements of this subsection. Equivalent performance shall be evaluated at maximum annual leachate flow conditions.

In accordance with 35 IAC 811.306(d)(5), the GMF Pond was designed and constructed with an alternate liner system composed of the following, from lowest elevation to highest elevation:

- Three (3) feet of compacted clay with a hydraulic conductivity less than $9.8x10^{-7}$ cm/sec (from actual field testing);
- A geosynthetic clay liner (Bentomat SDN); and
- A 60-mil HDPE geomembrane.

In addition to the Part 811 requirements, the Duck Creek GMF Pond has a second 60-mil HDPE geomembrane with an active leachate collection system in the interstitial space between the two geomembranes. From the lowest geomembrane going upward, the additional components are listed below:

- One-foot of drainage sand for the leachate collection system;
- One-foot of cushion soil; and
- A second 60-mil HDPE geomembrane.

The dual liner with interstitial leachate collection system was designed to limit leachate head on the bottom geomembrane to 12 inches or less.

In April 2015, the United States Environmental Protection Agency published rules at 40 CFR Part 257, Subpart D, regulating the disposal of coal combustion residuals (CCR) in landfills and surface impoundments located in association with electrical utilities utilizing coal as the primary fuel source. Liner system performance criteria for existing CCR surface impoundments is contained in 40 CFR Part 257, Subpart D, as follows:

257.71 Liner design criteria for existing CCR surface impoundments.

(a)(1) No later than October 17, 2016, the owner or operator of an existing CCR surface impoundment must document whether or not such unit was constructed with any one of the following:

(i) A liner consisting of a minimum of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec;

(ii) A composite liner that meets the requirements of §257.70(b); or

(iii) An alternative composite liner that meets the requirements of §257.70(c).

(2) The hydraulic conductivity of the compacted soil must be determined using recognized and generally accepted methods.

(3) An existing CCR surface impoundment is considered to be an existing unlined CCR surface impoundment if either:

(i) The owner or operator of the CCR unit determines that the CCR unit is not constructed with a liner that meets the requirements of paragraphs (a)(1)(i), (ii), or (iii) of this section; or

(ii) The owner or operator of the CCR unit fails to document whether the CCR unit was constructed with a liner that meets the requirements of paragraphs (a)(1)(i), (ii), or (iii) of this section.

(4) All existing unlined CCR surface impoundments are subject to the requirements of §257.101(a).

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer attesting that the documentation as to whether a CCR unit meets the requirements of paragraph (a) of this section is accurate.

(c) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(f), the notification requirements specified in §257.106(f), and the Internet requirements specified in §257.107(f).

As referenced in 40 CFR 257.71(a)(1)(ii) and (iii), 40 CFR 257.70(b) and (c) -- Design criteria for new CCR landfills and any lateral expansion of a CCR landfill -- provide:

(b) A composite liner must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be:

(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

(2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes;

(3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.

(c) If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met:

(1) An alternative composite liner must consist of two components; the upper component consisting of, at a minimum, a 30-mil GM, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. If the lower component of the alternative liner is compacted soil, the GM must be installed in direct and uniform contact with the compacted soil.

(2) The owner or operator must obtain certification from a qualified professional engineer that the liquid flow rate through the lower component of the alternative composite liner is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison shall be no greater than 1×10^{-7} cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods. The liquid flow rate comparison must be made using Equation 1 of this section, which is derived from Darcy's Law for gravity flow through porous media.

(Eq. 1) $$\frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right)$$

Where,
Q = flow rate (cubic centimeters/second);
A = surface area of the liner (squared centimeters);
q = flow rate per unit area (cubic centimeters/second/squared centimeter);
k = hydraulic conductivity of the liner (centimeters/second);
h = hydraulic head above the liner (centimeters); and t = thickness of the liner (centimeters).

(3) The alternative composite liner must meet the requirements specified in paragraphs (b)(1) through (4) of this section.

In accordance with 40 CFR 257.70(b)(1) above, the composite liner in the Duck Creek GMF Pond was constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation. This information is located in Section 4 and Section 5 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

In accordance with 40 CFR 257.70(b)(2) above, the composite liner in the Duck Creek GMF Pond was constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component, including on slopes. This information is located in Section 4 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

In accordance with 40 CFR 257.70(b)(3) above, the composite liner in the Duck Creek GMF Pond was placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift. This information is located in Section 4 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

In accordance with 40 CFR 257.70(b)(4) above, the composite liner in the Duck Creek GMF Pond was installed to cover all surrounding earth likely to be in contact with the CCR or leachate. This information is located in the "Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station, Canton, Fulton County, Illinois. Feezor Engineering, Inc. (March 2009, Revised July 2009)" in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

The purpose of this report is to document that the existing composite liner in the Duck Creek GMF Pond meets the minimum requirements of 40 CFR 257.71(a)(1)(iii), i.e., an alternative composite liner that meets the requirements of § 257.70(c).

Briefly, in comparison:

35 IAC 811.306(d)(5)(A) requires a compacted clay liner of at least three (3) feet in thickness with a hydraulic conductivity of less than $1x10^{-7}$ cm/sec, overlain by a geomembrane of no less than 60-mils in thickness.

In addition, the Duck Creek GMF Pond has a second 60-mil HDPE geomembrane overlying an interstitial leachate collection system.

40 CFR 257.71(a)(1)(iii) requires that an alternative composite liner meet the requirements of 40 CFR 257.70(c), which requires (A) a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than $1x10^{-7}$ cm/sec; and (B) an upper component consisting of, at a minimum, a 30-mil geomembrane. If the geomembrane is composed of high-density polyethylene (HDPE), the geomembrane must be a minimum of 60-mils in thickness.

The soil liner comparison in 40 CFR 257.70(c)(2) is based on an assumed water driving head. In the ideal case, there should be no driving head as the overlying geomembrane would prevent downward migration of water. However, for practical purposes, the driving head is the water head on the overlying geomembrane. For the GMF Pond as-built case, the driving head is limited to 12-inches by the interstitial leachate collection system. For the comparison case, the double geomembrane liner would not exist, and the maximum driving head would be approximately 33.7 feet (the elevation difference between the lowest portion of the clay liner and the overlying pond surface).

The 40 CFR 257.70(c)(2) demonstration calculations comparing these two scenarios are contained in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

In summary, the lower component of the minimum alternative composite liner required by 40 CFR 257.70(c) has a flow rate per unit area of 1.785×10^{-6} cm/sec. The geosynthetic clay liner (GCL) in the GMF Pond has a flow rate per unit area of 4.9×10^{-8} cm/sec, and the as-built clay liner for the GMF Pond has a flow rate per unit area of 1.307×10^{-6} cm/sec. Consequently, each of the two components of the as-built liner of the GMF Pond exceeds the performance standard set by 40 CFR 257.70(c)(2) for the lower component of an alternative composite liner.

The major components of the construction and Construction Quality Assurance (CQA) of the GMF Pond liner are discussed in the sections below.

2. Foundation Preparation

Foundation preparation consisted of removing the soil to foundation grade in the bottom of the GMF Pond, construction of the perimeter berm containing the GMF Pond, and surveying and certifying the foundation surface.

Foundation preparation in 2008 consisted of removing excess soil above foundation grade, construction of the perimeter berm containing the GMF Pond, and surveying and certifying the subgrade surface prior to construction of the test soil liner and the full scale soil liner.

The construction contractor began removing soil material to foundation grade and stockpiling the cut material for later reuse as liner material. Unsuitable sand material was removed from several locations and these areas were backfilled with suitable foundation soils. The foundation surface was proof rolled and visually observed and any unsuitable soils were reworked or removed and replaced.

Foundation backfill lifts were compacted with a Cat 815 sheepsfoot compactor and tested for compaction using a Troxler nuclear moisture/density gauge at a minimum rate of one test per 10,000 yd^3 (minimum one test per compacted lift). Fill was placed in approximately 8-inch lifts and compacted to at least 95% Standard Proctor maximum dry density with moisture contents of -2% to +2% of optimum. Nuclear moisture/density and Standard Proctor test results are included in Appendix E in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

Finished foundation grades were verified by survey and certified, and CQA certifications of completion were provided by the CQA Officer (Appendices K and L in the Duck Creek GMF Pond Liner Documentation Report located in the operating record).

3. Berm Construction

The perimeter berm was constructed with structural fill excavated and hauled directly from within the GMF Pond and other borrow areas within the facility. Nuclear moisture/density gauge testing was performed during berm construction at a minimum rate of one test per 10,000 yd^3 (and a minimum one test per compacted lift). Fill was placed in approximately 8-inch lifts and compacted with a Cat 815 or 825 sheepsfoot compactor to at least 95% Standard Proctor maximum dry density with moisture contents of -2% to +2% of optimum. Areas that showed deficiencies in compaction or moisture content were reworked or removed, and then compacted with a Cat 815 or 825 sheepsfoot compactor and tested for moisture/density. Nuclear moisture/density and Standard Proctor test results are included in Appendix E of the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

After berm construction was completed, eight Shelby tube samples were collected from the berm, and a soil sample from each tube was tested to determine in-place hydraulic conductivity (or permeability). In-place berm hydraulic conductivities ranged from 2.2×10^{-8} cm/sec to 1.0×10^{-7} cm/sec. Permeability test results and a drawing showing Shelby tube sample locations are included in Appendix E-3 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

4. Test Soil Liner

Prior to construction of the full scale soil liner, two test soil liners were constructed using two different borrow sources. Test Soil Liner No. 1 was constructed in the southeast corner of the GMF Pond footprint. Test Soil Liner No. 2 was constructed to the northeast of the GMF Pond at a location outside the footprint, on higher ground, to avoid flooding from heavy rainfalls being experienced at the project site. The purpose of the test soil liners was to verify that the material and methods of construction proposed for the full scale soil liner would provide the quality of construction required by the design.

The borrow materials for Test Soil Liner No. 1 were the natural glacial till materials taken from the lower ±5 feet of GMF Pond excavation footprint. The borrow materials for Test Soil Liner No. 2 were obtained from the natural glacial till materials taken from the upper excavation levels in the GMF Pond footprint.

Pursuant to the CQA Plan, the test soil liners were sampled and tested for physical properties utilizing both laboratory and field testing. Required were at least five (5) two-stage field tests to determine both vertical and horizontal hydraulic conductivity and at least two (2) undisturbed Shelby tube samples tested in the laboratory for vertical hydraulic conductivity to determine if there was a statistical correlation with the field tests.

4.1 Test Soil Liner No. 1

4.1.1 Prequalification of Borrow Materials

While no prequalification testing was required by the regulations, a program of laboratory testing was carried out on typical samples of the glacial till materials used for the construction of Test Soil Liner No. 1. Tables 4.1 and 4.2 summarize the primary borrow material properties determined from the testing (Appendix F-1 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record).

Table 4.1 Properties of Borrow Materials for Test Soil Liner No. 1

Sample Location	Percent of Fines	Liquid Limit	Plasticity Index	Maximum Dry Density (MDD)	Optimum Moisture Content (OMC)
GMF Pond Southeast Floor	70.9%	22%	5%	122.4 pcf	11.0%
GMF Pond Northwest Floor	68.4%	23%	7%	122.9 pcf	11.6%

Table 4.2 Results of Constant Head Permeability Tests on Borrow Materials

Sample Location	Dry Density	Moisture Content	Permeability Result
GMF Pond	95% of MDD	OMC	2.1×10^{-6} cm/sec
Southeast Floor	95% of MDD	3% Wet of OMC	9.6×10^{-8} cm/sec
GMF Pond	95% of MDD	OMC	9.1×10^{-7} cm/sec
Northwest Floor	95% of MDD	3% Wet of OMC	3.8×10^{-8} cm/sec

The measured percentages of fines and permeability values confirmed that the material was suitable to achieve the required design hydraulic conductivity. Based on these results, the field compaction criteria for the soil liner were set as follows:

Dry Density ≥ 95% MDD
Moisture Content = 0% to 5% Wet of OMC

4.1.2 Construction

The construction of Test Soil Liner No. 1 was initiated on May 1, 2008. The test soil liner was built in five lifts of approximately 8-inches and compacted with a Cat 815 sheepsfoot compactor.

Nuclear moisture/density gauge testing was performed at a minimum rate of one test per acre per lift or one test per 1,000 yd^3 to 95% Standard Proctor MDD with moisture contents of optimum to +5%. Nuclear moisture/density test results and a drawing showing the testing locations are included in Appendix F-3 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record. The Standard Proctor test reports are included in Appendix F-4 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

On June 17, 2008, Test Soil Liner No. 1 was completed after it was smooth drum rolled and then covered with plastic sheeting to prevent moisture loss.

4.1.3 Sampling and Testing Programs for Test Soil Liner

Pursuant to the CQA Plan, the test soil liner was sampled and tested for physical properties utilizing both laboratory and field testing. Required were at least five (5) two-stage field tests to determine the hydraulic conductivity (both vertical and horizontal hydraulic conductivity were calculated), and at least two (2) undisturbed Shelby tube samples tested in the laboratory for vertical hydraulic conductivity to determine a statistical correlation with the field tests.

4.1.3.1 Laboratory Testing

Three (3) Shelby tube samples (ST-01 thru ST-03) were collected from the original Test Soil Liner No. 1 on May 28, 2008. On June 18, 2008, three (3) additional Shelby tube samples (ST-04 thru ST-06) were collected from the test soil liner following repairs from flooding. A sample from each tube was tested for particle size analysis, Atterberg limits, and/or hydraulic conductivity. Table 4.3 summarizes the results of the testing (Appendix F-5 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record contains laboratory test reports and Shelby tube sampling locations).

Table 4.3 Results of Laboratory Testing Program for Test Soil Liner No. 1

Sample No.	Percent of Fines	Liquid Limit	Plasticity Index	Hydraulic Conductivity, k_v	Lift
ST-01-5	67.7%	22%	7%	2.5×10^{-7} cm/sec	2
ST-02-2	71.8%	23%	7%	1.7×10^{-7} cm/sec	4/5
ST-03-3	65.0%	21%	5%	8.7×10^{-8} cm/sec	3/4
ST-04-5				3.0×10^{-7} cm/sec	2
ST-05-3				1.7×10^{-7} cm/sec	4
ST-06-2				2.1×10^{-7} cm/sec	4/5

4.1.3.2 Field Testing

Six (6) two-stage (Boutwell) field permeability tests were conducted on Test Soil Liner No. 1. The tests were carried out to measure the limiting values of field saturated hydraulic conductivity. The first stage of the test measures the maximum possible value for the vertical component of permeability (k_v) and the second stage measures the maximum possible value for the horizontal component of permeability (k_h). One test installation malfunctioned during testing and was abandoned. Table 4.4 summarizes the results of the testing.

Table 4.4 Results of Field Testing Program for Test Soil Liner No. 1

Date of Installation	Test No.	Stage 1 Permeability, k_v	Stage 2 Permeability, k_h
July 18 and 19, 2008	1	9.77×10^{-8} cm/sec	6.23×10^{-8} cm/sec
July 18 and 19, 2008	2	2.20×10^{-7} cm/sec	1.54×10^{-7} cm/sec
July 18 and 19, 2008	3	3.17×10^{-6} cm/sec	9.53×10^{-7} cm/sec
July 18 and 19, 2008	4	Abandoned	Abandoned
July 18 and 19, 2008	5	1.84×10^{-7} cm/sec	5.17×10^{-7} cm/sec
July 18 and 19, 2008	6	9.71×10^{-8} cm/sec	1.30×10^{-7} cm/sec

4.2 Test Soil Liner No. 2

4.2.1 Prequalification of Borrow Materials

Prequalification testing of the borrow materials for the gypsum stack soil liner was not a requirement of the CQA Plan. However, Shelby tube samples collected from the test soil liner were tested for particle size analysis, Atterberg limits, and hydraulic conductivity.

4.2.2 Construction

The construction of Test Soil Liner No. 2 was initiated on July 28, 2008. The test soil liner was built in five approximately 8-inch lifts and compacted with a Cat 815 sheepsfoot compactor.

Nuclear moisture/density gauge testing was performed at a minimum rate of one per acre per lift or one per 1,000 yd^3 to 95% Standard Proctor MDD with moisture contents of optimum to +5%. Nuclear moisture/density test results and a drawing showing the testing locations are included in Appendix F-3 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record. The Standard Proctor test reports are included in Appendix F-4 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

On August 1, 2008, Test Soil Liner No. 2 was completed after it was smooth drum rolled and then covered with plastic sheeting.

4.2.3 Sampling and Testing Programs for Test Soil Liner

Pursuant to the CQA Plan, the test soil liner was sampled and tested for physical properties utilizing both laboratory and field testing. Required were at least five (5) two-stage field tests to determine the hydraulic conductivity (both vertical and horizontal hydraulic conductivity were calculated), and at least two (2) undisturbed Shelby tube samples tested in the laboratory for vertical hydraulic conductivity to determine a statistical correlation with the field tests.

4.2.3.1 Laboratory Testing

Three (3) Shelby tube samples were collected from the test liner. A sample from each tube was tested for particle size analysis, Atterberg limits, and hydraulic conductivity. Table 4.5 summarizes the results of the testing (Appendix F-5 of the Duck Creek GMF Pond Liner Documentation Report located in the operating record contains laboratory test reports and Shelby tube sampling locations).

Table 4.5 Results of Laboratory Testing Program for Test Soil Liner No. 2

Sample No.	Percent of Fines	Liquid Limit	Plasticity Index	Hydraulic Conductivity, k_v	Lift
ST-08-1	95.7%	34%	14%	1.1×10^{-7} cm/sec	3/4
ST-09-2	97.5%	38%	18%	1.3×10^{-8} cm/sec	4
ST-10-3	95.0%	36%	17%	1.3×10^{-8} cm/sec	3

4.2.3.2 Field Testing

Five (5) two-stage (Boutwell) field permeability tests were conducted on Test Soil Liner No. 2. The tests were carried out to measure the limiting values of field saturated hydraulic conductivity. The first stage of the test measures the maximum possible value for the vertical component of permeability (k_v) and the second stage measures the maximum possible value for the horizontal component of permeability (k_h). A complete report of the field testing and data is included in the "Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station, Canton, Fulton County, Illinois. Feezor Engineering, Inc. (March 2009, Revised July 2009)" included in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

Table 4.6 summarizes the results of the testing.

Table 4.6 Results of Field Testing Program for Test Soil Liner No. 2

Date of Installation	Test No.	Stage 1 Permeability, k_v	Stage 2 Permeability, k_h
August 4 and 5, 2008	1	5.87×10^{-8} cm/sec	2.79×10^{-6} cm/sec
August 4 and 5, 2008	2	3.92×10^{-8} cm/sec	9.79×10^{-9} cm/sec
August 4 and 5, 2008	3	1.44×10^{-7} cm/sec	3.09×10^{-8} cm/sec
August 4 and 5, 2008	4	5.53×10^{-7} cm/sec	5.28×10^{-7} cm/sec
August 4 and 5, 2008	5	3.59×10^{-6} cm/sec	4.29×10^{-7} cm/sec

4.3 CQA Certification of Test Soil Liners

Based on the laboratory and field test results, the CQA Officer certified the construction of the test soil liners and that construction of the full scale soil liner could begin using the same soils and procedures used to construct the test liners.

5. Full Scale Soil Liner Construction

Soil materials excavated from the GMF Pond and from the north clay liner soil stockpile were used to construct the 3-ft thick soil liner within the GMF Pond. The soil was placed in approximately 8-inch lifts and compacted with a Cat 815 sheepsfoot compactor. Material placement commenced at the north end of the GMF Pond and proceeded to the south. Nuclear moisture/density gauge testing was performed at a minimum rate of one test per acre per lift or one test per 1,000 yd^3. As-placed densities met at least 95% Standard Proctor MDD with moisture contents of optimum to +5%. Nuclear moisture/density and Standard Proctor test results are included in Appendix G in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

Eighteen (18) Shelby tube samples were collected from the soil liner at various stages of construction. The hydraulic conductivity of the compacted soil liner was sampled and laboratory tested in accordance with ASTM D5084. A sample from each tube was tested to determine hydraulic conductivity. The sample intervals included at least one permeability test from each of the five liner construction lifts. The hydraulic conductivity results ranged from 8.6×10^{-9} cm/sec to 9.8×10^{-7} cm/sec. Permeability test results and a drawing showing Shelby tube sample locations are included in Appendix G-3 in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

Base grades and completed liner elevations were surveyed to ensure construction to the design grades and to verify minimum soil liner thickness. Record drawings and certified survey data are included in Appendices K and L, respectively, in the Duck Creek GMF Pond Liner Documentation Report located in the operating record. After the soil liner was smooth drum rolled, CQA certifications of its construction and grades were provided by the CQA Officer prior to installation of the GCL and 60-mil HDPE geomembrane liner.

6. GCL Installation

The GCL panels were placed on the rolled surface of the compacted soil liner. Panels were placed on the slopes with the long edge of the panel parallel to the direction of drainage. Panels on the floor were oriented in a manner to make installation as efficient as possible. GCL seams were constructed by overlapping their adjacent edges, generally 6 to 12 inches. The GCL panels included a proprietary groove along the longitudinal seams to ensure a proper seal. Seams at the end of panels were shingled in the direction of the grade and granular bentonite was applied to seams at end-of-rolls and at repairs at a rate of ¼ pound per lineal foot.

A third party engineering firm monitored the installation of all geosynthetic materials and assembled the manufacturing quality control (MQC) data, manufacturing quality assurance (MQA) testing data, installer subgrade acceptance, panel placement information, laboratory CQA test data from destruct samples, and field CQA test data for seam welding integrity. All of this data is included in the "Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station, Canton, Fulton County, Illinois. Feezor Engineering, Inc. (March 2009, Revised July 2009)" in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

7. Lower HDPE Geomembrane Liner Installation

Prior to installation of the lower 60-mil textured HDPE geomembrane liner on the floor and side slopes of the GMF Pond, the surface of the full scale soil liner was accepted by the geomembrane installer. In addition, the installation of the GCL was accepted by the geomembrane installer. Installation of the lower geomembrane liner began on September 27, 2008, and placement continued through November 5, 2008. Textured geomembrane liner was used on the GMF Pond floor and side slopes.

The lower HDPE geomembrane was placed immediately over the GCL. On the side slopes, the HDPE geomembrane was laid parallel to the slope and the tie-in weld with the bottom geomembrane was welded a minimum of 5 feet past the toe of the slope. Adjacent panels were overlapped approximately 4-6 inches and were shingled in the direction of the drainage.

Production seaming of the geomembrane panels was made using a dual hot wedge fusion welder. This device creates an air channel between two fused seams that can later be tested with pressurized air to assure there is no leakage. Destruct sample sites and repairs were welded with extrusion welds which were checked for leaks with a vacuum box. All seams were sampled at a rate of one destruct sample for every 500 feet of seam and tested for strength parameters in the laboratory.

8. Upper HDPE Geomembrane Liner Installation

Following installation of the lower 60-mil textured HDPE geomembrane liner, a 10-oz. non-woven geotextile was placed on top of the geomembrane. Twelve inches of drainage media was then installed on the 10-oz. geotextile. Leachate collection pipes and appropriate leachate collection sumps were installed within this drainage layer. The drainage layer was then covered with a 4-oz. non-woven geotextile, one-foot of cushion soil, and a second 60-mil HDPE geomembrane. The second geomembrane was installed utilizing the same practices as the lower geomembrane.

A third party engineering firm monitored the installation of all geosynthetic materials and assembled the manufacturing quality control (MQC) data, manufacturing quality assurance (MQA) testing data, installer subgrade acceptance, panel placement information, laboratory CQA test data from destruct samples, and field CQA test data for seam welding integrity. All of this data is included in the "Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station, Canton, Fulton County, Illinois. Feezor Engineering, Inc. (March 2009, Revised July 2009)" in the Duck Creek GMF Pond Liner Documentation Report located in the operating record.

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ATTACHMENT M

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HISTORY OF POTENTIAL EXCEEDANCES

This presentation of the History of Potential Exceedances, and any corrective action taken to remediate groundwater, is provided to meet the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.230(d)(2)(M) for the Duck Creek Power Plant GMF Pond, Illinois Environmental Protection Agency (IEPA) ID No. W0578010001-04.

Note

Groundwater concentrations from 2015 to 2021 presented in the Hydrogeologic Site Characterization Report (HCR) Table 4-1, and evaluated and summarized in the following tables, are considered potential exceedances because the methodology used to determine them is proposed in the Statistical Analysis Plan (Appendix A to Groundwater Monitoring Plan [GMP]), which has not been reviewed or approved by IEPA at the time of submittal of the 35 I.A.C. § 845 Operating Permit application.

Alternate sources for potential exceedances as allowed by 35 I.A.C. § 845.650(e) have not yet been evaluated. These will be evaluated and presented in future submittals to IEPA as appropriate.

Table 1 summarizes how the potential exceedances were determined. Table 2 is a summary of all potential exceedances.

Background Concentrations

Background monitoring wells identified in the GMP include G02S, G50S, and G51S.

For monitoring wells that have been historically monitored in accordance with Title 40, Code of Federal Regulations, Part 257, Subpart D (Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments), background concentrations calculated from sampling events in 2015-2017 were compared to the standards identified in 35 I.A.C. § 845.600(a)(1). For constituents with calculated background concentrations in 2015-2017 greater than the standards in 35 I.A.C. § 845.600(a)(1), those calculated background concentrations were used as Groundwater Protection Standards (GWPSs) for comparing to statistical calculation results for each compliance well to determine potential exceedances. Compliance well statistical calculations consider concentrations from all sampling events in 2015-2021.

For all other monitoring wells, either newly constructed in 2021 or existing wells not monitored under Title 40, Code of Federal Regulations, Part 257, Subpart D, background concentrations calculated from the eight sampling events required by 35 I.A.C. § 845.650(b)(1)(A), to be collected within 180 days from April 21, 2021, were compared to the standards identified in 35 I.A.C. § 845.600(a)(1). For constituents with calculated background concentrations greater than the standards in 35 I.A.C. § 845.600(a)(1), those calculated background concentrations were used as GWPSs. Compliance well statistical calculations from that same time period were compared to the GWPSs to determine potential exceedances.

Corrective Action

No corrective actions have been taken to remediate the groundwater.

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G51L	PMP	845	pH (field)	SU	02/19/2021 - 02/19/2021	Most recent sample	6.8	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G52L	PMP	845	pH (field)	SU	02/19/2021 - 02/19/2021	Most recent sample	6.4	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G53L	PMP	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.8	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G53S	UA	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.8	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G54C	BR	845	Antimony, total	mg/L	04/14/2021 - 06/01/2021	All ND - Last	0.003	0.006	0.003	0.006	Standard
G54C	BR	845	Arsenic, total	mg/L	04/14/2021 - 06/01/2021	CI around mean	0.000774	0.010	0.0092	0.01	Standard
G54C	BR	845	Barium, total	mg/L	04/14/2021 - 06/01/2021	CI around mean	0.31	2.0	0.28	2	Standard
G54C	BR	845	Beryllium, total	mg/L	04/14/2021 - 06/01/2021	All ND - Last	0.001	0.004	0.001	0.004	Standard
G54C	BR	845	Boron, total	mg/L	04/14/2021 - 06/01/2021	CI around mean	-0.0552	2.0	0.21	2	Standard
G54C	BR	845	Cadmium,total	mg/L	04/14/2021 - 06/01/2021	All ND - Last	0.001	0.005	0.001	0.005	Standard
G54C	BR	845	Chloride, total	mg/L	04/14/2021 - 06/01/2021	CI around mean	1.4	200	17	200	Standard
G54C	BR	845	Chromium, total	mg/L	04/14/2021 - 06/01/2021	CI around median	0	0.10	0.0059	0.1	Standard
G54C	BR	845	Cobalt, total	mg/L	04/14/2021 - 06/01/2021	CI around median	0	0.006	0.002	0.006	Standard
G54C	BR	845	Fluoride, total	mg/L	04/14/2021 - 06/01/2021	CI around mean	0.34	4.0	0.50	4	Standard
G54C	BR	845	Lead, total	mg/L	04/14/2021 - 06/01/2021	Future median	0.001	0.015	0.015	0.0075	Background
G54C	BR	845	Lithium, total	mg/L	04/14/2021 - 06/01/2021	All ND - Last	0.020	0.040	0.020	0.04	Standard
G54C	BR	845	Mercury, total	mg/L	04/14/2021 - 06/01/2021	All ND - Last	0.0002	0.002	0.00098	0.002	Standard
G54C	BR	845	Molybdenum, total	mg/L	04/14/2021 - 06/01/2021	CI around mean	0.024	0.10	0.0023	0.1	Standard
G54C	BR	845	pH (field)	SU	04/14/2021 - 06/01/2021	CI around mean	7.1	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G54C	BR	845	Radium-226 + Radium 228, tot	pCi/L	04/14/2021 - 06/14/2021	CI around mean	-2.06	5.0	2.0	5	Standard
G54C	BR	845	Selenium, total	mg/L	04/14/2021 - 06/01/2021	CI around median	0	0.050	0.0012	0.05	Standard
G54C	BR	845	Sulfate, total	mg/L	04/14/2021 - 06/01/2021	CI around mean	39	400	55	400	Standard
G54C	BR	845	Thallium, total	mg/L	04/14/2021 - 06/01/2021	All ND - Last	0.001	0.002	0.001	0.002	Standard
G54C	BR	845	Total Dissolved Solids	mg/L	04/14/2021 - 06/01/2021	CI around mean	616	1200	483	1200	Standard

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G54L	PMP	845	Antimony, total	mg/L	04/14/2021 - 07/27/2021	All ND - Last	0.003	0.006	0.003	0.006	Standard
G54L	PMP	845	Arsenic, total	mg/L	04/14/2021 - 07/27/2021	CI around mean	0.00259	0.010	0.0092	0.01	Standard
G54L	PMP	845	Barium, total	mg/L	04/14/2021 - 07/27/2021	CI around mean	0.14	2.0	0.28	2	Standard
G54L	PMP	845	Beryllium, total	mg/L	04/14/2021 - 07/27/2021	All ND - Last	0.001	0.004	0.001	0.004	Standard
G54L	PMP	845	Boron, total	mg/L	04/14/2021 - 07/27/2021	CI around mean	0.020	2.0	0.21	2	Standard
G54L	PMP	845	Cadmium,total	mg/L	04/14/2021 - 07/27/2021	All ND - Last	0.001	0.005	0.001	0.005	Standard
G54L	PMP	845	Chloride, total	mg/L	04/14/2021 - 07/27/2021	CI around median	5.2	200	17	200	Standard
G54L	PMP	845	Chromium, total	mg/L	04/14/2021 - 07/27/2021	CI around median	0.004	0.10	0.0059	0.1	Standard
G54L	PMP	845	Cobalt, total	mg/L	04/14/2021 - 07/27/2021	CI around mean	0.00178	0.006	0.002	0.006	Standard
G54L	PMP	845	Fluoride, total	mg/L	04/14/2021 - 07/27/2021	CI around median	0.25	4.0	0.50	4	Standard
G54L	PMP	845	Lead, total	mg/L	04/14/2021 - 07/27/2021	All ND - Last	0.001	0.015	0.015	0.0075	Background
G54L	PMP	845	Lithium, total	mg/L	04/14/2021 - 07/27/2021	All ND - Last	0.020	0.040	0.020	0.04	Standard
G54L	PMP	845	Mercury, total	mg/L	04/14/2021 - 07/27/2021	CI around median	0.0002	0.002	0.00098	0.002	Standard
G54L	PMP	845	Molybdenum, total	mg/L	04/14/2021 - 07/27/2021	CI around mean	0.000575	0.10	0.0023	0.1	Standard
G54L	PMP	845	pH (field)	SU	02/22/2021 - 07/27/2021	CI around mean	6.5	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G54L	PMP	845	Radium-226 + Radium 228, tot	pCi/L	04/14/2021 - 07/27/2021	CI around mean	0.25	5.0	2.0	5	Standard
G54L	PMP	845	Selenium, total	mg/L	04/14/2021 - 07/27/2021	All ND - Last	0.001	0.050	0.0012	0.05	Standard
G54L	PMP	845	Sulfate, total	mg/L	04/14/2021 - 07/27/2021	CI around mean	54	400	55	400	Standard
G54L	PMP	845	Thallium, total	mg/L	04/14/2021 - 07/27/2021	All ND - Last	0.001	0.002	0.001	0.002	Standard
G54L	PMP	845	Total Dissolved Solids	mg/L	04/14/2021 - 07/27/2021	CI around mean	631	1200	483	1200	Standard
G54S	UA	257	Antimony, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.003	0.006	0.003	0.006	Standard
G54S	UA	257	Arsenic, total	mg/L	01/30/2015 - 06/28/2017	CI around geomean	0.00107	0.010	0.00959	0.01	Standard
G54S	UA	257	Barium, total	mg/L	12/04/2015 - 06/28/2017	CI around mean	0.21	2.0	0.32	2	Standard
G54S	UA	257	Beryllium, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.001	0.004	0.0013	0.004	Standard

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G54S	UA	257	Boron, total	mg/L	01/30/2015 - 02/22/2021	CI around mean	0.032	2.0	0.059	2	Standard
G54S	UA	257	Cadmium,total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.001	0.005	0.001	0.005	Standard
G54S	UA	257	Chloride, total	mg/L	01/30/2015 - 02/22/2021	CI around median	2.2	200	22	200	Standard
G54S	UA	257	Chromium, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.004	0.10	0.0058	0.1	Standard
G54S	UA	257	Cobalt, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.002	0.006	0.002	0.006	Standard
G54S	UA	257	Fluoride, total	mg/L	12/04/2015 - 02/22/2021	CI around median	0.25	4.0	0.56	4	Standard
G54S	UA	257	Lead, total	mg/L	01/30/2015 - 06/28/2017	All ND - Last	0.001	0.0075	0.002	0.0075	Standard
G54S	UA	257	Lithium, total	mg/L	12/04/2015 - 06/28/2017	CI around median	0.010	0.040	0.010	0.04	Standard
G54S	UA	257	Mercury, total	mg/L	12/04/2015 - 06/28/2017	Future median	0.0002	0.0024	0.0024	0.002	Background
G54S	UA	257	Molybdenum, total	mg/L	12/04/2015 - 06/28/2017	CI around mean	0.00161	0.10	0.0042	0.1	Standard
G54S	UA	257	pH (field)	SU	01/30/2015 - 06/21/2021	CI around mean	6.9	6.5/9.0	6.5/7.5	6.5/9	Standard/Standard
G54S	UA	257	Radium-226 + Radium 228, tot	pCi/L	12/04/2015 - 06/28/2017	CI around mean	0.52	5.0	2.0	5	Standard
G54S	UA	257	Selenium, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.001	0.050	0.0014	0.05	Standard
G54S	UA	257	Sulfate, total	mg/L	01/30/2015 - 02/22/2021	CI around median	42	400	97	400	Standard
G54S	UA	257	Thallium, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.001	0.0028	0.0028	0.002	Background
G54S	UA	257	Total Dissolved Solids	mg/L	12/04/2015 - 06/21/2021	CI around mean	492	1200	499	1200	Standard
G55L	PMP	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.7	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G55S	UA	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.8	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G56L	PMP	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.6	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G56S	UA	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.6	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G57L	PMP	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.8	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G57S	UA	257	Antimony, total	mg/L	12/04/2015 - 06/28/2017	CI around median	0.003	0.006	0.003	0.006	Standard
G57S	UA	257	Arsenic, total	mg/L	02/04/2015 - 06/28/2017	CI around median	0.001	0.010	0.00959	0.01	Standard
G57S	UA	257	Barium, total	mg/L	12/04/2015 - 06/28/2017	CI around median	0.13	2.0	0.32	2	Standard

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G57S	UA	257	Beryllium, total	mg/L	12/04/2015 - 06/28/2017	CI around median	0.001	0.004	0.0013	0.004	Standard
G57S	UA	257	Boron, total	mg/L	02/04/2015 - 02/22/2021	CI around median	0.010	2.0	0.059	2	Standard
G57S	UA	257	Cadmium,total	mg/L	12/04/2015 - 06/28/2017	CI around median	0.001	0.005	0.001	0.005	Standard
G57S	UA	257	Chloride, total	mg/L	02/04/2015 - 02/22/2021	CI around median	18	200	22	200	Standard
G57S	UA	257	Chromium, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.004	0.10	0.0058	0.1	Standard
G57S	UA	257	Cobalt, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.002	0.006	0.002	0.006	Standard
G57S	UA	257	Fluoride, total	mg/L	12/04/2015 - 02/22/2021	CI around mean	0.26	4.0	0.56	4	Standard
G57S	UA	257	Lead, total	mg/L	02/04/2015 - 06/28/2017	CI around median	0.001	0.0075	0.002	0.0075	Standard
G57S	UA	257	Lithium, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.010	0.040	0.010	0.04	Standard
G57S	UA	257	Mercury, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.0002	0.0024	0.0024	0.002	Background
G57S	UA	257	Molybdenum, total	mg/L	12/04/2015 - 06/28/2017	CI around median	0.001	0.10	0.0042	0.1	Standard
G57S	UA	257	pH (field)	SU	02/04/2015 - 02/22/2021	CI around mean	7.0	6.5/9.0	6.5/7.5	6.5/9	Standard/Standard
G57S	UA	257	Radium-226 + Radium 228, tot	pCi/L	12/04/2015 - 06/28/2017	CI around mean	0.025	5.0	2.0	5	Standard
G57S	UA	257	Selenium, total	mg/L	12/04/2015 - 06/28/2017	All ND - Last	0.001	0.050	0.0014	0.05	Standard
G57S	UA	257	Sulfate, total	mg/L	02/04/2015 - 02/22/2021	CI around geomean	53	400	97	400	Standard
G57S	UA	257	Thallium, total	mg/L	12/04/2015 - 06/28/2017	Future median	0.001	0.0028	0.0028	0.002	Background
G57S	UA	257	Total Dissolved Solids	mg/L	12/04/2015 - 02/22/2021	CI around mean	492	1200	499	1200	Standard
G58L	PMP	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.8	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G58S	UA	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.6	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G59L	PMP	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.7	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G59S	UA	845	pH (field)	SU	02/22/2021 - 02/22/2021	Most recent sample	6.8	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G60L	PMP	845	Antimony, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.003	0.006	0.003	0.006	Standard
G60L	PMP	845	Arsenic, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.001	0.010	0.0092	0.01	Standard
G60L	PMP	845	Barium, total	mg/L	04/14/2021 - 07/28/2021	CI around mean	0.014	2.0	0.28	2	Standard

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G60L	PMP	845	Beryllium, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.001	0.004	0.001	0.004	Standard
G60L	PMP	845	Boron, total	mg/L	04/14/2021 - 07/28/2021	CI around geomean	0.021	2.0	0.21	2	Standard
G60L	PMP	845	Cadmium,total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.001	0.005	0.001	0.005	Standard
G60L	PMP	845	Chloride, total	mg/L	04/14/2021 - 07/28/2021	CI around mean	16	200	17	200	Standard
G60L	PMP	845	Chromium, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.004	0.10	0.0059	0.1	Standard
G60L	PMP	845	Cobalt, total	mg/L	04/14/2021 - 07/28/2021	CI around mean	0.00164	0.006	0.002	0.006	Standard
G60L	PMP	845	Fluoride, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.25	4.0	0.50	4	Standard
G60L	PMP	845	Lead, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.001	0.015	0.015	0.0075	Background
G60L	PMP	845	Lithium, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.020	0.040	0.020	0.04	Standard
G60L	PMP	845	Mercury, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.0002	0.002	0.00098	0.002	Standard
G60L	PMP	845	Molybdenum, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.001	0.10	0.0023	0.1	Standard
G60L	PMP	845	pH (field)	SU	02/23/2021 - 07/28/2021	CI around mean	6.1	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G60L	PMP	845	Radium-226 + Radium 228, tot	pCi/L	04/14/2021 - 07/28/2021	CI around mean	-0.0854	5.0	2.0	5	Standard
G60L	PMP	845	Selenium, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.001	0.050	0.0012	0.05	Standard
G60L	PMP	845	Sulfate, total	mg/L	04/14/2021 - 07/28/2021	CI around median	125	400	55	400	Standard
G60L	PMP	845	Thallium, total	mg/L	04/14/2021 - 07/28/2021	All ND - Last	0.001	0.002	0.001	0.002	Standard
G60L	PMP	845	Total Dissolved Solids	mg/L	04/14/2021 - 07/28/2021	CI around mean	538	1200	483	1200	Standard
G60S	UA	257	Antimony, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.003	0.006	0.003	0.006	Standard
G60S	UA	257	Arsenic, total	mg/L	02/04/2015 - 06/29/2017	CI around geomean	0.00136	0.010	0.00959	0.01	Standard
G60S	UA	257	Barium, total	mg/L	12/04/2015 - 06/29/2017	CI around mean	0.12	2.0	0.32	2	Standard
G60S	UA	257	Beryllium, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.001	0.004	0.0013	0.004	Standard
G60S	UA	257	Boron, total	mg/L	02/04/2015 - 02/23/2021	CI around mean	0.016	2.0	0.059	2	Standard
G60S	UA	257	Cadmium,total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.001	0.005	0.001	0.005	Standard
G60S	UA	257	Chloride, total	mg/L	02/04/2015 - 02/23/2021	CI around geomean	8.9	200	22	200	Standard

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G60S	UA	257	Chromium, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.004	0.10	0.0058	0.1	Standard
G60S	UA	257	Cobalt, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.002	0.006	0.002	0.006	Standard
G60S	UA	257	Fluoride, total	mg/L	12/04/2015 - 02/23/2021	CI around mean	0.27	4.0	0.56	4	Standard
G60S	UA	257	Lead, total	mg/L	02/04/2015 - 06/29/2017	CB around linear reg	-0.0104	0.0075	0.002	0.0075	Standard
G60S	UA	257	Lithium, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.010	0.040	0.010	0.04	Standard
G60S	UA	257	Mercury, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.0002	0.0024	0.0024	0.002	Background
G60S	UA	257	Molybdenum, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.001	0.10	0.0042	0.1	Standard
G60S	UA	257	pH (field)	SU	02/04/2015 - 02/23/2021	CI around mean	6.7	6.5/9.0	6.5/7.5	6.5/9	Standard/Standard
G60S	UA	257	Radium-226 + Radium 228, tot	pCi/L	12/04/2015 - 06/29/2017	CI around mean	0.66	5.0	2.0	5	Standard
G60S	UA	257	Selenium, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.001	0.050	0.0014	0.05	Standard
G60S	UA	257	Sulfate, total	mg/L	02/04/2015 - 02/23/2021	CB around linear reg	94	400	97	400	Standard
G60S	UA	257	Thallium, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.001	0.0028	0.0028	0.002	Background
G60S	UA	257	Total Dissolved Solids	mg/L	12/04/2015 - 02/23/2021	CI around mean	534	1200	499	1200	Standard
G61S	UA	845	pH (field)	SU	02/23/2021 - 02/23/2021	Most recent sample	6.5	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G62L	PMP	845	pH (field)	SU	02/24/2021 - 02/24/2021	Most recent sample	6.7	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G63L	PMP	845	pH (field)	SU	02/24/2021 - 02/24/2021	Most recent sample	6.7	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G63S	UA	845	pH (field)	SU	02/24/2021 - 02/24/2021	Most recent sample	7.0	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G64L	PMP	845	pH (field)	SU	02/25/2021 - 02/25/2021	Most recent sample	7.0	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G64S	UA	257	Antimony, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.003	0.006	0.003	0.006	Standard
G64S	UA	257	Arsenic, total	mg/L	02/04/2015 - 06/29/2017	CI around geomean	0.00251	0.010	0.00959	0.01	Standard
G64S	UA	257	Barium, total	mg/L	12/04/2015 - 06/29/2017	CI around mean	0.17	2.0	0.32	2	Standard
G64S	UA	257	Beryllium, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.001	0.004	0.0013	0.004	Standard
G64S	UA	257	Boron, total	mg/L	02/04/2015 - 02/24/2021	CI around mean	0.017	2.0	0.059	2	Standard
G64S	UA	257	Cadmium,total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.001	0.005	0.001	0.005	Standard

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G64S	UA	257	Chloride, total	mg/L	02/04/2015 - 02/24/2021	CB around linear reg	3.1	200	22	200	Standard
G64S	UA	257	Chromium, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.004	0.10	0.0058	0.1	Standard
G64S	UA	257	Cobalt, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.002	0.006	0.002	0.006	Standard
G64S	UA	257	Fluoride, total	mg/L	12/04/2015 - 02/24/2021	CI around median	0.30	4.0	0.56	4	Standard
G64S	UA	257	Lead, total	mg/L	02/04/2015 - 06/29/2017	CI around mean	0.00131	0.0075	0.002	0.0075	Standard
G64S	UA	257	Lithium, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.010	0.040	0.010	0.04	Standard
G64S	UA	257	Mercury, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.0002	0.0024	0.0024	0.002	Background
G64S	UA	257	Molybdenum, total	mg/L	12/04/2015 - 06/29/2017	CI around mean	0.00152	0.10	0.0042	0.1	Standard
G64S	UA	257	pH (field)	SU	02/04/2015 - 06/21/2021	CI around mean	6.9	6.5/9.0	6.5/7.5	6.5/9	Standard/Standard
G64S	UA	257	Radium-226 + Radium 228, tot	pCi/L	12/04/2015 - 06/29/2017	CI around mean	0.63	5.0	2.0	5	Standard
G64S	UA	257	Selenium, total	mg/L	12/04/2015 - 06/29/2017	CI around median	0.001	0.050	0.0014	0.05	Standard
G64S	UA	257	Sulfate, total	mg/L	02/04/2015 - 02/24/2021	CI around median	25	400	97	400	Standard
G64S	UA	257	Thallium, total	mg/L	12/04/2015 - 06/29/2017	All ND - Last	0.001	0.0028	0.0028	0.002	Background
G64S	UA	257	Total Dissolved Solids	mg/L	12/04/2015 - 06/21/2021	CI around mean	416	1200	499	1200	Standard
P60	PMP	845	Arsenic, total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	0.020	0.010	0.0092	0.01	Standard
P60	PMP	845	Boron, total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	0.056	2.0	0.21	2	Standard
P60	PMP	845	Cadmium,total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	0.001	0.005	0.001	0.005	Standard
P60	PMP	845	Chloride, total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	32	200	17	200	Standard
P60	PMP	845	Lead, total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	0.036	0.015	0.015	0.0075	Background
P60	PMP	845	pH (field)	SU	02/24/2021 - 03/24/2021	Most recent sample	6.6	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
P60	PMP	845	Sulfate, total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	53	400	55	400	Standard
R61L	PMP	845	pH (field)	SU	02/23/2021 - 02/23/2021	Most recent sample	6.6	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard

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TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Notes:
Potential exceedance of GWPS
HSU = hydrostratigraphic unit:
- BR = Bedrock
- PMP = Potential Migration Pathway
- UA = Uppermost Aquifer

Program = regulatory program data were collected under:
- 257 = 40 C.F.R. Part 257 Subpart D (Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments)
- 845 = 35 I.A.C. Part 845 (Sampling events completed to assess well locations for inclusion in the Part 845 monitoring well network)

mg/L = milligrams per liter
pCi/L = picoCuries per liter
SU = standard units
Sample Count = number of samples from Sampled Date Range used to calculate the Statistical Result
Statistical Calculation = method used to calculate the statistical result:
- All ND - Last = All results were below the reporting limit, and the last determined reporting limit is shown
- CB around linear reg = Confidence band around linear regression
- CI around geomean = Confidence interval around the geometric mean
- CI around mean = Confidence interval around the mean
- CI around median = Confidence interval around the median
- Future median = Median of the three most recent samples
- Most recent sample = Result for the most recently collected sample used due to insufficient data

Statistical Result = calculated in accordance with Statistical Analysis Plan using constituent concentrations observed at monitoring well during all sampling events within the specified date range
For pH, the values presented are the lower / upper limits
GWPS = Groundwater Protection Standard
GWPS Source:
- Standard = standard specified in 35 I.A.C. § 845.600(a)(1)
- Background = background concentration (see cover page for additional information)

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TABLE 2. SUMMARY OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
G52L	PMP	845	pH (field)	SU	02/19/2021 - 02/19/2021	Most recent sample	6.4	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
G60L	PMP	845	pH (field)	SU	02/23/2021 - 07/28/2021	CI around mean	6.1	6.5/9.0	6.6/7.4	6.5/9	Standard/Standard
P60	PMP	845	Arsenic, total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	0.020	0.010	0.0092	0.01	Standard
P60	PMP	845	Lead, total	mg/L	03/24/2021 - 03/24/2021	Most recent sample	0.036	0.015	0.015	0.0075	Background

Notes:
HSU = hydrostratigraphic unit:
PMP = Potential Migration Pathway
Program = regulatory program data were collected under:
257 = 40 C.F.R. Part 257 Subpart D (Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments)
845 = 35 I.A.C. Part 845 (Sampling events completed to assess well locations for inclusion in the Part 845 monitoring well network)
mg/L = milligrams per liter
pCi/L = picoCuries per liter
SU = standard units
Sample Count = number of samples from Sampled Date Range used to calculate the Statistical Result
Statistical Calculation = method used to calculate the statistical result:
CI around mean = Confidence interval around the mean
Most recent sample = Result for the most recently collected sample used due to insufficient data
Statistical Result = calculated in accordance with Statistical Analysis Plan using constituent concentrations observed at monitoring well during all sampling events within the specified date range
For pH, the values presented are the lower / upper limits
GWPS = Groundwater Protection Standard
GWPS Source:
Standard = standard specified in 35 I.A.C. § 845.600(a)(1)
Background = background concentration (see cover page for additional information)

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ATTACHMENT N

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Certification of Financial Assurance Requirements

On June 17, 2021, Illinois Power Resources Generating, LLC provided financial assurance in the form of performance bonds to the Illinois Environmental Protection Agency in the amount of $20,670,871 for Ash Pond 1, Ash Pond 2, the Bottom Ash Basin, and the GMF Pond at the Duck Creek Power Plant.[1]

I, Matthew A. Goering, Senior Vice President of Illinois Power Resources Generating, LLC, do hereby certify to the best of my knowledge for the above referenced CCR Units that the financial assurance instruments satisfy the requirements of 35 I.A.C. Part 845, Subpart I.



Matthew A. Goering
Senior Vice President
Illinois Power Resources Generating, LLC

[1] In the operating permit applications, the Ash Pond 1 is referred to as the Ash Pond No. 1, and the Ash Pond 2 is referred to as the Ash Pond No. 2.

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ATTACHMENT O

Electronic Filing: Received, Clerk's Office 06/20/2024

Stantec Consulting Services Inc.
1859 Bowles Avenue Suite 250, Fenton MO 63026-1944

October 12, 2016
File: let_002_175666013_certification
Revision 0

Initial Hazard Potential Classification Assessment
EPA Final CCR Rule
GMF Pond
Duck Creek Power Station
Fulton County, Illinois

1.0 PURPOSE

This report documents Stantec's certification of the initial hazard potential classification assessment for the Duck Creek Power Station GMF Pond.

40 CFR 257.73(a)(2) requires the owner or operator of an existing CCR surface impoundment to conduct an initial hazard potential classification assessment and document the hazard potential classification, and the basis for the classification, of the CCR unit as either a high hazard potential CCR surface impoundment, a significant hazard potential CCR surface impoundment, or a low hazard potential CCR surface impoundment.

2.0 FINDINGS

A visual analysis was performed to evaluate potential hazards associated with a failure of the GMF Pond perimeter containment dike. Failure scenarios were considered along the perimeter dike. Breach scenarios were evaluated for potential downstream impacts to structures, infrastructure, frequently occupied facilities/areas, and waterways. Potential for impacts was evaluated by determining probable breach flow paths using available elevation data and imagery of the impoundment along with the nearby area.

The analysis indicates that a breach of the north, east, and south embankments have potential to impact structures on the Duck Creek Power Station property prior to flowing into the Duck Creek Cooling Pond. A breach of the west embankment would likely impact North Bethel Cemetery Road and the railroad to/from the power station prior to flowing into the Duck Creek Cooling Pond. North Bethel Cemetery Road is intermittently used and the at-risk populations are considered transient. In accordance with Federal guidelines, loss of life is not considered probable for scenarios where persons are only temporarily in the potential inundation area. It was concluded that a breach failure of the GMF Pond containment dike will not result in probable loss of human life. However, it is anticipated that a breach failure of the containment dike will release stored CCR materials into downstream areas and waterways causing environmental damage.

40 CFR 257.53 defines a "significant hazard potential CCR surface impoundment" as a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

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Based on the results of the analysis summarized above, the GMF Pond was assigned a Significant hazard potential classification per 40 CFR 257.53.

3.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Matthew Hoy, being a Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that;

1. the information contained in this report and the underlying data in the operating record was prepared in accordance with the accepted practice of engineering and is accurate as of the date of my signature below; and

2. the initial hazard potential classification assessment for the Duck Creek Power Station GMF Pond was conducted in accordance with the requirements specified in 40 CFR 257.73.

SIGNATURE _____ DATE 10/12/2016

ADDRESS: Stantec Consulting Services Inc.
1859 Bowles Avenue Suite 250
Fenton MO 63026-1944

TELEPHONE: (636) 343-3880



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ATTACHMENT P

Electronic Filing: Received, Clerk's Office 06/20/2024

AECOM

Submitted to
Illinois Power Resources
Generating, LLC
17751 North Cilco Road
Canton, IL 61520

Submitted by
AECOM
1001 Highlands Plaza Drive West
Suite 300
St. Louis, MO 63110

October 2016

CCR Rule Report: Initial Structural Stability Assessment

For

GMF Pond

At Duck Creek Power Station

Electronic Filing, Received, Clerk's Office 06/20/2024

1 Introduction

This Coal Combustion Residual (CCR) Rule Report documents that the Gypsum Management Facility (GMF) Pond at the Illinois Power Resources Generating, LLC Duck Creek Power Station meets the structural stability assessment requirements specified in 40 Code of Federal Regulations (CFR) §257.73(d). The GMF Pond is located near Canton, Illinois in Fulton County, approximately 2.5 miles north of the Duck Creek Power Station. The GMF Pond serves as the wet impoundment basin for gypsum produced by the wet scrubber system at the Duck Creek Power Station.

The GMF Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that an initial structural stability assessment for an existing CCR surface impoundment be completed by October 17, 2016. In general, the initial structural stability assessment must document that the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices.

The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial structural stability assessment was conducted in accordance with the requirements of 40 CFR § 257.73(d). The owner or operator must prepare a periodic structural stability assessment every five years.

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2 Initial Structural Stability Assessment

40 CFR §257.73(d)(1)
The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with [the standards in (d)(1)(i)-(vii)].

An initial structural stability assessment has been performed to document that the design, construction, operation and maintenance of the GMF Pond is consistent with recognized and generally accepted good engineering practices and meets the standards in §257.73(d)(1)(i)-(vii). The results of the structural stability assessment are discussed in the following sections. Based on the assessment and its results, the design, construction, operation, and maintenance of the GMF Pond were found to be consistent with recognized and generally accepted good engineering practices and meets the standards in 257.73(d)(1)(i)-(vii).

2.1 Foundations and Abutments (§257.73(d)(1)(i))

CCR unit designed, constructed, operated, and maintained with stable foundations and abutments.

The stability of the foundations was evaluated using soil data from field investigations and reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM. Additionally, slope stability analyses were performed to evaluate slip surfaces passing through the foundations. The GMF Pond is a ring dike structure and does not have abutments.

The foundation consists of medium stiff to very stiff soil, which indicates stable foundations. Slope stability analyses exceed the criteria listed in §257.73(e)(1) for slip surfaces passing through the foundation. The slope stability analyses are discussed in the *CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station* (October 2016). A review of operational and maintenance procedures as well as current and past performance of the dikes has determined appropriate processes are in place for continued operational performance.

Based on the conditions observed by AECOM, the GMF Pond was designed and constructed with stable foundations. Operational and maintenance procedures are in place to address any issues related to the stability of foundations; therefore, the GMF Pond meets the requirements in §257.73(d)(1)(i).

2.2 Slope Protection (§257.73(d)(1)(ii))

CCR unit designed, constructed, operated, and maintained with adequate slope protection to protect against surface erosion, wave action and adverse effects of sudden drawdown.

The adequacy of slope protection was evaluated by reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM.

Based on this evaluation, adequate slope protection was designed and constructed at the GMF Pond. No evidence of significant areas of erosion or wave action were observed. The interior slopes are protected with a geomembrane liner that underlies the entire GMF Pond and extends up the interior slopes, and the exterior slopes are protected with vegetation. The geomembrane liner on the interior slopes isolates the embankment soils from surface erosion or wave action. Operational and maintenance procedures to repair the vegetation

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(exterior slopes) and liner (interior slopes) as needed are appropriate to protect against surface erosion or wave action. Given the presence of a liner that serves to prevent saturation of the dike's soils below the normal pool, sudden drawdown, as well as the corresponding adverse effects, is not applicable to the GMF Pond. Therefore, the GMF Pond meets the requirements in §257.73(d)(1)(ii).

2.3 Dike Compaction (§257.73(d)(1)(iii))

CCR unit designed, constructed, operated, and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.

The density of the dike materials was evaluated using soil data from field investigations and reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM. Additionally, slope stability analyses were performed to evaluate slip surfaces passing through the dike over the range of expected loading conditions as defined within §257.73(e)(1).

Based on this evaluation, the dike consists of stiff to very stiff material, which is indicative of mechanically compacted dikes. Slope stability analyses exceed the criteria listed in §257.73(e)(1) for slip surfaces passing through the dike. The slope stability analyses are discussed in the *CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station* (October 2016); therefore, the original design and construction of the GMF Pond included sufficient dike compaction. Operational and maintenance procedures are in place to identify and mitigate deficiencies in order to maintain sufficient compaction of the dikes to withstand the range of loading conditions. Therefore, the GMF Pond meets the requirements in §257.73(d)(1)(iii).

2.4 Vegetated Slopes (§257.73(d)(1)(iv))[1]

CCR unit designed, constructed, operated, and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection.

The adequacy of slope vegetation was evaluated by reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM.

Based on this evaluation, the vegetation on the exterior slopes is adequate as no substantial bare or overgrown areas were observed. Exposed geomembrane liners on the interior slopes are used as an alternate form of slope protection, which is adequate as significant tears or defects were not observed. Therefore, the original design and construction of the GMF Pond included adequate vegetation of the dikes and surrounding areas. Adequate operational and maintenance procedures are in place to regularly manage vegetation growth, including mowing and seeding any bare areas, as evidenced by the conditions observed by AECOM. Therefore, the GMF Pond meets the requirements in §257.73(d)(1)(iv).

[1] As modified by court order issued June 14, 2016, Utility Solid Waste Activities Group v. EPA, D.C. Cir. No. 15-1219 (order granting remand and vacatur of specific regulatory provisions).

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2.5 Spillways (§257.73(d)(1)(v))

CCR unit designed, constructed, operated, and maintained with a single spillway or a combination of spillways configured as specified in [paragraph (A) and (B)]:

(A) All spillways must be either:

(1) of non-erodible construction and designed to carry sustained flows; or

(2) earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.

(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:

(1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or

(2) 1000-year flood for a significant hazard potential CCR surface impoundment; or

(3) 100-year flood for a low hazard potential CCR surface impoundment.

The spillway was evaluated using design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM. Additionally, hydrologic and hydraulic analyses were completed to evaluate the capacity of the spillway relative to inflow estimated for the 1,000-year flood event for the significant hazard potential GMF Pond. The hazard potential classification assessment was performed by Stantec in 2016 in accordance with §257.73(a)(2).

The spillway is lined with a geomembrane, which is a non-erodible material. The ability of the spillway design to carry sustained flows, as well as the capacity of the spillway, was evaluated using hydrologic and hydraulic analysis performed per §257.82(a). The analysis found that the spillway can adequately manage flow during peak discharge resulting from the 1,000-year storm event without overtopping of the embankments. The hydrologic and hydraulic analyses are discussed in the *CCR Rule Report: Initial Inflow Design Flood Control System Plan for GMF Pond at Duck Creek Power Station* (October 2016). This also means that the design of the spillway is adequate to carry sustained flows. Operational and maintenance procedures are in place to repair any tears in the spillway liner and remove debris or other obstructions from the spillway, as evidenced by the conditions observed by AECOM. As a result, these procedures are appropriate for maintaining the spillway. Therefore, the GMF Pond meets the requirements in §257.73(d)(1)(v).

2.6 Stability and Structural Integrity of Hydraulic Structures (§257.73(d)(1)(vi))

CCR unit designed, constructed, operated, and maintained with hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.

Based on an evaluation of design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM, no hydraulic structures are present that underlie the base or pass through the dike of the GMF Pond. Therefore, the §257.73(d)(1)(vi) requirements are not applicable to the GMF Pond.

2.7 Downstream Slope Inundation/Stability (§257.73(d)(1)(vii))

CCR unit designed, constructed, operated, and maintained with, for CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

The structural stability of the downstream slopes of the GMF Pond was evaluated by comparing the location of the GMF Pond relative to adjacent water bodies using published United States Geological Survey (USGS) topographic maps, aerial imagery, and conditions observed in the field by AECOM.

Based on this evaluation, water bodies adjacent to the downstream slopes of the GMF Pond are not present. Water bodies within the vicinity of the GMF Pond include the Duck Creek Cooling Pond and several small unnamed ponds. These water bodies are located several hundred feet or more beyond the GMF Pond

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downstream slopes. The adjacent GMF Pond is a non-CCR surface impoundment and is not a river, stream, or lake. Therefore, adjacent water bodies that can inundate the downstream slopes of the GMF Pond are not present.

Based on this evaluation, the requirements in §257.73(d)(1)(vii) are not applicable to the GMF Pond, as inundation of the downstream slopes is not expected to occur.

3 Certification Statement

CCR Unit: Illinois Power Resources Generating, LLC; Duck Creek Power Station; GMF Pond

I, Victor A. Modeer, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this CCR Rule Report, and the underlying data in the operating record, has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the initial structural stability assessment dated October 13, 2016 was conducted in accordance with the requirements of 40 CFR § 257.73(d).

VICTOR A. MODEER JR.

Printed Name

10/13/16

Date



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October 2016

CCR Rule Report: Initial Safety Factor Assessment

For

GMF Pond

At Duck Creek Power Station

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1 Introduction

This Coal Combustion Residual (CCR) Rule Report documents that the Gypsum Management Facility (GMF) Pond at the Illinois Power Resources Generating, LLC Duck Creek Power Station meets the safety factor assessment requirements specified in 40 Code of Federal Regulations (CFR) §257.73(e). The GMF Pond is located near Canton, Illinois in Fulton County, approximately 2.5 miles north of the Duck Creek Power Station. The GMF Pond serves as the wet impoundment basin for gypsum produced by the wet scrubber system at the Duck Creek Power Station.

The GMF Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the initial safety factor assessment for an existing CCR surface impoundment be completed by October 17, 2016.

The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial safety factor assessment meets the requirements of 40 CFR § 257.73(e). The owner or operator must prepare a safety factor assessment every five years.

2 Initial Safety Factor Assessment

40 CFR §257.73(e)(1)
The owner or operator must conduct initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

(iii) The calculated seismic factor of safety must equal or exceed 1.00.

(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

A geotechnical investigation program and stability analyses were performed to evaluate the design, performance, and condition of the earthen dikes of the GMF Pond. The exploration consisted of hollow-stem auger borings and laboratory program including strength and index testing. Data collected from the geotechnical investigation, available design drawings, construction records, inspection reports, previous engineering investigations, and other pertinent historic documents were utilized to perform the safety factor assessment and geotechnical analyses.

In general, the subsurface conditions at the GMF Pond consist of stiff to very stiff embankment fill (clay) intermittently overlying medium stiff to stiff loess (clay), which in turn overlies medium stiff to very stiff glacial till (clay) with trace sand and gravel. Phreatic water is within the foundation of the GMF Pond.

A representative cross section was analyzed using limit equilibrium slope stability analysis software to evaluate stability of the perimeter dike system and foundations. The cross section was located at the maximum embankment height for the GMF Pond. Due to the relatively short height of the GMF Pond embankments and uniform slope orientations, subsurface stratigraphy, and phreatic conditions, a single cross section at the maximum embankment height is sufficient to represent the critical cross section. The cross section was evaluated for each of the loading conditions stipulated in §257.73(e)(1).

A liquefaction susceptibly evaluation did not find soils susceptible to liquefaction within the GMF Pond dikes. As a result, the Soils Susceptible to Liquefaction loading condition (§257.73(e)(1)(iv)) is not applicable to the GMF Pond at the Duck Creek Power Station.

Results of the Initial Safety Factor Assessment, for the critical cross-section, are listed in **Table 1**.

Table 1 – Summary of Initial Safety Factor Assessments

Loading Conditions	§257.73(e)(1) Subsection	Minimum Factor of Safety	Calculated Factor of Safety
Maximum Storage Pool Loading	(i)	1.50	4.27
Maximum Surcharge Pool Loading	(ii)	1.40	4.26
Seismic	(iii)	1.00	2.37
Soils Susceptible to Liquefaction	(iv)	1.20	Not Applicable

Based on this evaluation, the GMF Pond meets the requirements in §257.73(e)(1).

3 Certification Statement

CCR Unit: Illinois Power Resources Generating, LLC; Duck Creek Power Station; GMF Pond

I, Victor A. Modeer, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this CCR Rule Report, and the underlying data in the operating record, has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the initial safety factor assessment dated October 13, 2016 meets the requirements of 40 CFR §257.73(e).

VICTOR A MODEER JR.

Printed Name

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Date



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October 2016

CCR Rule Report: Initial Inflow Design Flood Control System Plan

For

GMF Pond

At Duck Creek Power Station

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1 Introduction

This Coal Combustion Residual (CCR) Rule Report documents that the initial inflow design flood control system plan for Gypsum Management Facility (GMF) Pond at the Illinois Power Resources Generating, LLC Duck Creek Power Station meets the requirements specified in 40 Code of Federal Regulations (CFR) §257.82. The GMF Pond is located near Canton, Illinois in Fulton County, approximately 2.5 miles north of the Duck Creek Power Station. The GMF Pond serves as the wet impoundment basin for gypsum produced by the wet scrubber system at the Duck Creek Power Station.

The GMF Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the initial inflow design flood control system plan for an existing CCR surface impoundment be prepared by October 17, 2016. The plan must document how the inflow design flood control system has been designed and constructed to meet the requirements of 40 CFR §257.82 and be supported by appropriate engineering calculations.

The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the inflow design flood control system meets the requirements of 40 CFR §257.82. The owner or operator must prepare an inflow design flood control system plan every five years.

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2 Initial Inflow Design Flood Control System Plan

40 CFR §257.82
(a) The owner or operator of an existing … CCR surface impoundment … must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (2) of this section.

(1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.

(2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section.

(3) The inflow design flood is:

(i) For a high hazard potential CCR surface impoundment, …, the probable maximum flood;

(ii) For a significant hazard potential CCR surface impoundment, …, the 1,000-year flood;

(iii) For a low hazard potential CCR surface impoundment, …, the 100-year flood; or

(iv) For an incised CCR surface impoundment, the 25-year flood.

(b) Discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.

Analyses completed for the initial inflow design flood control system plan of the GMF Pond are described in the following subsections. Data and analysis results in the following subsections are based on spillway design information shown on design drawings, construction information, topographic surveys, information about operational and maintenance procedures provided by Illinois Power Resources Generating, LLC, and field measurements collected by AECOM. The analysis approach and results of the hydrologic and hydraulic analyses are presented in the following subsections.

The GMF Pond has a significant hazard potential, based on the initial hazard potential classification assessment performed by Stantec in 2016 in accordance with §257.73(a)(2).

2.1 Initial Inflow Design Flood Control Systems (§257.82(a))

An initial inflow design flood control system plan, supported by a hydraulic and hydrologic analysis, was developed for the GMF Pond by evaluating the effects of a 24-hour duration design storm for the 1,000-year Inflow Design Flood (IDF) using a hydrologic HydroCAD (Version 8.5) computer model and a starting water surface elevation of 616.0 feet. The computer model evaluated the GMF Pond's ability to collect and control the 1,000-year IDF under existing operational and maintenance procedures. Rainfall data for the 1,000-year IDF was obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14. The NOAA Atlas 14 rainfall depth is 9.37 inches.

The HydroCAD model results for the GMF Pond indicate that the CCR unit has sufficient storage capacity and spillway structures to adequately manage (1) flow into the CCR unit during and following the peak discharge of the 1,000-year IDF and (2) flow from the CCR unit to collect and control the peak discharge resulting from the 1,000-year IDF. The peak water surcharge elevation is 618.3 feet during the IDF, and the minimum crest elevation of the GMF Pond dike is 620.0 feet. Therefore, overtopping is not expected.

Based on this evaluation, the GMF Pond meets the requirements in §257.82(a).

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2.2 Discharge from the CCR Unit (§257.82(b))

40 CFR §257.82(b) provides that the discharge from the CCR unit must be handled in accordance with the surface water requirements under 40 CFR §257.3-3, which states the following:

(a) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act, as amended.

(b) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under section 404 of the Clean Water Act, as amended.

(c) A facility or practice shall not cause non-point source pollution of waters of the United States that violates applicable legal requirements implementing an areawide or Statewide water quality management plan that has been approved by the Administrator under section 208 of the Clean Water Act, as amended.

(d) Definitions of the terms Discharge of dredged material, Point source, Pollutant, Waters of the United States, and Wetlands can be found in the Clean Water Act, as amended, 33 U.S.C. 1251 et seq., and implementing regulations, specifically 33 CFR part 323 (42 FR 37122, July 19, 1977).

The handling of discharge was evaluated by reviewing design drawings, operational and maintenance procedures, conditions observed in the field by AECOM, and the inflow design flood control system plan developed per §257.82(a).

Based on this evaluation, the GMF Pond does not discharge into waters of the United States. Water from the GMF Pond is recycled for use in plant operations. Hydraulic and hydrologic analyses performed as part of the initial inflow design flood control system plan found the GMF Pond adequately manages outflow during the 1,000-year IDF, as overtopping of the GMF Pond embankments is not expected.

Therefore, discharge to waters of the United States is not expected during normal or IDF conditions, and the GMF Pond meets the requirements in §257.82(b).

3 Certification Statement

CCR Unit: Illinois Power Resources Generating, LLC; Duck Creek Power Station; GMF Pond

I, Victor A. Modeer, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this CCR Rule Report, and the underlying data in the operating record, has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the initial inflow design flood control system plan dated October 13, 2016 meets the requirements of 40 CFR §257.82.

VICTOR A MODEER SR.
Printed Name

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Date



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PART 845 SAFETY AND HEALTH PLAN

DUCK CREEK POWER PLANT
GMF POND AND BOTTOM ASH BASIN

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ACRONYMS & ABBREVIATIONS

%	Percent
§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
29 C.F.R.	Title 29 of the Code of Federal Regulations
ACGIH	American Conference of Governmental Industrial Hygienists
BAB	Bottom Ash Basin
CCR	Coal Combustion Residual
DCPP	Duck Creek Power Plant
GMFP	Gypsum Management Facility Pond
HAZWOPER	Hazardous Waste Operations and Emergency Response
ID	identification
IDLH	Immediately Dangerous to Life and Health
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
kV	kilovolt
NID	National Inventory of Dams
NIOSH	National Institute for Occupational Safety and Health
No.	number
OSHA	Occupational Safety and Health Administration
Part 845	35 I.A.C. Part 845: Residuals in Surface Impoundments
PEL	Permissible Exposure Level
PFAS	Per- and polyfluoroalkyl substances
PFD	Personal Flotation Device
PNOR	particulates not otherwise recognized
POC	Point of Contact
PPE	personal protective equipment
ppm	parts per million
SDS	Safety Data Sheet
Site	GMFP and BAB
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TWA	time-weighted averages
USCG	United States Coast Guard

REVISION SUMMARY

Revision Date	Description of Changes (Section title or number – description)	Responsible Party (individual name or title, company / agency name, document reference and date)

PREFACE

Illinois Power Resources Generating, LLC (IPRG) has prepared this Safety and Health Plan in accordance with requirements set forth in Title 35 of the Illinois Administrative Code (35 I.A.C.) Part 845: Residuals in Surface Impoundments (Part 845), Section (§) 845.530. IRPG assessed health and safety hazards of its coal combustion residual (CCR) surface impoundments to develop and update this Safety and Health Plan.

This document describes the minimum anticipated protective measures necessary for worker health and safety at Duck Creek Power Plant (DCPP) Gypsum Management Facility Pond (GMFP; Vistra identification [ID] number [No.] 203, Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04, National Inventory of Dams [NID] No. IL50573) and Bottom Ash Basin (BAB; Vistra ID No. 205, IEPA ID No. W0578010001-03, NID No. IL50716), collectively referred to as the Site. Employees of IPRG, contract workers, and third-party contractors must read and comply with the contents of this document. The contents of this document are not intended to cover all situations that may arise nor to waive any provisions specified in Federal, State, and local regulations or site owner / contractor health and safety requirements.

Third-party contractors are accountable for the health and safety of their employees. Third-party contractors are required to prepare a Safety and Health Plan that meets the minimum requirements herein. However, no requirements or provisions within this plan shall be construed as an assumption of IPRG of their legal responsibilities as an employer.

This Safety and Health Plan will be reviewed and updated annually, at a minimum. The Safety and Health Plan will also be updated if facility operations change, or a new hazard is identified.

1. INTRODUCTION

This Safety and Health Plan has been developed to outline the requirements to be met by employees of IPRG, contract workers, and third-party contractors while performing any activity to construct, operate, or close the CCR Units at the Site. This Safety and Health Plan has been developed to meet the requirements of 35 I.A.C. § 845.530 and describes the responsibilities, training requirements, protective equipment, and safety procedures necessary to minimize the risk of injury, fires, explosion, chemical spills, material damage incidents, and near misses related to CCR activities. This Safety and Health Plan incorporates by reference the Occupational Safety and Health Administration (OSHA) regulations contained in Title 29 of the Code of Federal Regulations (29 C.F.R.) § 1910 and 29 C.F.R. § 1926.

The requirements and guidelines in this Safety and Health Plan are based on a review of available information and data, and an evaluation of identified on-site hazards. This Safety and Health Plan will be reviewed with persons assigned to work at the Site and will be available on-site.

1.1 Site Description/History

The DCPP is a retired coal-fired power plant located in Section 30 of Township 6 North, Range 5 East, in Fulton County, Illinois and approximately 6 miles southeast of the town of Canton. The BAB is located immediately northeast of the power plant facility in Section 30, 31. The GMFP is located to the north in Section 18, east of Bethel Cemetery Road, and approximately 2 miles southeast of Canton, Illinois (Appendix A).

1.2 Facility Personnel

The following table outlines key facility personnel with respect to facility operations and health and safety.

Name	Position	Phone Number
Brandon Potter	Point-of-Contact (POC) /Plant Manager	618-210-3418
Security Guard	Security Guard	713-542-0619
Daryl Johnson	Environmental Manager	309-229-6088
Matt Ballance	Engineering Manager	618-343-7739 (office) 618-792-7274 (mobile)
Jason Campbell	Dam Safety Manager	271-753-8904 (Springfield) 217-622-3491 (mobile)
Stu Cravens	Senior Technical Expert	217-390-1503 (mobile)
Vic Modeer	Engineering Manager	618-541-0878
Charles Koudelka	Plant Closure Director	903-235-8633

1.3 Responsibilities

The following persons have responsibilities associated with communicating and implementing the Safety and Health Plan for the Site.

1.3.1 IPRG Point of Contact

The IPRG Point of Contact (POC) is a management-level person who is requiring employees, contract workers, or third-party contractors to enter the Site. The IPRG POC is responsible to communicate Safety and Health Plan information and requirements to employees, contract workers, and third-party contractors, and oversee work performed at the Site to the extent necessary to confirm implementation of Safety and Health Plan requirements.

1.3.2 IPRG Employees

IPRG employees are directly hired by IPRG. They are required to implement and/or follow Safety and Health Plan requirements as applicable to their work and exercise their "stop work authority" if safety requirements are unclear or unanticipated site conditions or hazards are observed.

1.3.3 Contract Workers

Contract workers are those hired by IPRG through an agency firm. Similar to IPRG employees, contract workers are required to implement and/or follow Safety and Health Plan requirements as applicable to their work and exercise their "stop work authority" if safety requirements are unclear or unanticipated site conditions or hazards are observed.

1.3.4 Third-Party Contractor Employees

Third-party contractor employees work for firms under contract to IPRG. Third-party contractors include prime contractors and all of their lower tier subcontractors. Similar to IPRG employees, third-party contractors are required to implement Safety and Health Plan requirements as applicable to their work and exercise their "stop work authority" if safety requirements are unclear or unanticipated site conditions or hazards are observed.

1.3.5 Third-Party Contractor Safety Competent Person

Third-party contractors will be required to designate a Safety Competent Person. The Safety Competent Person must be in a management position (*e.g.,* superintendent, foreman, etc.) with OSHA 30-hour construction safety certification who may perform other duties, unless IPRG requires a dedicated Safety Competent Person. A Safety Competent Person must be on site at all times when the subcontractor has employees performing work for IPRG and must possess a sound working knowledge of pertinent OSHA regulations, this Safety and Health Plan, and other applicable safety requirements related to the scope of work. Third-party contractors must also designate a backup Safety Competent Person that possesses the same authority and training. The competent person will ensure timely correction of safety deficiencies identified by IPRG. The Safety Competent Person is responsible to ensure Safety and Health Plan requirements have been communicated to lower-tier subcontractors and enforce Safety and Health Plan requirements.

2. SITE ACCESS & CONTROL

This section outlines requirements for ensuring that only authorized personnel and visitors are permitted at the Site.

2.1 Facility Security

Elements of site control include restricting access to the CCR Units to persons until they have met the training requirements outlined in this Safety and Health Plan and have been authorized to do so by DCPP POC or their representative.

All IPRG employees, contract workers, and third-party contractors must sign in and out with the security guard.

Upon arrival to the Site, all IPRG employees, contract workers, and third-party contractors must check in/out at Security. A COVID-19 screening must also be completed per Section 3.8.

2.2 Third-Party Contractor Management

Prior to working at the Site, all third-party prime contractors must maintain an active registration with ISNetworld and maintain a grade of A or B. Lower tier subcontractors are currently not required to be registered in ISNetworld, but this requirement may change at the discretion of IPRG.

2.3 Third-Party Contractor Safety and Health Plan

Prior to being authorized to conduct work at the Site, third-party contractors must develop and submit a Safety and Health Plan. The third-party contractor's Safety and Health Plan must be specific to the scope of work that they will be performing at the Site. The third-party contractor's Safety and Health Plan must meet or exceed all the requirements in this Safety and Health Plan, other IPRG requirements, and applicable regulations. All lower tier subcontractors of third-party contractors must meet the requirements in this Safety and Health Plan as well as the requirements outlined in the Safety and Health Plan of the third-party with whom they are contracted.

2.4 Authorized Personnel

At a minimum, authorized personnel who will be granted unescorted access to the project include IPRG employees, contract workers, and third-party contractors that meet the following:

- Reviewed this Safety and Health Plan and other applicable safety planning documentation
- Have completed all the training, medical surveillance, and drug screen and background investigation requirements as outlined in Section 3 of this Safety and Health Plan.

2.5 Visitors

Visitors must be escorted by Authorized Personnel through the Site if they have not reviewed this Safety and Health Plan or completed the training requirements outlined in Section 3 of this Safety and Health Plan. Visitors may not undertake any activity to construct, operate, or close a CCR surface impoundment.

2.6 Communication

Communication between workers and emergency services must be maintained at all times. Cellular service is consistently available and can be relied upon to summon emergency services.

3. TRAINING & MEDICAL REQUIREMENTS

Project personnel must be properly trained for the type of work being performed and in accordance with 35 I.A.C. § 845.530, 29 C.F.R. § 1926 and 29 C.F.R. § 1910, and IPRG policies. Additionally, personnel working in areas regulated by the OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) standards (29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65) must have current medical surveillance. All employees, contractors, and third-party contractors must complete the following prior to beginning any activity to construct, operate or close the CCR Units at the Site.

3.1 HAZWOPER Training

35 I.A.C. § 845.530(c)(2)(E) requires that all employees, contract workers, and third-party contractors be trained in accordance with 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65. The following training will be completed as required by job function:

- **OSHA 40-Hour Training** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, for those personnel who are expected to have extensive contact with contaminated materials and/or may be required to wear a respirator.
- **OSHA 24-Hour Training** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, for those personnel who are expected to have minimal contact with contaminated materials and will NOT be required to wear a respirator.
- **OSHA 8-hour Supervisor Training** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, for Site Supervisors, Foremen, Superintendents, and others who will be directing and managing site activities.
- **OSHA 8-hour Refresher** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, completed within 12 months of initial 40-hour or 24-hour training and annually thereafter.

The following matrix outlines HAZWOPER training requirements based on typical job functions at the Site. It is not intended to be all inclusive, new job functions must be evaluated per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65.

Training	Job Function
OSHA 40-hour	Ash handlers
OSHA 24-hour	Personnel not required to handle CCR materials
OSHA 8-hour Supervisor Training	Third-Party Contractor Safety Competent Persons
OSHA 8-hour refresher	All personnel

3.2 OSHA Construction Outreach Training

35 I.A.C. § 845.530(c)(2)(E) requires that all employees, contract workers, and third-party contractors complete an OSHA 10-hour or 30-hour construction safety training. These trainings will be completed as follows:

- All employees, contract workers, and third-party contract employees: OSHA 10-hour or 30-hour construction outreach training.
- Supervisors, superintendents, foreman and safety professionals: OSHA 30-hour construction outreach training.

3.3 Safety and Health Plan Review

Pursuant to 35 I.A.C. § 845.530(d)(e), before beginning any activity at the Site, and annually thereafter, all IPRG employees, contract workers, and third-party contractors must review the content of this HASP. After reviewing this Safety and Health Plan all personnel will understand the following:

- Procedures for using, inspecting, repairing, and replacing facility emergency and monitoring equipment
- Communications or alarm systems outlined in Section 6
- Response to fires and explosions outlined in Section 6
- Response to a spill or release of CCR
- Information about chemical hazards and hazardous materials outlined in Section 5
- The use of engineering controls, administrative controls, and personal protective equipment (PPE) outlined in Section 4

All personnel will acknowledge this HASP by signing the *Safety and Health Plan Acknowledgment Form (Appendix B).*

3.4 Emergency and Monitoring Equipment Training

All IPRG employees, contract workers, and third-party contractors must be aware of how to respond to alarms and other emergencies as outlined in Section 6 of this plan. Individuals may only use facility emergency and monitoring equipment if they have been trained in their use and authorized to do so by the designated POC. Additionally, a written release may need to be completed as required by Vistra Corporate Procedure FFA-POL-0006.

Individual IPRG employees and contract workers may be responsible for using, inspecting, repairing and replacing facility emergency monitoring equipment. These individuals will be trained in accordance with the Authorized Gas Testing training (or equivalent) or other procedures identified by IPRG. These individuals will review and adhere to the manufacturer's instructions, where applicable.

Third-party contractors are responsible for inspecting, repairing, and replacing any owned emergency (*i.e.*, fire extinguishers) and monitoring equipment (*i.e.*, air monitoring equipment). Third-party contractors will maintain procedures for using, inspecting, repairing, and replacing owned emergency and monitoring equipment that is consistent with the manufacturer's requirements. Third-party contractor employees who are responsible for this equipment will be trained in procedures for using, inspecting, and repairing owned equipment by their employer.

3.5 Hazard Communication

All employees, contract workers, and third-party contractors must be trained in chemical hazards (if any) associated with their work in accordance with 29 C.F.R. § 1910.1200. Work tasks performed at the Site may include exposure to compounds identified in the Hazard Communication section of this Safety and Health Plan and is included as part of the Safety and Health Plan Review outlined in Section 3.3.

3.6 Medical Surveillance

All employees, contract workers, and third-party contractors engaged in operations specified in 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65 and meet one of the criteria outlined in 29 C.F.R. § 1910.120(f)(2) and 29 C.F.R. § 1926.65(f)(2) must participate in a medical surveillance program that is administered by their employer. The criteria for participating in a medical surveillance program are:

- All employees who are or may be exposed to hazardous substances at or above the established permissible exposure limit, without regard to the use of respirators, for 30 days or more a year;
- All employees who wear a respirator for 30 days or more a year; or
- All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation.

The medical surveillance program must result in documentation that an individual is cleared to work on sites covered by 29 C.F.R. § 1910.120 and 20 C.F.R. § 1926.65 and is medically fit to wear a respirator when applicable.

3.7 Drug Screen and Background Investigations

IPRG requires that contract worker agencies and third-party contractors are responsible for ensuring that all personnel have completed and passed a drug and alcohol test and background investigation prior to on-site work as described in Appendix C.

3.8 COVID-19 Site Entry Guidelines

All personnel entering Vistra work sites shall review and adhere to the site entry guidelines provided in Appendix D.

3.9 Document Management

IPRG will maintain employee and contract employee training and medical surveillance records in the Maintenance Office. Third-party contractors are responsible for maintaining training and medical surveillance documentation for their employees. Third-party contractors will produce documentation upon IPRG request.

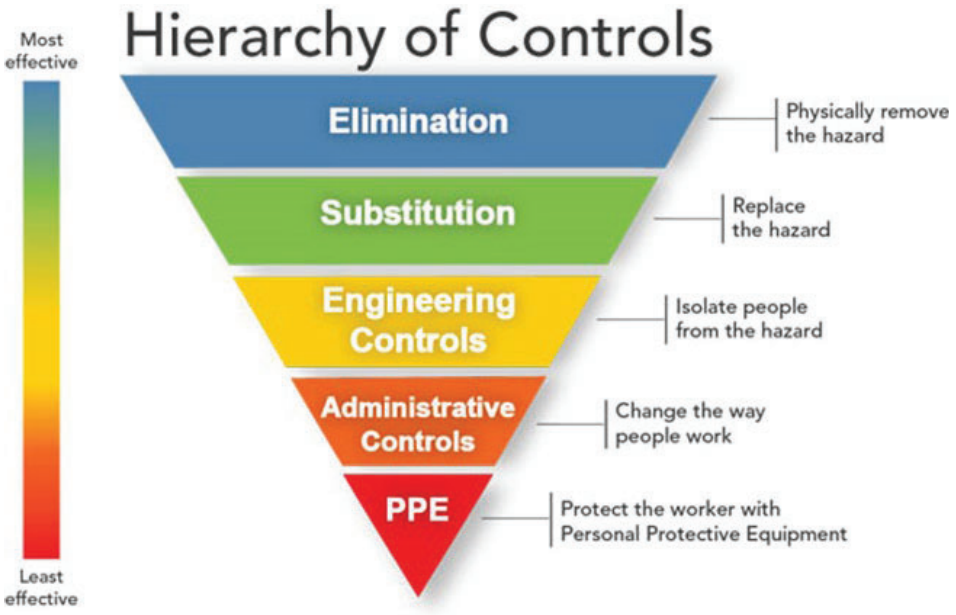
3.10 Industrial Hygiene Sampling Records

Upon receipt of exposure sampling results IPRG and third-party contractors must distribute exposure sampling results to employees within 15 business days unless otherwise required by applicable regulation. All personnel exposure sampling results and records must be maintained by the employee’s company for at least 30 years following termination of employment.

4. HAZARD & CONTROLS

The following section outlines general controls for the hazards and controls. Third-party contractors are still responsible for developing a Safety and Health Plan that incorporates requirements of this Safety and Health Plan, other safety requirements for the DCPP, as well as the third-party contractor's safety policies and procedures. Safety and Health Plans developed by third-party contractors must be specific to the site and the anticipated work means and methods. Safety and Health Plans that consist of only standard operating procedures or are not otherwise specific to the work performed at the Site will not be accepted by IPRG.

IPRG requires that a hierarchy of controls be considered when performing work at the GMFP or BAB. Implement controls that favor elimination, substitution, and engineering over the use of administrative controls and PPE when feasible. See the figure below for additional guidance (courtesy of the National Institute for Occupational Safety and Health [NIOSH]).



4.1 Ash/Unstable Surfaces

Prior to working in or on an ash pond, third-party contractors must notify the security guard and the POC. Work in or on an ash pond may not begin until the facility POC has approved the work and all personnel have signed in with the security guard. Upon completion of the work, third-party contractors must notify the POC and security guard that they have left the Site.

When working on ash ponds or unstable surfaces the following requirements must be implemented where applicable and feasible. The following table summarizes safety controls for work performed in ash ponds and on unstable surfaces and are aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work on ash ponds is no longer required	Use the lightest available tracked equipment to reduce ground pressure	Use crane mats or other cribbing to support heavy equipment on ash ponds	Traverse compacted paths that have previously been used by heavy equipment	Use a restraint (tethering) system to prevent falls or slips into unstable ash pond surfaces or surface water that represents a drowning hazard

Elimination	Substitution	Engineering	Administrative	PPE
			If an unstable condition exists, complete a Next Level Up Pre-Job Brief prior to accessing the ash pond.	
			Approach the ash pond from the most stable direction	
			Inspect travel paths for recent terrain shifts, particularly following heavy rains or rapid dewatering	
			Working alone on ash ponds is prohibited without pre-approval from the POC.	
			When a drowning hazard exists, implement requirements for working on/near water as outlined in Section 4.4.	
			Implement an emergency response plan with trained responders for falls into (or engulfment by) ash	

4.2 Ash Inhalation/Airborne Exposure

Ash that becomes airborne due to site activities or environmental conditions may result in an exposure to its components as outlined in Section 5.1. IPRG and third-party contractors are responsible for ensuring their respective employees' and contract workers' exposures are below occupational exposure limits. Upon request, third-party contractors must demonstrate to IPRG that exposure control methods are adequate. The following table summarizes airborne exposure controls and is aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work on ash ponds is no longer required	Substitute manual work methods for those that can be completed from the cab of a vehicle	Continually wet work areas to reduce the amount of ash that becomes airborne Equip vehicles and heavy equipment cabs with filters. Clean and change filters as required	Conduct air monitoring or exposure sampling to confirm that airborne exposure is below regulatory limits	If exposure levels are above the PEL, equip employees with respirators appropriate to the level of exposure

4.3 Stuck Vehicles/Equipment

If a vehicle or piece of equipment becomes stuck, a third-party towing or wrecking company who is trained in vehicle extraction must be retained and the IPRG POC will be notified. Bob's and Swise Towing (309-647-1633) is an approved extraction company that may be used to remove stuck vehicles. Third-party contractors may extract their own vehicle if they have an approved extraction plan, and a competent person is on site to implement the extraction. The extraction plan shall be included as part of the third-party contractor's reviewed and approved Safety and Health Plan. The above notifications are still required.

The hazards presented by stuck vehicles/equipment must not be underestimated. While the weight of the stuck equipment can be calculated, it's impossible to precisely calculate the other forces that are pulling against the towing vehicle which requires special training and experience to properly size towing equipment and select towing techniques. This is especially true for "complex" or high-hazard extractions involving equipment stuck at axle depth (or beyond) or sloped surfaces or any area where extraction activities could trigger shifts in the ground surface. No chains shall be used to remove stuck vehicles/equipment.

The following table summarizes safety controls related to stuck vehicles and equipment and are aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work on ash ponds is no longer required	Use the lightest available tracked equipment to reduce ground pressure Substitute tracked equipment for wheeled equipment	Use crane mats or other cribbing to support heavy equipment on ash ponds Lighten the load – Remove materials from stuck vehicles or equipment prior to extraction if possible	Only persons trained in vehicle extraction are permitted to remove stuck vehicles/equipment A professional towing/wrecking service is required Prepare for spills (damage to fuel or hydraulic systems)	All persons involved in removing stuck equipment must wear PPE that includes hard hat, safety boots, safety glasses, high visibility vests, and cut resistant gloves

4.4 Working Near/Over Water

All employees, contract workers, and third-party contractors must wear a United States Coast Guard (USCG) approved personal floatation device (PFD), when within 6 feet of water, over water, and/or wading in water where the danger of drowning exists. The PFD must be properly

secured to the wearer, free of all defects including rips, tears, stress, and fading, and be kept clean and free of excessive dirt and oil.

If the possibility of falling into water has been eliminated through the use of guardrails, fall restraint, or other method, the use of a PFD is no longer required.

When performing work on water from a vessel, at least one lifesaving rescue vessel (*e.g.,* a skiff) shall be immediately available at locations where employees are working over, in, on, or adjacent to water where the danger of drowning exists. However, if the water is so shallow that rescuers could simply walk/run into the water body without endangering themselves and/or others or the work was being conducted very close to shore (*e.g.,* the length of the skiff from shore would be greater than the working distance from shore and/or the skiff would foul on the bottom), a skiff would not be required.

The following table summarizes the requirements for working over/near water where a drowning hazard exists and are aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work near a drowning hazard is no longer required		Install guardrails that separate work areas from the drowning hazard	All work to be performed by at least two people where each is equipped with proper safety gear and capable of summoning emergency rescue	All personnel are required to wear suitable PFDs
		Utilize equipment (crowd-control barricades, safety fence, etc.) that will keep personnel at least 6 feet from a drowning hazard	When working on water use of a rescue skiff as outlined above	
			Use of a ring buoy with 90 feet of braided polycarbonate (or equivalent) line	
			Ring buoys must be positioned within 100 feet of work (maximum of 200 feet spacing)	

4.5 Heavy Equipment

All heavy equipment operators must be competent and authorized to operate each piece of heavy equipment. Forklift and telehandler (*e.g.,* Lull, JLG) operators must have a license or certificate that indicates they have passed a written test and "road" test for the equipment they will be operating within the last 3 years. Third-party contractors will provide proof of qualification upon request of IPRG.

Persons working around heavy equipment must implement the “25 Foot Rule.” The 25 Foot Rule requires that persons get the operator’s attention and permission prior to approaching closer than 25 feet to heavy equipment. Persons must walk quickly through blind spots. Loitering in heavy equipment blind spots (especially to the rear) must be avoided.

Temporary fuel storage tanks will be labelled as to their content and be protected from collision by Site vehicles using solid barricades including balusters, chain link fence, or equivalent. Spill kit (55-gallon sorbent capacity contained in an overpack) and one 20-pound Type ABC fire extinguisher will be located within 45 feet of fueling areas. Tanks will be rated for above ground use and will be double walled or have secondary containment in case of a leak. Tanks and dispensing hose will be bonded and grounded. On-site filling of fuel storage tanks will be completed with trucks that have automatic over-flow shutoffs. These trucks will be properly bonded to the storage tank and meet all of the other storage tank requirements. Temporary secondary containment must be provided in the refueling area that includes the storage tank and dispensing hoses.

Elimination	Substitution	Engineering	Administrative	PPE
		Heavy equipment (and vehicles) must be equipped with backup alarms, horns, roll-over protection (when feasible)	Operators must be competent and authorized	Operators must use seatbelts when equipped
		Vehicles and heavy equipment operated at night must have headlights, tail lamps, and reflectors	Forklift operators must have a current license or certificate (within 3 years)	High visibility vests are required when working around heavy equipment
			All vehicles and equipment must be turned off when not in use	
			Operators must inspect equipment daily prior to use	
			Persons working near heavy equipment must follow the “25 Foot Rule” and avoid lingering in blind spots as outlined above	
			Always obey site speed limits – 15 mph unless otherwise posted	

4.6 Overhead Powerlines

All overhead powerlines must be assumed to be energized until confirmed otherwise. The minimum clearance distance for equipment working near energized power lines must be in accordance with the table found in 29 C.F.R. § 1926.1408(h).

The following table summarizes safety controls for work near energized power lines:

Elimination	Substitution	Engineering	Administrative	PPE
Plan to work away from powerlines	Use heavy equipment with shorter booms/attachments to avoid coming close to power lines	Contact the utility owner to deenergize the line	Install signs to warn personnel of overhead powerlines	
		Contact the utility owner to install insulated sleeves over energized lines	Install a non-conductive distance marker to delineate minimum clearance	
			Use a dedicated spotter to ensure equipment does not enter minimum clearance distances	

4.7 Severe Weather

Severe weather conditions include but are not limited to high winds, electrical storms, heavy rain, and tornados can cause hazardous conditions at CCR surface impoundments. The primary control for severe weather is monitoring weather reports prior to beginning work and as work occurs throughout the day.

Monitor lightning using a commercially available mobile application if cellular service is available. When lightning is observed within 10 miles of the CCR surface impoundment, or a storm is imminent, take shelter in the nearest solid structure or fully enclosed vehicle. If possible, secure all tools, materials, and equipment prior to the storm arriving. Work may resume 30 minutes after the last lightning strike is observed within 10 miles. The following locations are acceptable shelter locations near the CCR Units:

- GMF Pump House at the landfill area
- Dumper House at the Coal Yard
- New Stack base

Do not conduct work on a CCR surface impoundment when there is a risk for tornados in the area. If on a CCR surface impoundment and a tornado forms, seek the nearest substantial shelter. The closest tornado shelters are the same as the severe weather shelter locations; shelter locations will be reviewed during the Site Orientation Training. If no shelter is available, attempt to evacuate to a shelter using a vehicle. If a tornado forms and you are not in a shelter, take one of the following actions:

- Stay in a vehicle with the seat belt on, keep your head below the windows and cover it with your hands
- If there is an area which is noticeably lower than the work area, lie in that area and cover your head with your hands.

The following table summarizes safety controls related to severe weather:

Elimination	Substitution	Engineering	Administrative	PPE
Plan outdoor tasks on days with low potential for severe weather.			Prior to beginning outdoor work monitor the day’s weather.	

Elimination	Substitution	Engineering	Administrative	PPE
			Periodically monitor weather throughout the day. Use a weather app which issues alerts for severe weather and lightning, assuming cell service is available	
			Utilize a weather radio if cellular service is inconsistent	
			Stop all outdoor work and seek shelter when lightning is observed	

4.8 Heat Stress

Heat stress can be a significant hazard, especially for workers wearing protective clothing. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly, within as little as 15 minutes. Employees, contract workers, and third-party contractors will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim, and in the prevention of heat stress incidents.

Workers will be encouraged to immediately report any heat-related problems that they experience or observe in fellow workers. Any worker exhibiting signs of heat stress and exhaustion should be made to rest in a cool location and drink plenty of water. Emergency help by a medical professional is required immediately for anyone exhibiting symptoms of heat stroke, such as red, dry skin, confusion, delirium, or unconsciousness. Heat stroke is a life-threatening condition that must be treated immediately by competent medical authority.

4.8.1 Heat Stress Prevention

To prevent heat stress, IPRG employees, contract workers, and third-party contractors will implement heat stress prevention measures as outlined in OSHA's Heat Index (below). A summary of these precautions is described below.

Heat Index	Risk Level	Protective Measures
Less than 91°F	Lower (Caution)	Basic heat safety and planning
91°F to 103°F	Moderate	Implement precautions and heighten awareness
103°F to 115°F	High	Additional precautions to protect workers
Greater than 115°F	Very High to Extreme	Triggers even more aggressive protective measures

Know the Symptoms: Some symptoms associated with heat stress are: Employees should be aware of these symptoms with themselves and with their co-workers:

- Elevated heart rate, lack of concentration, difficulty focusing on a task, fatigue
- Irritability and/or sickness
- Cramps, rash, headache
- Loss of desire to drink water
- Fainting
- Skin clammy, moist, and pale (severe heat exhaustion)
- Skin extremely dry and red (heat stroke)

Acclimatize: When high heat stress conditions arise, employees should be exposed to the heat for short work periods followed by longer periods of work. Acclimatization usually takes five (5) days and should be provided for all new employees and employees returning from an absence of two (2) weeks or more. Contact Corporate Health and Safety for proper procedures.

Hydration & Pace of Work: Make sure all employees intake plenty of water throughout the work day (sometimes as much as a quart per worker per hour) and let employees know where the drinking water is located. Adjust your work pace and expectations on how much work can be done during periods of high heat stress. Workers cannot do as much during periods of high heat stress compared with similar periods of low heat stress. After acclimatization, workers may be able to resume a more "normal" work pace as long as fluid intake is adequate.

Work/Rest Periods: If possible, heavy work should be scheduled during the cooler parts of the day (*i.e.,* early morning) and rest periods should be taken in cool areas for longer periods.

Personal Protective Equipment (PPE): Employees using PPE (*i.e.*, Tyvek® suits or other equipment which may retain heat) can be more susceptible to heat stress due to the fact that heat/sweat often cannot escape the suits and/or the equipment. Persons wearing PPE that contributes to heat stress require more hydration, longer rest periods, or a reduced pace of work. Also, more careful monitoring of each person's health status is required by co-workers and management.

The following table summarizes safety controls for heat related illnesses:

Elimination	Substitution	Engineering	Administrative	PPE
Perform outdoor, strenuous, tasks at cooler times of day/year	Use mechanized equipment in place of manual labor	Install fans or air conditioning units in the work area	Train all personnel to know the signs of heat stress/stroke and how to prevent it	Implement the use of cooling vests or other similar PPE
		Install a canopy to provide shade to work areas	Allow workers to acclimatize to the work environment	
		Provide cool, shaded break areas	Adjust work pace to allow for the effects of heat	
			Implement work/rest periods	

4.9 Cold Stress

The four environmental conditions that cause cold-related stress are low temperatures, high/cool winds (wind chill), dampness, and cold water. One, or any combination of these factors, can cause cold-related hazards. Cold stress, including frostbite and hypothermia, can result in severe health effects. Employees, contract employees, and third-party contractors will be instructed in the identification of a cold stress victim, the first-aid treatment procedures for the victim and in the prevention of heat stress incidents.

A dangerous situation of rapid heat loss may arise for any individual exposed to high winds and cold temperatures. Major risk factors for cold-related stresses include:

- Wearing inadequate or wet clothing thus increasing the effects of cold on the body.
- Taking certain drugs or medications such as alcohol, nicotine, caffeine, and medication thus inhibiting the body's response to the cold and/or impairing judgment.
- Having a cold or certain disease, such as diabetes, heart, vascular and thyroid problems, and thereby increasing susceptibility to the winter elements.
- Lower body-fat composition or other physiological differences. Statistics show that men experience far greater death rates due to cold exposure than women, potentially attributable to participation in risk-taking activities, lower body-fat composition and/or other physiological differences.
- Becoming exhausted or immobilized, especially due to injury or entrapment, thus speeding up the effects of cold weather.

The following table provides the resulting equivalent chill temperature to exposed skin because of increasing wind speeds at decreasing actual temperatures. Personnel shall be aware of predicted weather conditions before beginning site work and stay apprised of changes.

TABLE 2. Cooling Power or Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)*

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	−10	−20	−30	−40	−50	−60
	Equivalent Chill Temperature (°F)											
calm	50	40	30	20	10	0	−10	−20	−30	−40	−50	−60
5	48	37	27	16	6	−5	−15	−26	−36	−47	−57	−68
10	40	28	16	4	−9	−24	−33	−46	−58	−70	−83	−95
15	36	22	9	−5	−18	−32	−45	−58	−72	−85	−99	−112
20	32	18	4	−10	−25	−39	−53	−67	−82	−96	−110	−121
25	30	16	0	−15	−29	−44	−59	−74	−88	−104	−118	−133
30	28	13	−2	−18	−33	−48	−63	−79	−94	−109	−125	−140
35	27	11	−4	−20	−35	−51	−67	−82	−98	−113	−129	−145
40	26	10	−6	−21	−37	−53	−69	−85	−100	−116	−132	−148
(Wind speeds greater than 40 mph have little additional effect.)	LITTLE DANGER In < hr with dry skin. Maximum danger of false sense of security				INCREASING DANGER Danger from freezing of exposed flesh within one minute.				GREAT DANGER Flesh may freeze within 30 seconds.			
	Trenchfoot and immersion foot may occur at any point on this chart.											

*Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.
Equivalent chilll temperature requiring dry clothing to maintain core body tempearture above 36°C (96.8°F) per cold stress TLV

The following table summarizes safety controls for preventing cold stress:

Elimination	Substitution	Engineering	Administrative	PPE
Perform work during warm parts of the day or warmer parts of the year		Install heaters in enclosed work areas	Train all personnel on the symptoms of cold stress and how to prevent it	All personnel must wear multiple layers of clothing
		Provide a warm break area	Implement work/rest schedule	Utilize hand/foot warmers when required

An additional hazard in cold weather conditions is the increased risk for slips from the accumulation of ice and snow in general work areas, ruts where water is accumulated, and heavy equipment. The following table outlines controls that may be used for preventing slips:

Elimination	Substitution	Engineering	Administrative	PPE
Perform work during warm parts of the day or in areas free of accumulated areas		Clear snow in work areas		Use traction control devices (*i.e.,* YakTrax) on work boots to provide additional traction.
		Apply salt/sand to icy areas		
		Use equipment to access work areas		

4.10 Biological Hazards

The following are biological hazards that may be present at the Site.

4.10.1 Ticks (Lyme Disease) & Mites

Although Lyme disease has been detected throughout the continental United States, it is prevalent primarily in certain areas in New England, the Mid-Atlantic and the northern Midwest

states. Although Lyme disease is the most common tickborne illness, other tickborne illnesses include southern tick-associated rash illness, Rocky Mountain spotted fever, ehrlichiosis, and tularemia. More information on Lyme disease and other tickborne illnesses can be found from the CDC.

Prevention

- Standard field gear (work boots, socks, and light-colored coveralls) provides good protection against tick bites, particularly if the joints are taped. However, even when wearing field gear, the following precautions shall be taken when working in areas that might be infested with ticks:
  - Wear long pants and long-sleeved shirts that fit tightly at the ankles and wrists, tape cuffs if necessary
  - Wear light colored clothing so ticks can be easily spotted
  - Per- and polyfluoroalkyl substances (PFAS)-free tick repellents (DEET and Permethrin) must be used when walking in all overgrown areas. DEET (≥25 percent [%]) must be applied to skin while permethrin must be applied to clothes and allowed to dry. Spray outer clothing, particularly your pant legs and socks, BUT NOT YOUR SKIN, with an insect repellent that contains permethrin. For heavily infested tick areas, wear spun polypropylene coveralls that have been sprayed with permethrin.
  - Inspect clothing frequently
  - Inspect head and body thoroughly when you return from the field, particularly on your lower legs and areas covered with hair
  - When walking in wooded areas, wear a hard hat, and avoid contact with bushes, tall grass, or brush as much as possible

Removal

- Remove any ticks by tugging with tweezers or special tick removal tools
- Do not squeeze or crush the tick
- DO NOT use matches, a lit cigarette, nail polish, or any other type of chemical to "coax" the tick out

Treatment

- Disinfect the area with alcohol or a similar antiseptic after removal.
- Notify the Safety Competent Person of the embedded tick.
- For several days to several weeks after removal of the tick, look for the signs of the onset of Lyme disease, such as a rash.
- No further treatment is necessary for ticks embedded <48 hours.
- If other signs or symptoms of Lyme are observed (fever/chills, aches, and pains), then notify the Safety Competent Person and seek medical attention.

The following table summarizes safety controls to reduce the hazards associated with ticks and mites.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on tick and mite prevention. Areas of vegetation overgrowth and/or debris piles should be considered "high risk" areas	Wear light-colored long sleeved shirt tucked into pants. Tuck pant legs into socks
			Perform frequent tick checks in the field and a thorough tick check after completing work activities	Apply Permethrin to clothes and DEET (20% or more) to exposed skin
			Call licensed pesticide contractors to remove infestations of bees, wasps, fire ants, etc.	

4.10.2 Insect Bites/Stings

Stinging/biting insects at the Site include spiders, wasps, and bees. Contact with these insects may result in project personnel experiencing adverse health effects that range from being mildly uncomfortable to being life-threatening. Therefore, insects present a serious hazard to project personnel, and extreme caution must be exercised whenever Site and weather conditions increase the risk of encountering stinging insects. Some of the factors related to stinging insects that increase the degree of risk associated with accidental contact are as follows:

- The nests for these insects are frequently found in remote wooded or grassy areas or equipment staging areas where equipment has not been moved recently.
- Some people are hypersensitive to the toxins injected by a sting, and when stung, experience a violent and immediate allergic reaction resulting in a life-threatening condition known as anaphylactic shock. Anaphylactic shock manifests itself very rapidly and is characterized by extreme swelling of the body, eyes, face, mouth, and respiratory passages.
- The hypersensitivity needed to cause anaphylactic shock, can in some people accumulate over time and exposure, therefore even if someone has been stung previously and not experienced an allergic reaction, there is no guarantee that they will not have an allergic reaction if they are stung again
- Spider bites generally only cause localized reactions such as swelling, pain, and redness. However, bites from a Black Widow or Brown Recluse, or if you are allergic to spiders, can cause symptoms that are more serious.
- *If a worker knows that they are hypersensitive to bee, wasp, or hornet stings, or other insects, they must inform the Safety Competent Person prior to site work. Persons who have been prescribed epi-pens by their physician must have an epi-pen on the Site.*
- Inspect any clothing or PPE that has been left for a period of time prior to putting it on. Shake out the clothing and inspect the inside of safety shoes/boots prior to putting them on
- Nests in active work areas must be eradicated. Small nests may be handled by Site personnel using consumer-type insecticide. A pest control contractor should be hired to handle large or difficult to reach nests.

The following table outlines safety controls to reduce the risk of hazards associated with stinging/biting insects.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on stinging/biting insect prevention. Areas of vegetation overgrowth and/or debris piles should be considered "high risk" areas	Wear light-colored long sleeved shirt tucked into pants. Tuck pant legs into socks
		Eradicate nests in the work area as outlined above.	Instruct personnel to inspect/shake out clothing and work boots that have been left for a period of time.	Apply Permethrin to clothes and DEET (20% or more) to exposed skin – NOTE this will not repel bees/wasps
			Instruct employees who are hypersensitive to insect bites/stings to carry their epi-pen while on site	

4.10.3 Venomous Snakes

There are four species of venomous snakes in Illinois, they are:

- Copperhead
- Cottonmouth Water Moccasin
- Timber rattlesnake
- Eastern Massasauga

Generally, these snakes are found in the southern one-third of the state, with the Cottonmouth Water Moccasin found mostly in the southernmost portions of Illinois. Snakes are generally found in tall grass, wood piles, or other covered areas. Snakes are generally not aggressive towards humans, but if they are encountered avoid the snake and do not provoke it. If bitten by a snake that may be venomous seek medical treatment.

The following table outlines safety controls to reduce the hazard associated with venomous snakes.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove debris piles, overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on the identification of venomous snakes. Areas of vegetation overgrowth and/or debris piles should be considered "high risk" areas	If working in area with snakes cannot be avoided, wear snake chaps
			Instruct personnel to not disturb snakes if they identify one in their work area	

Elimination	Substitution	Engineering	Administrative	PPE
			Use caution when moving staged tools or materials into which snakes may have moved	

4.10.4 Poisonous Plants and Plant Hazards

Poison ivy and poison oak may be present at the Site. Poison ivy thrives in all types of light and usually grows in the form of a trailing vine; however, it can also grow as a bush and can attain heights of 10 feet or more. Poison ivy has pointed leaves that grow in clusters of three. Poison oak resembles poison ivy except that the poison oak leaves are more rounded rather than jagged like poison ivy, and the underside of poison oak leaves are covered with hair.

The skin reaction associated with contacting these plants is caused by the body's allergic reaction to toxins contained in oils produced by the plant. Becoming contaminated with the oils does not require contact with just the leaves. Contamination can be achieved through contact with other parts of the plant such as the branches, stems or berries, or contact with contaminated items such as tools and clothing. The allergic reaction associated with exposure to these plants will generally cause the following signs and symptoms:

Symptoms

- Blistering at the site of contact, usually occurring within 12 to 48 hours after contact and in many cases, persons experience almost immediate irritation.
- Reddening, swelling, itching, and burning at the site of contact.
- Pain, if the reaction is severe.
- Conjunctivitis, asthma, and other allergic reactions if the person is extremely sensitive to the poisonous plant toxin.

Prevention

- The best treatment appears to be removal of the irritating oil before it has had time to cause inflammation by wiping exposed skin with rubbing alcohol followed by washing with soap and water.
- A visual Site inspection and identification of the plants should be completed prior to starting work so that all individuals are aware of the potential exposure. Avoid contact with any poisonous plants on the Site, and keep a steady watch to identify, report, and mark poisonous plants found on the Site.
- Avoid contact with, and wash daily, contaminated tools, equipment, and clothing.
- Barrier creams (Ivy Block®) and orally administered desensitization may prove effective and should be tried to find the best preventive solution.
- Keeping the skin covered as much as possible (*i.e.*, long pants and long-sleeved shirts) in areas where these plants are known to exist will limit much of the potential exposure. PFAS-free spun polypropylene coveralls or Tyvek® may be worn to prevent contact of skin and clothes with poison ivy.

The following table outlines safety controls to mitigate the hazards associated with poisonous plants.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on the identification of poisonous plants	Wear pants and long sleeves when working in overgrown areas
			Instruct personnel to avoid areas where poisonous plants have been identified	Consider the use of a coverall when working in areas where these plants are present, especially for hypersensitive employees.
			Provide isopropyl alcohol along with soap and water to remove oils from skin, tools, and equipment.	

4.11 Working Alone

As outlined in Section 4.1, working alone while on an ash pond must be pre-approved by the POC. Working alone is prohibited for tasks deemed to be high risk by IPRG including, but not limited to, handling highly hazardous chemicals (sulfuric acid), work over/near water, excavation and trenching, hot work (grinding, welding and torch cutting), and elevated work that requires personal fall arrest. Third-party contractors are responsible for identifying potential high-risk tasks in their Safety and Health Plan and requiring that a buddy system be implemented while high risk work is performed. The buddy must be located in a safe area but may perform other tasks that do not prevent observing the person performing high risk work. Working alone may occur on and around other parts of the Site when there is no drowning hazard or risk of severe injury due to high-risk work.

Elimination	Substitution	Engineering	Administrative	PPE
	Modify work methods by substituting lower hazard methods for high hazard methods	Varies depending on the hazard, but for example, could include installing guardrails (temporary or permanent) which mitigates a fall hazard reducing the risk to levels where working alone may be permitted	Prohibit working alone on ash ponds and for other high hazard tasks without prior approval from the POC	
			Implement a buddy system whenever feasible (required for high hazard work)	

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Elimination	Substitution	Engineering	Administrative	PPE
			Implement a worker check-in, emergency alerting, and monitoring system	

5. HAZARD COMMUNICATION

As required by 35 I.A.C. § 845.530, the OSHA HAZWOPER standards (29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65) and OSHA Hazard Communication Standard, site personnel, subcontractors, and visitors must be informed of chemical hazards associated with their work area. The information in this section is based on:

- Recommendations in the most recent "NIOSH Pocket Guide to Chemical Hazards" by the Department of Health and Human Services, Centers for Disease Control and Prevention, and the NIOSH Pocket Guide.
- Requirements set forth in the OSHA regulations from as defined in Chapter 17 of 29 C.F.R. § 1910.1200(c) for all hazards not otherwise classified.

5.1 Coal Combustion Residuals

Primary exposure to CCR is through inhalation and skin contact. CCR is typically a fine, black, grey, or tan particulate. CCR is comprised of several components. The following table outlines the components of the CCR. The exact percentage of each component will vary based on the type of ash and location at the surface impoundment.

Chemical	Percentage	PEL	IDLH	ACGIH TLV	Symptoms of Exposure & Health Effects
Crystalline Silica	20-60% (total)	0.05 mg/m^3 (respirable)	25 mg/m^3 (respirable)	0.025 mg/m^3 (respirable)	Cough, dyspnoea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation eyes; [potential occupational carcinogen]
Iron oxide	1-10%	5 mg/m^3	2500 mg/m^3	5 mg/m^3	Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis)
Calcium oxide	10-30%	5 mg/m^3	25 mg/m^3	2 mg/m^3	irritation eyes, skin, upper respiratory tract; ulcer, perforation nasal septum; pneumonitis; dermatitis
Titanium dioxide	<3%	15 mg/m^3	ND	10 mg/m^3	Lung fibrosis; [potential occupational carcinogen]
Aluminosilicates	10-60%	15 mg/m^3 (PNOR)	ND	10 mg/m^3 (PNOR)	irritation eyes, skin, throat, upper respiratory system
Magnesium oxide	2-10%				
Magnesium dioxide	<2%				
Phosphorous pentoxide	≤2%				
Sodium oxide	1-10%				
Potassium oxide	≤1%				
Bromide salt	<0.1%				

Footnotes:

All values are 8-hour time-weighted averages (TWAs) unless otherwise indicated.

- PEL: Permissible Exposure Limit, the concentration an employee may be exposed to for an 8-hour work day for a 40-hour work week for which nearly all employees may be repeatedly exposed without adverse health effects.
- IDLH: IMMEDIATELY Dangerous to Life and Health, contaminant concentration which present the possibility for severe health consequences if exposed to the IDLH concentration without the appropriate personal protective equipment (PPE).
- ACGIH TLV: American Conference of Governmental Industrial Hygienists Threshold Limit Value
- mg/m^3 = milligrams per cubic meter of air
- PNOR: Particulates Not Otherwise Regulated
- ND: Not Determined

5.2 Safety Data Sheets

Pursuant to 35 I.A.C. § 845.530(b)(3), IPRG will provide Safety Data Sheets (SDSs) to all employees, contract workers, and third-party contractors for the CCR located at the Site. Third-party contractors will provide SDSs to the Environmental Manager prior to bringing a material on site. SDSs are provided in Appendix E.

5.3 Signage

The absence of any of the following signage does not mean that a potential hazard does not exist. Signage will be posted by IPRG, but employees, contract workers, and third-party contractors must remain vigilant for changing site conditions.

To aid in hazard communication and pursuant to 35 I.A.C. § 845.530(f), IPRG will post the following signs at the Site:

- Signs identifying the hazards of CCR, including dust inhalation when handling CCR.
- Signs identifying unstable CCR areas that make the operation of heavy equipment hazardous.
- Signs identifying the necessary safety measures and necessary precautions, including the proper use of PPE.

The following signs may also be posted at the CCR units to aid in hazard communication:

- Overhead electrical lines that may be struck by heavy equipment of vehicles will have signs warning drivers of their presence.

6. EMERGENCY RESPONSE PLAN

This emergency response section details actions to be taken in the event of site emergencies. This section is consistent with the DCPP Emergency Response Plan. All personnel on site must be familiar with emergency signals and the content of this section.

6.1 Emergency Phone Numbers & Notifications

Emergency Number	
Site Address	**Emergency Phone Number**
17751 North Cilco Rd Canton, IL 61520	911
	Security Guard: 713-542-0619

Medical Treatment	
Local Hospital	**Phone Number**
Graham Hospital 410 East Elm St Canton, IL	309-647-4088

Incident Notifications		
Title	**Name**	**Contact Number**
Security Guard		712-542-0619
POC	Brandon Potter	618-210-3418

6.2 Evacuation Signal

Upon receiving notification to evacuate, all personnel will leave the work area and proceed to the muster point.

6.3 Muster Point

The muster point for the Site is located at the Security Office by the Main Entrance (Appendix A). The following locations are acceptable severe weather shelter locations near the CCR Units:

- GMF Pump House at the land fill area
- Dumper House at the Coal Yard
- New Stack base

6.4 Calls for Emergency Support

In the case of an emergency, site personnel will call **911** followed by notifying the security guard (713-542-0619). The security guard will coordinate the arrival of on-site emergency personnel. The individual calling for emergency support will briefly explain the nature of the emergency and site conditions as follows:

- Indicate his/her name
- Location of emergency
- Description of emergency conditions that may require special rescue equipment, such as confined spaces, excavations, and elevated work platforms
- Potential chemical hazards and recommended PPE

6.5 Fire & Explosion Response Plan

Trained site personnel may respond to incipient stage fires using a 20-pound Type ABC dry chemical fire extinguisher or hose. An incipient stage fire is a fire which is in the initial or beginning stage and which can be controlled or extinguished by portable fire extinguishers, Class

II standpipe or small hose systems without the need for protective clothing or breathing apparatus. Personnel shall only attempt to extinguish the fire if it is safe to do so.

A fire that CANNOT be readily extinguished with a fire extinguisher will require evacuation of the work area personnel to Muster Point areas per this Safety and Health Plan. If personal injuries result from any fire or explosion, the procedures outlined in the Personal Injury Response Plan will also be followed.

All fires or explosions must be reported to the contacts outlined in Section 6.1 of this Safety and Health Plan.

6.6 Injury Response Plan

Treatment for minor injuries will be provided on site using available first aid supplies and personnel trained in first aid. All third-party contractors must have at least one individual on site who is trained in first aid, CPR, and AED use. Third-party contractors must provide their own first aid kits and AED. For minor injuries that are not life-threatening but require further medical attention, employees should be treated by occupational physicians at occupational clinics whenever possible. Treatment of minor injuries by emergency room or personal physicians should be avoided. When injured workers are released back to work with restrictions, all subcontractors are expected to accommodate those restrictions.

Emergency medical incidents include puncture wounds to the head, chest, and abdomen, serious head and spinal cord injuries, and loss of consciousness must be treated at the hospital emergency room listed in Section 6.1 of this Safety and Health Plan.

All injuries must be reported to the contacts outlined in Section 6.1 of this Safety and Health Plan.

6.7 Spill Response Plan

In general, IPRG employees, contract workers, and third-party contractors are trained and equipped to handle small spills associated with their work. Third-party contractors must include an approved spill response plan in their Safety and Health Plan. Site personnel will generally respond to spills as follows:

- Stop the leak immediately if it can be done without directly contacting the leaking material.
- Remove or stop all ignition sources (hot work, generators, etc.) that are within 25 feet of any part of the spill.
- On-site personnel should immediately secure the area to prevent unauthorized entry into the spill area.
- Although not likely given the anticipated types of spills, site personnel must immediately initiate evacuation if a spill may cause an explosion, death, or serious injury.
- Site personnel may only respond to incipient stage fires regardless if such fires are associated with a spill.
- PPE for spills to open areas generally requires Modified Level D PPE (poly-coat Tyvek®, nitrile gloves, and boot covers or boot decontamination). Over-boots or boot covers may also be used if persons cleaning the spill would have to walk on spilled materials. Latex gloves are not acceptable and will degrade with exposure to petroleum products.
- Contact the Environmental Manager upon containing the spill.

6.8 CCR Spill or Release Response Plan

Response to minor or incidental spills of CCR will be managed as outlined in the General Spill Response Plan. An incidental release is a release of a hazardous substance which does not pose a significant safety or health hazard to employees in the immediate vicinity or to the employee cleaning it up, nor does it have the potential to become an emergency within a short time frame. Incidental releases are limited in quantity, exposure potential, or toxicity and present minor

safety or health hazards to employees in the immediate work area or those assigned to clean them up. An incidental spill may be safely cleaned up by employees who are familiar with CCR. Response to major releases of CCR will be in accordance with the DCPP Emergency Action Plan, which can be found on the Luminant CCR website at https://www.luminant.com/ccr/.

6.9 Ash Pond Rescue

Ash ponds may be unstable and represent an engulfment hazard if persons and equipment traverse the surface, berms, or other unstable areas. Special training is required on behalf of emergency responders to retrieve persons and equipment who become trapped in unstable ash. **Untrained persons must not enter unstable areas** in an attempt to conduct rescue because of the significant potential that they will also become victims. Call 911 and the Guard Shack emergency number and state that an "ash pond rescue" is required. The Guard Shack will notify the designated service to perform the ash pond rescue. On-site personnel should remain on stand-by to support the ash pond rescue team as necessary.

6.10 Incident Reporting

All incidents must be reported to the contacts outlined in Section 6.1 of this Safety and Health Plan. An Incident Report must be completed for all injuries, illnesses, spills, fire, explosion, or property damage. The absence of an injury does not preclude the need to complete an Incident Report as such incidents will be classified as "near miss" or "other." It will include, but is not limited to, the nature of the problem, time, location, and corrective actions taken to prevent recurrence.

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APPENDIX A
SITE MAP

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PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 750 1,500 Feet

SITE MAP

APPENDIX A

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

PART 845 SAFETY AND HEALTH PLAN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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APPENDIX B
SAFETY AND HEALTH PLAN ACKNOWLEDGMENT FORM

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SAFETY AND HEALTH PLAN ACKNOWLEDGEMENT FORM

I HEREBY CERTIFY THAT I HAVE READ AND UNDERSTOOD ALL HEALTH AND SAFETY PROCEDURES AS STATED HEREIN:

Name and Affiliation (printed)	Signature	Date

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APPENDIX C
DRUG SCREEN POLICIES AND SUPPLEMENTAL TERMS

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Drug and Background Investigations

Contractor is solely responsible for ensuring that all members of Contractor Project Team have completed and passed all drug and alcohol tests and background investigations required under this Attachment and under Contractor's own programs before assigning such personnel to perform Work. Contractor is also solely responsible for ensuring that such testing and investigations are performed in accordance with all applicable laws.

1. Required Investigations. Except as otherwise required by applicable law, Required Investigations shall consist of all of the following:

   1.1 a 7-panel drug screening;

   1.2 a background investigation that includes a criminal records check in all counties where the applicable person has resided for at least the last seven (7) years;

   1.3 a third-party verification of previous employment and the highest education level completed by the applicable person;

   1.4 a check of the National Sex Offender Registry and Terrorist Watch List (Denied Parties); and

   1.5 a check of Motor Vehicles Record (if work to be performed by the applicable person requires driving as part of the defined duties).

2. Notices to Tested Persons Regarding Background Checks. All background checks will be conducted in compliance with applicable provisions of the Fair Credit Reporting Act.
3. Forms and Testing Organization for Drug Tests. Except for those positions subject to Department of Transportation ("DOT") drug and alcohol testing regulations, all drug testing shall be performed using the Universal Toxicology four part "Non-DOT" Chain of Custody and Request Form with white and blue top page, and shall be conducted by an independent third-party organization.

4. Pass/Fail Standards – Background Checks. A person shall be deemed to have failed the applicable background check if:

   4.1 information is reported through the background check process indicating that such person has failed to disclose or misrepresented information requested at any time about such a person's criminal background history; or

   4.2 such person has ever committed any felony constituting a violent crime, crime against a person, sexual offense or fraud; or

   4.3 such person has committed any other felony, or has been incarcerated for a felony, within ten (10) years prior to the date of such background check (i.e., for these felonies there must be a ten (10) year lapse in time from the later of the commission and the end of any period of incarceration); or

   4.4 such person has committed any misdemeanor that:

      4.4.1 involves violence that is sexually related; or

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4.4.2 consists of a DUI that is the second (or more) DUI in the last two (2) years prior to the date of the background check; or

4.4.3 consists of a theft-related offense; provided that there can be no more than one theft by check and it must have been for an amount less that $100; or

4.4.4 consists of any drug-related misdemeanor committed at any time within forty-eight (48) months prior to the date of the background check.

4.4 For purposes of both felonies and misdemeanors, a person is deemed to have committed the applicable offense if he/she is convicted or enters a plea of guilty or nolo contendere for such offense (to include, without limitation, sentences of probation and deferred adjudication).

5. Pass/Fail Standards – Drug Tests. A person shall be deemed to have failed the applicable drug test if any of the following maximum cut-off levels are exceeded, unless there is a legitimate medical explanation for the presence of a tested substance at or above the applicable cut-off level:

5.1	Amphetamines	500ng/mL
5.2	Barbiturates	150ng/mL
5.3	Benzodiazepines	150ng/mL
5.4	Cocaine	150ng/mL
5.5	Marijuana	150ng/mL
5.6	Opiates	2000ng/mL
5.7	Phencyclidine	25ng/mL

For any positions subject to DOT drug and alcohol testing requirements, testing shall be conducted according to the applicable DOT panel and cutoff levels.

6. Other Requirements.

6.1 Background checks and drug tests will be paid for by Contractor without reimbursement by Company.

6.2 Contractor will keep background checks and drug test records while the applicable persons are working pursuant to this Agreement and for three (3) years thereafter.

6.3 Upon request, Contractor will provide a certification to Company that no person required hereunder to pass a background check or drug test has failed such investigation or test. Contractor will not provide the specific results of the background check or drug test of any individual to Company.

6.4 If any person required under this Agreement to pass a background check or drug test fails such check or test, Contractor will not report the specific results of such check or test to Company and will not allow such individual to perform any Work for Company. Although such person may not be assigned to perform any Work for Company, nothing in this Attachment requires Contractor to take any other action with respect to such person's employment with Contractor.

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Supplemental Terms for Onsite Services

1. SAFETY

1.1 Contractor agrees that any safety-related assistance or initiatives undertaken by Company will not relieve Contractor while on Company Property from responsibility for the implementation of, and compliance with, safe working practices, as developed from their own experience, or as imposed by law or regulation, and will not in any way, affect the responsibilities resting with Contractor under the provisions of any agreement to which these policies are attached and to meet all safety requirements as specified by the Occupational Safety & Health Administration (OSHA), the Mine Safety Health Administration (MSHA), including the "Mining Contractor Safety Reference Handbook" located at http://www.vistraenergy.com/wp-content/uploads/2016/12/Contractors-Safety-Handbook_Final-MC-08262016.pdf, the Department of Transportation (DOT) and any other applicable state or federal safety and health laws or regulations.

1.2 In the event that a material safety data sheet, warning label, or other documentation concerning the use of hazardous chemicals at any property owned or controlled by Company or any of its affiliates (collectively, "Company Properties"), applies to any materials or equipment provided by Contractor as an aspect of the Work, such documentation will be provided by Contractor to Company prior to the commencement of any such Work.

1.3 Contractor will report to Company all accidents involving personal injuries (including death) and damage to property occurring directly or indirectly as a result of the Work performed by Contractor hereunder immediately, but in no event, no later than 24 hours after the occurrence of any such accident. Any accident or incident occurring directly or indirectly as a result of the Work which Contractor must report to a regulatory agency (e.g. OSHA, MSHA, TCEQ) must also be reported to Company immediately following notification to the regulatory agency.

2. SECURITY

2.1 It will be the affirmative duty of Contractor to ensure that Contractor Group assists in carrying out all security measures, to include reporting all information or knowledge of matters adversely affecting security to Company's designated security personnel.

2.2 Company reserves the right to exclude any of Contractor's employees from any Company Property by denial of access, suspension or revocation of access authorization, preemptory expulsion, or by any other means, without notice or cause. Former Company employees, and any of Contractor's employees who previously have been excluded from any Company Property, may be brought onto Company property or facilities only if prior approval from Company is obtained. If Contractor terminates a member of Contractor Group performing Work on Company's premises, Contractor shall inform Company immediately, but in no event, no later than twenty-four (24) hours after such employee is terminated in order for Company to remove access to Company Property for such employee.

2.3 Company measures may also include investigations, whether by Company or law enforcement officials. Contractor agrees to cooperate in such investigations and understands that Company

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reserves the right to require anyone in Contractor Group to authorize appropriate agencies to release his or her criminal records to Contractor as a condition of either initial or continued permission for access to any Company Property. Investigations may include searches of Contractor Group. Such searches may include searches of facilities assigned to Contractor Group, search of all Company Property areas and property at such Company Property areas, searches of including, but not limited to, offices, lockers, desks, lunch boxes, packages and motor vehicles (regardless of ownership). Without limiting the foregoing, Contractor acknowledges and agrees that all members of Contractor Group, to the extent that Company reasonably determines that such members require security badge access prior to entering onto any Company Property, shall be required to comply with Company's standard security badge requirements, including without limitation a background check to be performed by Company.

3. ISNETWORLD

3.1 Contractor agrees to maintain at Contractor's expense a subscription with ISNetworld (www.ISNetworld.com), Company's safety compliance program or any replacement program therefor, as directed by Company, for the Term of the Agreement. Contractor shall also furnish ISNetworld with any information requested by ISNetworld relating to ISNetworld's evaluation of the Contractor's safety program and practices. As a minimum, requested documents will be related to safety, health, and insurance (i.e., regulatory required training, certifications, safety plans, safe and secure workplace practices, insurance certificates, etc.), OSHA and MSHA injury rates and Experience Modification Rate (EMR).

3.2 Contractor has and during the performance of this Agreement shall continue to report full, complete and accurate information to ISNetworld concerning Contractor's employees.

4. MATERIALS, EQUIPMENT AND LABOR. Contractor will be solely responsible for the proper storage, transportation and disposal of any product or waste, other than sandblasting waste, used or generated in connection with the Work in accordance with all applicable Environmental Laws. Contractor will dispose of all waste materials, other than sandblasting waste, at an off-site disposal facility approved for such waste materials pursuant to applicable Environmental Laws and will complete and sign all waste manifests as the generator of such waste. Company will be responsible for the storage, transportation and disposal of any sandblasting waste generated during the performance of the Work.

5. CONDITIONS AFFECTING WORK

5.1 Contractor will investigate and acquaint itself with the conditions affecting the Work, including but not limited to those related to the transportation, disposal, handling and storage of materials and waste; availability of labor, water, electric power and roads; the uncertainties of weather, river stages or similar physical conditions at the site; the conformation and condition of the ground; and the character of equipment and facilities needed preliminary to and during prosecution of the Work. Contractor has satisfied itself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered. Contractor's failure to acquaint itself with any conditions affecting the Work or any available related information will not relieve it from responsibility for properly estimating the difficulty or cost of successfully performing the Work.

5.2 Contractor assumes full responsibility for investigating conditions and determining the existence and magnitude of any hazards to the physical well-being of property of Contractor, the employees, agents, and servants of Contractor, or any other person or entity who is or may become involved in

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the performance of Work, and any and all other persons in the vicinity of the Work. Contractor will advise all of the above-specified persons or entities of any hazards relating to Work, and will ensure that those persons or entities are advised of and fully understand the nature of the hazards and safety precautions that can be taken to eliminate or minimize dangers relating to the hazards.

5.3 Contractor will provide information to Company regarding hazardous chemicals and/or consumable products that contain constituents listed in 40 CFR 372.65 used at any Company Property. Contractor will report the amount of such material carried on and off the site, the amount actually used and the manner of use. Contractor will provide the maximum quantity of the material stored on site at any one time and if a waste material was collected, where it was disposed of (location name and address). Contractor will provide information on the amount of material used for the previous calendar year by the first of February.

5.4 Contractor will use its best efforts to ensure that the Work is performed so as to minimize any adverse impact upon natural resources and the environment and will use best industry practices in this regard at all times.

5.5 Contractor acknowledges and agrees that all members of Contractor Group performing Work at any Company Generation or Mining Property are required to view Company's "Contractor/Visitor Safety Orientation" video (in the case of Company Generation property), when applicable, and to read and adhere to Company's "Contractor/Visitor Safety Booklet" (in the case of Company Mining property) prior to performing any Work at any Company Generation or Mining Property.

5.6 Contractor will immediately notify Company as soon as Contractor has reason to believe that Contactor, or any employee or other person performing the Work, is not or may not be performing the Work in compliance with applicable Environmental Laws. Contractor will provide Company with written notice to Company of such actual or potential non-compliance within three (3) days following the discovery thereof. Contractor will take immediate steps to ensure compliance with all applicable Environmental Laws and will, if directed by Company, cease all Work until authorized by Company to resume the Work.

5.7 Contractor will report to Company all accidents involving personal injuries (including death) and damage to property occurring directly or indirectly as a result of the Work performed by Contractor hereunder immediately, but in no event, no later than 24 hours after the occurrence of any such accident. Any accident or incident occurring directly or indirectly as a result of the Work which Contractor must report to a regulatory agency (e.g. OSHA, MSHA, TCEQ) must also be reported to Company immediately following notification to the regulatory agency.

6. WORK SITE PERMITS AND LICENSES

6.1 Subject to the following two paragraphs, Contractor will obtain, prior to the commencement of the Work, and provide to Company upon request, all permits, licenses and governmental authorizations, at its sole expense, required for the performance of the Work. Contractor will be solely responsible for maintaining compliance with such permits, licenses and governmental authorizations.

6.2 In the event that a storm water discharge permit is required for the performance of the Work, (i) Contractor will be responsible for filing a Notice of Intent with respect to the Work, in addition to any Notice of Intent that Company may be required to file, and (ii) Contractor will coordinate with

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Company in the preparation and execution of a Storm Water Pollution Prevention Plan for the Work Site.

6.3 In the event that the performance of the Work involves the handling or abatement of asbestos-containing materials, Contractor will coordinate with Company in the preparation and filing of all required notification forms.

7. ACCESS. Should Contractor desire access to the Work Site over any land not controlled by Company, it will, at its sole expense, obtain all proper permits or written permission necessary for that access.

8. COMPANY FACILITIES. Contractor will not use Company's sanitary facilities, changehouses, shops, parks, storage buildings, tools, equipment or other facilities unless so directed by Company. Contractor will not discharge, without Company's prior written authorization, any product or waste used or generated in connection with the Work through any (i) Company-permitted outfall, (ii) Company-owned or operated pollution control equipment, or (iii) storm or sanitary sewer located at or in the vicinity of the Work Site. Any request for authorization to discharge will include, at a minimum, either a copy of the Material Safety Data Sheet for the product or a written description of the waste, including a list of the constituents of the waste and the relative concentrations thereof.

9. ENVIRONMENTAL

9.1 In the event that Contractor discovers during the performance of the Work any substance at the Work Site that is not the subject of the Work or has not otherwise been identified by Company for Contractor, which substance Contractor has reason to believe is or may be a Hazardous Substance that (i) has been or may be released or spilled into the soil, surface water, or groundwater or in a building or structure, or (ii) consists of asbestos-containing materials, lead-based paint, batteries, thermostats, lighting equipment, or equipment containing polychlorinated biphenyls, Contractor will immediately stop Work and notify Company of the discovery. Contractor will not resume the Work until receiving authorization from Company to do so.

9.2 The term "Hazardous Substance" means any product, waste, emission or substance defined, listed or designated as a hazardous or toxic substance, hazardous waste, hazardous material or pollutant by or pursuant to any Environmental Law and includes, but is not limited to, any petroleum-based product, substance or waste, including any additives associated therewith, pesticides, fertilizers, solvents, polychlorinated biphenyls, mercury, lead, lead-based paint, asbestos-containing material or explosives.

9.3 Contractor will immediately notify Company in the event of a spill or release of any material which Contractor knows or has reason to believe is a Hazardous Substance, whether onto the ground, into any body of water, a storm or sanitary sewer, or the air, or anywhere on property owned or controlled by Company, including within any building or structure. Contractor will be solely responsible, as may be required by applicable Environmental Laws, for, in consultation with Company, (i) notifying the appropriate governmental agencies of such spill or release caused or permitted by the acts or omissions of Contractor and (ii) for the cleanup and remediation of such spill or release.

10. PROTECTION OF HIGHWAYS AND RAILROADS. Contractor will make suitable arrangements with governmental authorities and railroads for the construction of all structures, whether underneath or over roads, railroads or rights-of-way to protect the public from accident or delay. Contractor will repair, at its

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own expense, to the satisfaction of the governmental authorities or other owners, all roads, railroads and bridges that may be damaged by, or given undue wear due to the Work.

11. CLEANING UP

11.1 Contractor will at all times keep the Work Site free of waste materials or rubbish caused by the Work. After completing the Work, Contractor will remove all its waste materials, rubbish, tools, supplies, equipment and surplus materials from and about the Work Site.

11.2 If Contractor fails to keep the Work Site clean or to clean up after completing the Work, Company may do so and charge all costs of cleaning up to Contractor. Those costs may be deducted from the final payment to Contractor.

12. COLLATERAL WORK. Company and other contractors may be working at the Work Site. Company reserves the right to coordinate the performance of Contractor's Work with the work of others. Contractor will cooperate with and will not delay, impede or otherwise impair the work of others. Company does not guarantee Contractor continuous uninterrupted access to the Work Site, but will provide such access as good construction practices will allow, considering the other activities in the area.

13. ALCOHOLIC BEVERAGES, DRUGS AND WEAPONS. Contractor will inform all members of Contractor Group who may be involved in the performance of any Work of the following Company rules relating to alcoholic beverages, drugs and weapons, with which all personnel are expected to comply:

13.1 Bringing, attempting to bring, possessing, using or being under the influence of intoxicants, drugs, or narcotics while on any Company Property, including but not limited to parking areas, is prohibited. Possessing alcoholic beverages in sealed containers is permitted, however, in designated parking areas.

13.2 Prescription or over-the-counter medications that could affect the performance of safety-sensitive work are allowed on Company Property only if they have been previously cleared by Contractor. Contractor must confirm that the medication and dosage do not impair an individual's ability to perform safety-sensitive work before clearing the individual to perform such work while under the influence of the medication.

13.3 Bringing, attempting to bring, possessing or using firearms, whether classified as legal or illegal, while on any Company Property, including but not limited to buildings, parking areas, recreation facilities, equipment and vehicles, is prohibited, unless otherwise required by applicable law. Use or possession of firearms for specific situations is permitted if approved by function or higher level management of Company.

13.4 Off-the-job involvement with intoxicants, illegal drugs, or illegal narcotics that adversely affects Company's business, to include impairing the individual's ability to perform his job or the public trust in the safe operation of Company, is prohibited.

13.5 Any conduct on any Company Property which is in violation of any state or federal law or regulation is considered a violation of these rules and a breach of any agreement to which these policies are attached.

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13.6 In order to enforce these rules, all individuals with access to any Company Property as well as the vehicles, offices, lockers and any personal belongings of such individuals on any Company Property are subject to search by Company and its agents, to include security representatives appointed or employed by Company. Individuals may be required to take a blood, urinalysis or Breathalyzer test, or submit to other recognized investigatory tests or procedures as are deemed appropriate or necessary by Company in the investigation of a violation of these rules.

14. TITLE AND RIGHT. Nothing in the Agreement will vest Contractor with any right of property in materials used after they have been attached to or incorporated into the Work, nor materials for which Contractor has received full or partial payment. All those materials, upon being so attached, incorporated or paid for, will become the property of Company. Any gravel, sand, stone, minerals, timber or other materials excavated, uncovered, developed or obtained in the Work, or on any land belonging to Company may be used, in the performance of the Work, provided such materials meet the requirements of this Agreement. Any objects or natural materials or animals excavated or exposed that may have historical significance or constitute a threatened or endangered species must be brought to the attention of Company.

15. PROTECTION AGAINST LIENS AND ENCUMBRANCES

15.1 Contractor will not at any time permit any lien, attachment or other encumbrance ("Encumbrance") by any person or persons whosoever or by reason of any claim or demand against Contractor to be placed or remain on the property of Company, including, but not limited to, the Work Site upon which Work is being performed or equipment and materials that are being furnished. To prevent an Encumbrance from being placed on the property of Company, Contractor will furnish during the progress of any Work, as requested from time to time, verified statements showing Contractor's total outstanding indebtedness in connection with the Work.

15.2 If Contractor allows any indebtedness to accrue to subcontractors or others and fails to pay or discharge that indebtedness within five (5) days after demand, then Company may withhold any money due Contractor until that indebtedness is paid or pay the indebtedness and apply that amount against the money due Contractor.

15.3 If Contractor allows any Encumbrances, whether valid or invalid to be placed on the property of Company, any and all claims or demands for payment to Contractor will be denied by Company until the Encumbrance is removed. If the Encumbrance is not removed immediately, Company may pay that claim or demand and deduct the amount paid, together with all related expenses, including attorneys' fees, from any further payment due Contractor, or at Company's election, Contractor will, upon demand, reimburse Company for the amount paid and all related expenses. Any payment made in good faith by Company will be binding on Contractor.

16. TERMINATION FOR DEFAULT

16.1 If a petition in bankruptcy should be filed by Contractor, or if Contractor should make a general assignment for the benefit of creditors, or if a receiver should be appointed due to the insolvency of Contractor, or if Contractor should refuse or fail to supply enough properly skilled workmen or proper equipment, materials or services or should fail to make prompt payment to subcontractors, or to pay promptly for materials or labor, or disregard laws, ordinances or the instruction of Company's Contract Coordinator, or if Contractor should refuse or fail to abide by the SOW Construction Schedule or otherwise violate any provisions of the Agreement or SOW, then Company, upon a

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determination by Company's Contract Coordinator that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy available to it after giving Contractor seven (7) days' written notice, terminate the Agreement or the SOW and take possession of the Work Site. In the event of such a termination, Company may use all or part of Contractor's equipment and materials and may finish the Work by whatever method Company may deem expedient. In such event, Contractor will not be entitled to receive any further payment hereunder until the Work is finished. If the unpaid balance of the SOW fees will exceed the expense of finishing the Work, including compensation of Company's Contract Coordinator, other Company personnel, third party engineering companies, or other contractors for additional services, such excess will be paid to Contractor. If the expense of finishing the Work will exceed such unpaid balance, Contractor will pay the difference to Company within fifteen (15) days of receiving an invoice for same. The expenses incurred by Company herein, and the damage incurred through Contractor's default, will be determined by Company's Contract Coordinator, in its sole discretion, and such determination will be binding as between the parties.

16.2 In the event of a termination under the provisions of this Section 3, Contractor will transfer and assign to Company, in accordance with Company's instructions, all Work, all construction records, reports, permits, data and information, other materials (including all Company-supplied materials), supplies, Work in progress and other goods for which Contractor is entitled to receive reimbursement hereunder, and any and all plans, drawings, sketches, specifications, and information in connection with the Work, and will take such action as may be necessary to secure Company, at Company's sole election, the rights of Contractor under any or all orders and subcontracts made in connection with the Work.

16.3 In the event that Company so directs or authorizes, Contractor will sell at a price approved by Company, or retain at a mutually agreeable price, any such materials, supplies, Work in progress, or other goods as referred to in the preceding paragraph. In any event, Company will receive any and all records, plans, drawings, data, permits, specifications, sketches, reports, or other information relating to the Work. The proceeds of any such sale or the agreed price will be paid or credited to Company in such manner as Company may direct so as to reduce the amount payable by Company under this Section 3.

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APPENDIX D
COVID-19 SITE ENTRY GUIDELINES

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COVID-19 Vistra Site Entry Guidelines – *Effective: June 17, 2021*
These guidelines are applicable to ALL PERSONNEL entering Vistra work sites.

To enter a Vistra work site, each person must answer the following three questions with a "no" answer *and* pass the required temperature testing *unless* they display their Vistra vaccination sticker on their employee badge or hardhat:

Site Entry Questions:

1. In the past 10 days, have you tested positive for COVID-19 or are you currently waiting on test results?

2. In the past 10 days, have you been within six feet of someone, where masks were not worn, who:
    a. has tested positive for COVID-19,
    b. is known to be waiting on test results for COVID-19, or
    c. is under a quarantine order?

3. In the past 10 days, have you or someone who has been within six feet of you where masks were not worn had:
    a. flu-like symptoms,
    b. a deep, dry cough,
    c. recent shortness of breath or difficulty breathing,
    d. new loss of taste or smell, and/or
    e. fever of 100 degrees or above?

Temperature Testing:

You must register a temperature between 96- and 100-degrees Fahrenheit as described in the temperature procedures. (see next page for testing procedures)

- If your temperature is below 96 degrees, retest with a different device.
- If your temperature is 100-degrees Fahrenheit or above, retest on another device preferably an ear thermometer, if your temperature still registers 100-degrees Fahrenheit or above you may not enter the site.

Clearance to enter the site:

- If you have answered **"no"** to all three questions ***and*** passed the temperature test, you may enter the site.
- ***If you have an approved Vistra vaccination sticker, you are cleared to enter the site without the temperature test or answering COVID screening questions.***
- If you passed the temperature test ***and*** answered "Yes" to any of the questions, but have been cleared through VistraTravelerSafety (HR clearance) to enter the Vistra work site for that instance of exposure, testing, or symptoms, you may enter the site.

Anyone *not* cleared to enter the work site must immediately leave the work site and notify their supervisor who will notify HR at VistraTravelerSafety@vistracorp.com for next steps.

Any symptomatic employee, unvaccinated employee exposed to COVID-19 or any employee tested for COVID-19 as described above must be cleared through VistraTravelerSafety prior to returning to work.

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Required Temperature Testing Procedures:

All persons entering the site without a Vistra vaccination sticker, who have cleared all questions above, will also submit to temperature testing or self-administer a temperature test as required by the facility management. If a self-administered test is required, then a member of the management team or their designee will witness the testing; however, where that is not practicable, each person must attest that they are only entering the site premises because they have passed the screening questions and temperature test required for entry. Also:

a. Hats may cause false high temperatures and should not be worn for five minutes immediately preceding a forehead temperature test.
b. Each person is responsible for ensuring all self-testing materials and areas touched during testing are sanitized.
c. All personnel should maintain a **distance of at least six feet** from other people during this process or wear required masks.

Temperature Testing Requirements:

1. **All persons entering the site without a Vistra vaccination sticker must register a temperature between 96- and 100-degrees Fahrenheit. Any such person who has a temperature not within that range or who triggers an alarm on a thermal camera** must **retest with a different device**, preferably an **ear thermometer**, if available. If the second test registers a temperature of 100 degrees or above:
    a. That person **may not enter** the Vistra work site and must notify their supervisor, who will notify HR at VistraTravelerSafety@vistracorp.com for next steps.
    b. If there is significant inconsistency between the two tests, repeat another temperature test and use the two closest readings.
2. **Anyone who registers a temperature between 96- and 100-degrees Fahrenheit** may proceed to their work site.
    - **If temperature is below 96 degrees, wait a few minutes and retest with a different device.**

Control rooms and communal areas:

All persons entering the site without a Vistra vaccination sticker should maintain at least six-feet distance from other people as much as possible and should wear face coverings when six-feet distance is not feasible. No one should gather in communal areas (including the temperature-testing area) without a Vistra vaccination sticker. Only operators are allowed in control rooms without plant manager approval.

Vistra Vaccination Sticker protocols:

All persons with a valid Vistra vaccination sticker do not have to socially distance or wear masks while at the site. They will also not be required to quarantine as a part of COVID-19 exposures unless exhibiting COVID-19 symptoms. To be eligible for these protocols, each person must have their approved Vistra vaccination sticker easily visible at all times while at work. If someone who has applied for a Vistra vaccination sticker believes they have specific health conditions that may affect the ability to have a full immune response to the vaccination, please consult your health provider prior to working without a mask.

Any symptomatic employee, unvaccinated employee exposed to COVID-19 or any employee tested for COVID-19 as described above must be cleared through VistraTravelerSafety prior to returning to work.

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DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	ASTM Bottom Ash
Synonyms:	Ash; Ashes; Ash residues; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Coal Fly Ash; Pozzolan; Waste solids.
Formula:	UVCB Substance

1.2 Relevant Identified Uses of the Substance or Mixture and Uses Advices Against

Relevant Identified Uses:	Component of wallboard, concrete, roofing material, bricks, cement kiln feed.
Uses Advised Against:	None known.

1.3 Details of the Supplier of the SDS

Manufacturer/Supplier:	Dynegy, Inc.
Street Address:	601 Travis Street, Suite 1400
City, State and Zip Code:	Houston, TX 77002
Customer Service Telephone:	800-633-4704

Section 2
Hazards Identification

2.1 Classification of the Substance

GHS Classification(s) according to OSHA Hazard Communication Standard (29 CFR 1910.1200):

- Eye Irritant, Category 2A
- STOT-SE, Category 3 (Respiratory Irritation)
- Carcinogen, Category 1A
- STOT-RE, Category 1 (Lungs)
- Toxic to Reproduction, Category 2

2.2 Label Elements

Labelling according to 29 CFR 1910.1200 Appendices A, B and C*	
Hazard Pictogram(s):	
Signal word:	**DANGER**
Hazard Statement(s):	*Causes serious eye irritation.* *May cause respiratory irritation.* *May cause damage to lungs after repeated/prolonged exposure via inhalation.* *May cause cancer of the lung.* *Suspected of damaging fertility or the unborn child.*
Precautionary Statement(s):	*Obtain special instructions before use.* *Do not handle until all safety precautions have been read and understood.* *Avoid breathing dust.* *Wash thoroughly after handling.* *Do not eat drink or smoke when using this product.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Use outdoors or in a well-ventilated area.* *If exposed or concerned: Get medical advice/attention.* *Store in a secure area.* *Dispose of product in accordance with local/national regulations.*

** Fly ash and other coal combustion products (CCPs) are UVCB substances (unknown or variable composition or biological). Various CCPs, noted as ashes/ash residuals; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Waste solids, ashes under TSCA are defined as: "The residuum from the burning of a combination of carbonaceous materials. The following elements may be present as oxides: aluminum, calcium, iron, magnesium, nickel, phosphorus, potassium, silicon, sulfur, titanium, and vanadium." Ashes including fly ash and fluidized bed combustion ash are identified by CAS number 68131-74-8. The exact composition of the ash is dependent on the fuel source and flue additives composed of many constituents. The classification of the final substance is dependent on the presence of specific identified oxides as well as other trace elements.*

2.3 Other Hazards

Listed Carcinogens:

-Respirable Crystalline Silica

IARC: [Yes] **NTP:** [Yes] **OSHA:** [Yes] **Other:** **(ACGIH)** [Yes]

Section 3
Composition/Information on Ingredients

Substance	***CAS No.***	***Percentage (%)***	***GHS Classification***
Crystalline Silica	*14808-60-7*	*20 - 40%*	*Repeat Dose STOT, Category 1* *Carcinogen, Category 1A*
Silica, crystalline respirable (RCS)	*14808-60-7*	***See Footnote 1***	*Repeat Dose STOT, Category 1* *Carcinogen. Category 1A*
Aluminosilicates[2]	***Various, see Footnote 2***	*10 - 60%*	*Single Exposure STOT, Category 3*
Calcium oxide (CaO)	*1305-78-8*	*10 - 30%*	*Skin Irritant, Category 2* *Eye Irritant, Category 1* *Single Exposure STOT, Category 3*
Iron oxide	*1309-37-1*	*1 - 10%*	*Not Classified*
Manganese dioxide (MnO_2)	*1313-13-9*	*<2%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Magnesium oxide	*1309-48-4*	*2 - 10%*	*Not Classified*
Phosphorus pentoxide (P_2O_5)	*1314-56-3*	*≤2%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Sodium oxide	*1313-59-3*	*1 - 10%*	*Not Classified*
Potassium oxide (K_2O)	*12136-45-7*	*≤1%*	*Skin Irritant Category 2* *Eye Irritant Category 2B*
Titanium dioxide (TiO_2)	*13463-67-7*	*<3%*	*Not Classified*
Bromide salt (calcium)	*7789-41-5*	***See Footnote 3***	*Toxic to Reproduction Category 2*

[1] *The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen 1A has been assigned.*

[2] *Aluminosilicates (CAS# 1327-36-2) may be in the form of mullite (CAS# 1302-93-8); aluminosilicate glass; pozzolans (CAS# 71243-67-9); or calcium aluminosilicates such as tricalcium aluminate (C3A), or calcium sulfoaluminate (C4A3S). The form is dependent on the source of the coal and or the process used to create the CCP. Pulverized coal combustion would be more likely to create high levels of pozzolans. Aluminosilicates may have inclusions of calcium, titanium, iron, potassium, phosphorus, magnesium and other metal oxides.*

[3] *Analytical data are not available to demonstrate that the concentration of bromide salt is <0.1%; therefore, a GHS classification of Toxic to Reproduction Category 2 has been assigned.*

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Section 4
First Aid Measures

4.1 Description of First Aid Measures

Inhalation:	If product is inhaled and irritation of the nose or coughing occurs, remove person to fresh air. Get medical advice/attention if respiratory symptoms persist.
Skin Contact:	If skin exposure occurs, wash with soap and water.
Eye Contact:	If product gets into the eye, rinse copiously with water for several minutes. Remove contact lenses, if present and easy to do. Seek medical attention/advice if irritation occurs or persists.
Ingestion:	No specific first aid measures are required.

4.2 Most Important Health Effects, Both Acute and Delayed

Acute Effects: Direct exposure may cause respiratory irritation, eye irritation and skin irritation. The product dust can dry and irritate the skin and cause dermatitis and can irritate eyes and skin through mechanical abrasion.

Chronic Effects: Chronic exposure may cause lung damage from repeated exposure. Prolonged inhalation of respirable crystalline silica above certain concentrations may cause lung diseases, including silicosis and lung cancer. Repeated exposure to dusts containing inorganic bromide salts may affect fertility and/or result in effects to the unborn child.

4.3 Indication of Any Immediate Medical Attention and Special Treatment Needed

Seek first aid or call a doctor or Poison Control Center if contact with eyes occurs and irritation remains after rinsing. Get medical advice if inhalation occurs and respiratory symptoms persist.

Section 5
Firefighting Measures

5.1 Extinguishing Media

Suitable Extinguishing Media:	Product is not flammable. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Not applicable, the product is not flammable.

5.2 Special Hazards Arising from the Substance or Mixture

Hazardous Combustion Products:	None known.

5.3 Advice for Firefighters

Special Protective Equipment and Precautions for Firefighters:	As with any fire, wear self-contained breathing apparatus (NIOSH approved or equivalent) and full protective gear.

Section 6
Accidental Release Measures

6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Personal precautions/Protective Equipment:	See Section 8.2.2 Individual Protective Measures. For concentrations exceeding Occupational Exposure Levels (OELs), use a self-contained breathing apparatus (SCBA).
Emergency procedures:	Use scooping, water spraying/flushing/misting or ventilated vacuum cleaning systems to clean up spills. Do not use pressurized air.

6.2 Environmental Precautions

Environmental precautions:	Prevent contamination of drains or waterways and dispose according to local and national regulations.

6.3 Methods and Material for Containment and Cleaning Up

Methods and materials for containment and cleaning up:	Do not use brooms or compressed air to clean surfaces. Use dust collection vacuum and extraction systems. Large spills of dry product should be removed by a vacuum system. Dampened material should be removed by mechanical means and recycled or disposed of according to local and national regulations.

See Sections 8 and 13 for additional information on exposure controls and disposal.

Section 7
Handling and Storage

7.1 Precautions for Safe Handling

Practice good housekeeping. Use adequate exhaust ventilation, dust collection and/or water mist to maintain airborne dust concentrations below permissible exposure limits (note: respirable crystalline silica dust may be in the air without a visible dust cloud).

Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain and test ventilation and dust collection equipment. In cases of insufficient ventilation, wear a NIOSH approved respirator for silica dust when handling or disposing dust from this product. Avoid contact with skin and eyes. Wash or vacuum clothing that has become dusty. Avoid eating, smoking, or drinking while handling the material.

7.2 Conditions for Safe Storage, Including any Incompatibilities

Minimize dust produced during loading and unloading.

Section 8
Exposure Controls/Personal Protection

8.1 Control Parameters

OCCUPATIONAL EXPOSURE LIMITS					
SUBSTANCE		**OSHA PEL TWA (mg/m^3)**	**NIOSH REL TWA (mg/m^3)**	**ACGIH TLV TWA (mg/m^3)**	**CA - OSHA PEL (mg/m^3)**
Calcium oxide		5	2	2	2
Particulates Not Otherwise Regulated	Total	15	15	10	10
	Respirable	5	5	3	5
Respirable Crystalline Silica	Respirable	0.05	0.05	0.025	0.05
Manganese dioxide (as manganese compounds)	Total	5 (Ceiling)	1 3 (STEL)	0.1	0.2
	Respirable	-	-	0.02	-

8.2 Exposure Controls

8.2.1 Engineering Controls

Provide ventilation to maintain the ambient workplace atmosphere below the occupational exposure limit(s). Use general and local exhaust ventilation and dust collection systems as necessary to minimize exposure.

8.2.2 Personal Protective Equipment (PPE)

Respiratory protection:	Wear a NIOSH approved particulate respirator if exposure to airborne particulates is unavoidable and where occupational exposure limits may be exceeded. If airborne exposures are anticipated to exceed applicable PELs or TLVs, a self-contained breathing apparatus or airline respirator is recommended.
Eye and face protection:	If eye contact is possible, wear protective glasses with side shields. Avoid contact lenses.
Hand and skin protection:	Wear gloves and protective clothing. Wash hands with soap and water after contact with material.

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Section 9
Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Property: Value	Property: Value
Appearance (physical state, color, etc.): Fine tan/ gray particulate	**Upper/lower flammability or explosive limits:** Not applicable
Odor: Odorless[1]	**Vapor Pressure (Pa):** Not applicable
Odor threshold: Not applicable	**Vapor Density:** Not applicable
pH (25 °C) (in water): 8 - 11	**Specific gravity or relative density:** 2.2 – 2.9
Melting point/freezing point (°C): Not applicable	**Water Solubility:** Slight
Initial boiling point and boiling range (°C): Not applicable	**Partition coefficient: n-octane/water:** Not determined
Flash point (°C): Not determined	**Auto ignition temperature (°C):** Not applicable
Evaporation rate: Not applicable	**Decomposition temperature (°C):** Not determined
Flammability (solid, gas): Not combustible	**Viscosity:** Not applicable

[1] The use of urea or aqueous ammonia injected into the flue gas to reduce nitrogen oxides (NOx) emissions may result in the presence of ammonium sulfate or ammonium bisulfate in the ash at less than 0.1%. When ash containing these substances becomes wet under high pH (>9), free ammonia gas may be released resulting in objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces.

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Section 10
Stability and Reactivity

10.1 Reactivity:	The material is an inert, inorganic material primarily composed of elemental oxides.
10.2 Chemical stability:	The material is stable under normal use conditions.
10.3 Possibility of hazardous reactions:	The material is a relatively stable, inert material; however, when ash containing ammonia becomes wet under high pH (>9), free ammonia gas may be released resulting in an objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces. Polymerization will not occur.
10.4 Conditions to avoid:	Product can become airborne in moderate winds. Dry material should be stored in silos. Materials stored out of doors should be covered or maintained in a damp condition.
10.5 Incompatible materials:	None known.
10. 6 Hazardous decomposition products:	None known.

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Section 11
Toxicological Information

11.1 Information on Toxicological Effects

Endpoint	Data
Acute oral toxicity	LD50 > 2000 mg/kg
Acute dermal toxicity	LD50 > 2000 mg/kg
Acute inhalation toxicity	LD50 > 5.0 mg/L
Skin corrosion/irritation	Does not meet the classification criteria but may cause slight skin irritation. Product dust can dry the skin which can result in irritation.
Eye damage/irritation	Causes serious eye irritation. Positive scores for conjunctiva irritation and chemosis in 2/3 animals based on average of 24, 48 and 72-hour scores with irritation clearing within 21 days; no corneal or iritis effects observed.
Respiratory/skin sensitization	Not a respiratory or dermal sensitizer.
Germ cell mutagenicity	Not mutagenic in in-vitro and in-vivo assays with or without metabolic activation.
Carcinogenicity	Not available. Respirable crystalline silica has been identified as a carcinogen by OSHA, NTP, ACGIH and IARC.
Reproductive toxicity	No developmental toxicity was observed in available animal studies. Reproductive studies on CCPs showed either no reproductive effects, or some effects on male and female reproductive organs and parameters but without a clear dose response. Inorganic bromide salts have been shown to have adverse effects on reproductive parameters in some animal studies.
STOT-SE	CCPs when present as a nuisance dust may result in respiratory irritation.
STOT-RE	In a 180-day inhalation study with fly ash dust, no effects were observed at the highest dose tested. NOEC = 4.2 mg/m^3; it is not possible to assess the level at which toxicologically significant effects may occur. Repeated inhalation exposures to high levels of respirable crystalline silica may result in lung damage (i.e., silicosis).
Aspiration Hazard	Not applicable based product form.

Section 12
Ecological Information

12.1 Toxicity

Fly Ash (CAS# 68131-74-8)	
Toxicity to Fish	LC50 > 100 mg/L
Toxicity to Aquatic Invertebrates	Data indicates that the test substance is not toxic to *Daphnia magna* (EC50 undetermined)
Toxicity to Aquatic Algae and Plants	EC50 = 10 mg/L
Calcium oxide CAS# 1305-78-8	
Toxicity to Fish	LC50 = 50.6 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Invertebrates	EC50 = 49.1 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Algae and Plants	NOEC =48 mg/L @ 72 hours based on $Ca(OH)_2$ The initial pH of the test medium was not directly related to the biologically relevant effects. The formation of precipitates is likely the result of the reaction between CO_2 dissolved in the medium.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

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Section 13
Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status

  All components are listed on the TSCA Inventory.

- California Proposition 65

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:

  - Respirable crystalline silica
  - Titanium dioxide

- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Ammonium bisulfate	7803-63-6	No	Yes	No	No
Ammonium sulfate	7783-20-2	Yes	No	Yes	No
Calcium oxide	1305-78-8	Yes	Yes	Yes	No
Iron oxide	1309-37-1	Yes	Yes	Yes	No
Magnesium oxide	1309-48-4	No	Yes	No	No
Phosphorus pentoxide (or phosphorus oxide)	1314-56-3	Yes	Yes	Yes	No
Potassium oxide	12136-45-7	No	Yes	No	No
Silica-crystalline (SiO_2), quartz	14808-60-7	Yes	Yes	Yes	No
Sodium oxide	1313-59-3	No	Yes	No	No
Titanium dioxide	13463-67-7	Yes	Yes	Yes	Yes

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

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Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 23, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency
- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration resulting in the mortality of 50 % of an animal population
- LD50: Dose resulting in the mortality of 50 % of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey
- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

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16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	2*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
****** Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

DISCLAIMER:

This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

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DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	ASTM Class C Fly Ash
Synonyms:	Coal Fly Ash, Pozzolan
Formula:	UVCB Substance

1.2 Relevant Identified Uses of the Substance or Mixture and Uses Advices Against

Relevant Identified Uses:	Component of wallboard, concrete, roofing material, bricks, cement kiln feed.
Uses Advised Against:	None known.

1.3 Details of the Supplier of the SDS

Manufacturer/Supplier:	Dynegy, Inc.
Street Address:	601 Travis Street, Suite 1400
City, State and Zip Code:	Houston, TX 77002
Customer Service Telephone:	800-633-4704

Section 2
Hazards Identification

2.1 Classification of the Substance

GHS Classification(s) according to OSHA Hazard Communication Standard (29 CFR 1910.1200):

- Eye Irritant, Category 2A
- STOT-SE, Category 3 (Respiratory Irritation)
- Carcinogen, Category 1A
- STOT-RE, Category 1 (Lungs)
- Toxic to Reproduction, Category 2

2.2 Label Elements

Labelling according to 29 CFR 1910.1200 Appendices A, B and C*	
Hazard Pictogram(s):	
Signal word:	**DANGER**
Hazard Statement(s):	*Causes serious eye irritation.* *May cause damage to lungs after repeated/prolonged exposure via inhalation.* *May cause respiratory irritation.* *May cause cancer of the lung.* *Suspected of damaging fertility or the unborn child.*
Precautionary Statement(s):	*Obtain special instructions before use.* *Do not handle until all safety precautions have been read and understood.* *Avoid breathing dust.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Wash thoroughly after handling.* *Do not eat drink or smoke when using this product.* *Use outdoors or in a well-ventilated area.* *If exposed or concerned: Get medical advice/attention.* *Store in a secure area.* *Dispose of product in accordance with local/national regulations.*

** Fly ash and other coal combustion products (CCPs) are UVCB substances (unknown or variable composition or biological). Various CCPs, noted as ashes/ash residuals; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Waste solids, ashes under TSCA are defined as: "The residuum from the burning of a combination of carbonaceous materials. The following elements may be present as oxides: aluminum, calcium, iron, magnesium, nickel, phosphorus, potassium, silicon, sulfur, titanium, and vanadium." Ashes including fly ash and fluidized bed combustion ash are identified by CAS number 68131-74-8. The exact composition of the ash is dependent on the fuel source and flue additives composed of many constituents. The*

classification of the final substance is dependent on the presence of specific identified oxides as well as other trace elements.

2.3 Other Hazards

Listed Carcinogens:

-Respirable Crystalline Silica

IARC: [Yes] **NTP:** [Yes] **OSHA:** [Yes] **Other:** **(ACGIH)** [Yes]

Section 3
Composition/Information on Ingredients

Substance	***CAS No.***	***Percentage (%)***	***GHS Classification***
Crystalline Silica	*14808-60-7*	*30 - 60%*	*Repeat Dose STOT, Category 1* *Carcinogen, Category 1A*
Silica, crystalline respirable (RCS)	*14808-60-7*	***See Footnote 1***	*Repeat Dose STOT, Category 1* *Carcinogen, Category 1A*
Aluminosilicates	*71243-67-9* *1327-36-2*	*30 - 60%*	*Single Exposure STOT, Category 3*
Iron oxide	*1309-37-1*	*1 - 10%*	*Not Classified*
Calcium oxide (CaO)	*1305-78-8*	*20 - 30%*	*Skin Irritant, Category 2* *Eye Irritant, Category 1* *Single Exposure STOT, Category 3*
Magnesium oxide	*1309-48-4*	*2 - 10%*	*Not Classified*
Phosphorus pentoxide (P_2O_5)	*1314-56-3*	*≤2%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Sodium oxide	*1313-59-3*	*1-8%*	*Not Classified*
Potassium oxide (K_2O)	*12136-45-7*	*≤1%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Titanium dioxide (TiO_2)	*13463-67-7*	*<3%*	*Not Classified*
Bromide salt (calcium)	*7789-41-5*	***See Footnote 2***	*Toxic to Reproduction, Category 2*

Footnote 1: *The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen, Category 1A has been assigned.*

Footnote 2: *Analytical data are not available to demonstrate that the concentration of bromide salt is <0.1%; therefore, a GHS classification of Toxic to Reproduction, Category 2 has been assigned.*

Section 4
First Aid Measures

4.1 Description of First Aid Measures

Inhalation:	If product is inhaled and irritation of the nose or coughing occurs, remove person to fresh air. Get medical advice/attention if respiratory symptoms persist.
Skin Contact:	If skin exposure occurs, wash with soap and water.
Eye Contact:	If product gets into the eye, rinse copiously with water for several minutes. Remove contact lenses, if present and easy to do. Seek medical attention/advice if irritation occurs or persists.
Ingestion:	No specific first aid measures are required.

4.2 Most Important Health Effects, Both Acute and Delayed

Acute Effects: Direct exposure may cause respiratory irritation, eye irritation and skin irritation. The product dust can dry and irritate the skin and cause dermatitis and can irritate eyes and skin through mechanical abrasion.

Chronic Effects: Chronic exposure may cause lung damage from repeated exposure. Prolonged inhalation of respirable crystalline silica above certain concentrations may cause lung diseases, including silicosis and lung cancer. Repeated exposure to dusts containing inorganic bromide salts may affect fertility and/or result in effects to the unborn child.

4.3 Indication of Any Immediate Medical Attention and Special Treatment Needed

Seek first aid or call a doctor or Poison Control Center if contact with eyes occurs and irritation remains after rinsing. Get medical advice if inhalation occurs and respiratory symptoms persist.

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Section 5
Firefighting Measures

5.1 Extinguishing Media

Suitable Extinguishing Media:	Product is not flammable. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Not applicable, the product is not flammable.

5.2 Special Hazards Arising from the Substance or Mixture

Hazardous Combustion Products:	None known.

5.3 Advice for Firefighters

Special Protective Equipment and Precautions for Firefighters:	As with any fire, wear self-contained breathing apparatus (NIOSH approved or equivalent) and full protective gear.

Section 6
Accidental Release Measures

6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Personal precautions/Protective Equipment:	See Section 8.2.2 Individual Protective Measures. For concentrations exceeding Occupational Exposure Levels (OELs), use a self-contained breathing apparatus (SCBA).
Emergency procedures:	Use scooping, water spraying/flushing/misting or ventilated vacuum cleaning systems to clean up spills. Do not use pressurized air.

6.2 Environmental Precautions

Environmental precautions:	Prevent contamination of drains or waterways and dispose according to local and national regulations.

6.3 Methods and Material for Containment and Cleaning Up

Methods and materials for containment and cleaning up:	Do not use brooms or compressed air to clean surfaces. Use dust collection vacuum and extraction systems. Large spills of dry product should be removed by a vacuum system. Dampened material should be removed by mechanical means and recycled or disposed of according to local and national regulations.

See Sections 8 and 13 for additional information on exposure controls and disposal.

Section 7
Handling and Storage

7.1 Precautions for Safe Handling

Practice good housekeeping. Use adequate exhaust ventilation, dust collection and/or water mist to maintain airborne dust concentrations below permissible exposure limits (note: respirable crystalline silica dust may be in the air without a visible dust cloud).

Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain and test ventilation and dust collection equipment. In cases of insufficient ventilation, wear a NIOSH approved respirator for silica dust when handling or disposing dust from this product. Avoid contact with skin and eyes. Wash or vacuum clothing that has become dusty. Avoid eating, smoking, or drinking while handling the material.

7.2 Conditions for Safe Storage, Including any Incompatibilities

Minimize dust produced during loading and unloading.

Section 8
Exposure Controls/Personal Protection

8.1 Control Parameters

OCCUPATIONAL EXPOSURE LIMITS					
SUBSTANCE		**OSHA PEL TWA (mg/m^3)**	**NIOSH REL TWA (mg/m^3)**	**ACGIH TLV TWA (mg/m^3)**	**CA - OSHA PEL (mg/m^3)**
Calcium oxide		5	2	2	2
Particulates Not Otherwise Regulated	Total	15	15	10	10
	Respirable	5	5	3	5
Respirable Crystalline Silica	Respirable Crystalline Silica	0.05	0.05	0.025	0.05
Titanium dioxide	Total	15	2.4 (fine) 0.3 (ultrafine)	10	10
Manganese dioxide (as manganese compounds)	Total	5 (Ceiling)	1 3 (STEL)	0.1	0.2
	Respirable	-	-	0.02	-

8.2 Exposure Controls

8.2.1 Engineering Controls

Provide ventilation to maintain the ambient workplace atmosphere below the occupational exposure limit(s). Use general and local exhaust ventilation and dust collection systems as necessary to minimize exposure.

8.2.2 Personal Protective Equipment (PPE)

Respiratory protection:	Wear a NIOSH approved particulate respirator if exposure to airborne particulates is unavoidable and where occupational exposure limits may be exceeded. If airborne exposures are anticipated to exceed applicable PELs or TLVs, a self-contained breathing apparatus or airline respirator is recommended.
Eye and face protection:	If eye contact is possible, wear protective glasses with side shields. Avoid contact lenses.
Hand and skin protection:	Wear gloves and protective clothing. Wash hands with soap and water after contact with material.

Section 9
Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Property: Value	Property: Value
Appearance (physical state, color, etc.): Fine tan/ gray particulate	**Upper/lower flammability or explosive limits:** Not applicable
Odor: Odorless[1]	**Vapor Pressure (Pa):** Not applicable
Odor threshold: Not applicable	**Vapor Density:** Not applicable
pH (25 °C) (in water): Not Determined	**Specific gravity or relative density:** 2.2 – 2.9
Melting point/freezing point (°C): Not applicable	**Water Solubility:** Slight
Initial boiling point/boiling range (°C): NA	**Partition coefficient: n-octane/water:** NA
Flash point (°C): Not determined	**Auto ignition temperature (°C):** Not applicable
Evaporation rate: Not applicable	**Decomposition temperature (°C):** Not determined
Flammability (solid, gas): Not combustible	**Viscosity:** Not applicable

[1] The use of urea or aqueous ammonia injected into the flue gas to reduce nitrogen oxides (NOx) emissions may result in the presence of ammonium sulfate or ammonium bisulfate in the ash at less than 0.1%. When ash containing these substances becomes wet under high pH (>9), free ammonia gas may be released resulting in objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces.

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Section 10
Stability and Reactivity

10.1 Reactivity:	The material is an inert, inorganic material primarily composed of elemental oxides.
10.2 Chemical stability:	The material is stable under normal use conditions.
10.3 Possibility of hazardous reactions:	The material is a relatively stable, inert material; however, when ash containing ammonia becomes wet under high pH (>9), free ammonia gas may be released resulting in an objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces. Polymerization will not occur.
10.4 Conditions to avoid:	Product can become airborne in moderate winds. Dry material should be stored in silos. Materials stored out of doors should be covered or maintained in a damp condition.
10.5 Incompatible materials:	None known.
10. 6 Hazardous decomposition products:	None known.

Section 11
Toxicological Information

11.1 Information on Toxicological Effects

Endpoint	Data
Acute oral toxicity	LD50 > 2000 mg/kg
Acute dermal toxicity	LD50 > 2000 mg/kg
Acute inhalation toxicity	LD50 > 5.0 mg/L
Skin corrosion/irritation	Does not meet the classification criteria but may cause slight skin irritation. Product dust can dry the skin which can result in irritation.
Eye damage/irritation	Causes serious eye irritation. Positive scores for conjunctiva irritation and chemosis in 2/3 animals based on average of 24, 48 and 72-hour scores with irritation clearing within 21 days; No corneal or iritis effects observed.
Respiratory/skin sensitization	Not a respiratory or dermal sensitizer.
Germ cell mutagenicity	Not mutagenic in in-vitro and in-vivo assays with or without metabolic activation.
Carcinogenicity	Not available. Respirable crystalline silica has been identified as a carcinogen by OSHA, NTP, ACGIH and IARC.
Reproductive toxicity	No developmental toxicity was observed in available animal studies. Reproductive studies on CCPs showed either no reproductive effects, or some effects on male and female reproductive organs and parameters but without a clear dose response. Inorganic bromide salts have been shown to have adverse effects on reproductive parameters in some animal studies.
STOT-SE	CCPs when present as a nuisance dust may result in respiratory irritation.
STOT-RE	In a 180-day inhalation study with fly ash dust, no effects were observed at the highest dose tested. NOEC = 4.2 mg/m^3; it is not possible to assess the level at which toxicologically significant effects may occur. Repeated inhalation exposures to high levels of respirable crystalline silica may result in lung damage (i.e., silicosis).
Aspiration Hazard	Not applicable based product form.

Section 12
Ecological Information

12.1 Toxicity

Fly Ash C (CAS# 68131-74-8)	
Toxicity to Fish	LC50 > 100 mg/L
Toxicity to Aquatic Invertebrates	Data indicates that the test substance is not toxic to *Daphnia magna* (EC50 undetermined).
Toxicity to Aquatic Algae and Plants	EC50 = 10 mg/L

Calcium oxide CAS# 1305-78-8	
Toxicity to Fish	LC50 = 50.6 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Invertebrates	EC50 = 49.1 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Algae and Plants	NOEC =48 mg/L @ 72 hours based on $Ca(OH)_2$ The initial pH of the test medium was not directly related to the biologically relevant effects. The formation of precipitates is likely the result of the reaction between CO_2 dissolved in the medium.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

Section 13

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Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status

  All components are listed on the TSCA Inventory.

- California Proposition 65.

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:

  - Respirable crystalline silica

- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Ammonium bisulfate	7803-63-6	No	Yes	No	No
Ammonium sulfate	7783-20-2	Yes	No	Yes	No
Calcium oxide	1305-78-8	Yes	Yes	Yes	No
Iron oxide	1309-37-1	Yes	Yes	Yes	No
Magnesium oxide	1309-48-4	No	Yes	No	No
Manganese oxide-as manganese compounds	1313-13-9; Various	No	No	Yes	Yes
Phosphorus pentoxide (or phosphorus oxide)	1314-56-3	Yes	Yes	Yes	No
Potassium oxide	12136-45-7	No	Yes	No	No
Silica-crystalline (SiO2), quartz	14808-60-7	Yes	Yes	Yes	No
Sodium oxide	1313-59-3	No	Yes	No	No
Titanium dioxide	13463-67-7	Yes	Yes	Yes	Yes

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 23, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency

- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration resulting in the mortality of 50 % of an animal population
- LD50: Dose resulting in the mortality of 50 % of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey
- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	2*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
*** Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

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DISCLAIMER:

This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

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ATTACHMENT T

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Phil Morris
Illinois Power Resources Generating
Luminant
1500 Eastport Plaza Drive
Collinsville, IL 62234

May 19, 2021

Mr. Darin LeCrone, P.E.
Manager, Industrial Unit
Bureau of Water, Division of Water Pollution Control, Permits Section
Illinois Environmental Protection Agency
1021 North Grand Avenue, East
Springfield, IL 62794-9276

Re: CCR Surface Impoundment Category Designation and Justification for Illinois Power Resources Generating, LLC

Dear Mr. LeCrone:

Pursuant to 35 I.A.C. 845.700(c), Illinois Power Resources Generating, LLC submits the information necessary to categorize the CCR surface impoundments located at the Edwards Power Plant and the now retired Duck Creek Power Plant. The following parameters were used in assessing and justifying each assigned category.

- Category 1 – *Impacts to existing potable water supply well or impacts to groundwater quality within the setback of an existing potable water supply well.*
  - This review includes an assessment of potable water wells within 2,500 feet of CCR surface impoundments to determine whether any potential impacts are occurring within the setback zone of any community water supply well established under the Illinois Groundwater Protection Act.
  - This information was developed during the Part 845 rulemaking and is summarized in Attachment 1, Table 2: Impacts to Potable Water Supply.
- Category 2 – *Imminent threat to human health or the environment or have been designated by IEPA under (g)(5)*
  - The surface impoundments at Edwards and Duck Creek Power Plants do not pose an imminent threat to human health or the environment. There are no known conditions at or around the facility where someone or something may be exposed to contaminant concentrations reasonably expected to cause harm
- Category 3 – *Located in areas of environmental justice ("EJ") concern*
  - EJ areas were evaluated using the EJ mapping link from IEPA's webpage located at https://www2.illinois.gov/epa/topics/environmental-justice. Per the IEPA mapping tool, the EJ Status thresholds were determined as twice the state averages for Minority and Low Income consistent with 35 IAC 845.700(g)(6).
  - An EJ map denoting the facilities with impoundments is located in Attachment 2.

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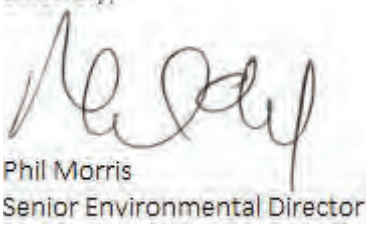
- Category 4-7
  - Category 4 - Inactive CCR surface impoundments that have an exceedance of the groundwater protection standards in Section 845.600
  - Category 5 - Existing CCR surface impoundments that have exceedances of the groundwater protection standards in Section 845.600
  - Category 6 - Inactive CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600.
  - Category 7 – Existing CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600

Based on the information above, category designations have been assigned. The category designations for each CCR impoundment are shown in Attachment 1, Table 1: Category Designations.

If you have any questions regarding this submittal, please contact Phil Morris at 618-343-7794 or phil.morris@vistracorp.com.

Sincerely,



Phil Morris
Senior Environmental Director

Attachments

R001680

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Attachment 1

Table 1: Category Designation

Facility	Pond Description	Classifications	Potable Water Supply Impacts (Category 1)	Human Health or Environment Threat (Category 2)	Located within Environmental Justice Areas[1] (Category 3)	Standards Exceedances[2] (Categories 4,5,6,7)	Impoundment Category 845.700(g)
Edwards	Ash Pond 1	Existing	No	No	No	Yes	5
Duck Creek	Bottom Ash Basin	Inactive	No	No	Yes	NA[3]	3
	GMF Pond	Inactive	No	No	Yes	NA[3]	3
	GMF Recycle Pond	Inactive	No	No	Yes	NA[3]	3

[1] See Attachment 2 Environmental Justice Area Map

[2] Ground water analyses for purposes of categories 4-7, assumptions have been made based on current groundwater data. However, since sampling and analysis is ongoing and subject to IEPA review and approval, IPGC reserves the right to update its category designations for Categories 4-7.

[3] NA for this determination since the CCR surface impoundment was assign a highest priority category

Table 2: Impacts to Potable Water Supply

Site Name	Private and Semi-Private Wells	Non-Community Water Supply (CWS) Wells	Non-CWS Surface Water Intakes	Community Water Supply Wells	CWS Surface Water Intakes
Edwards	**Present, but not at risk** Seven (7) water wells were identified and one (or possibly two) are located potentially downgradient of the site. Based on Ramboll's review of groundwater data, these wells are unlikely to be impacted by coal ash constituents.	**Present, but not at risk** One non-CWS well was identified; however, it is unlikely to be at risk because of its hydrogeologic location relative to the power plant.	Absent	Absent	Absent
Duck Creek	**Present, but not at risk** Three (3) water wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant and/or they are abandoned. None of the off-site wells are located in a downgradient direction.	Absent	Absent	Absent	Absent

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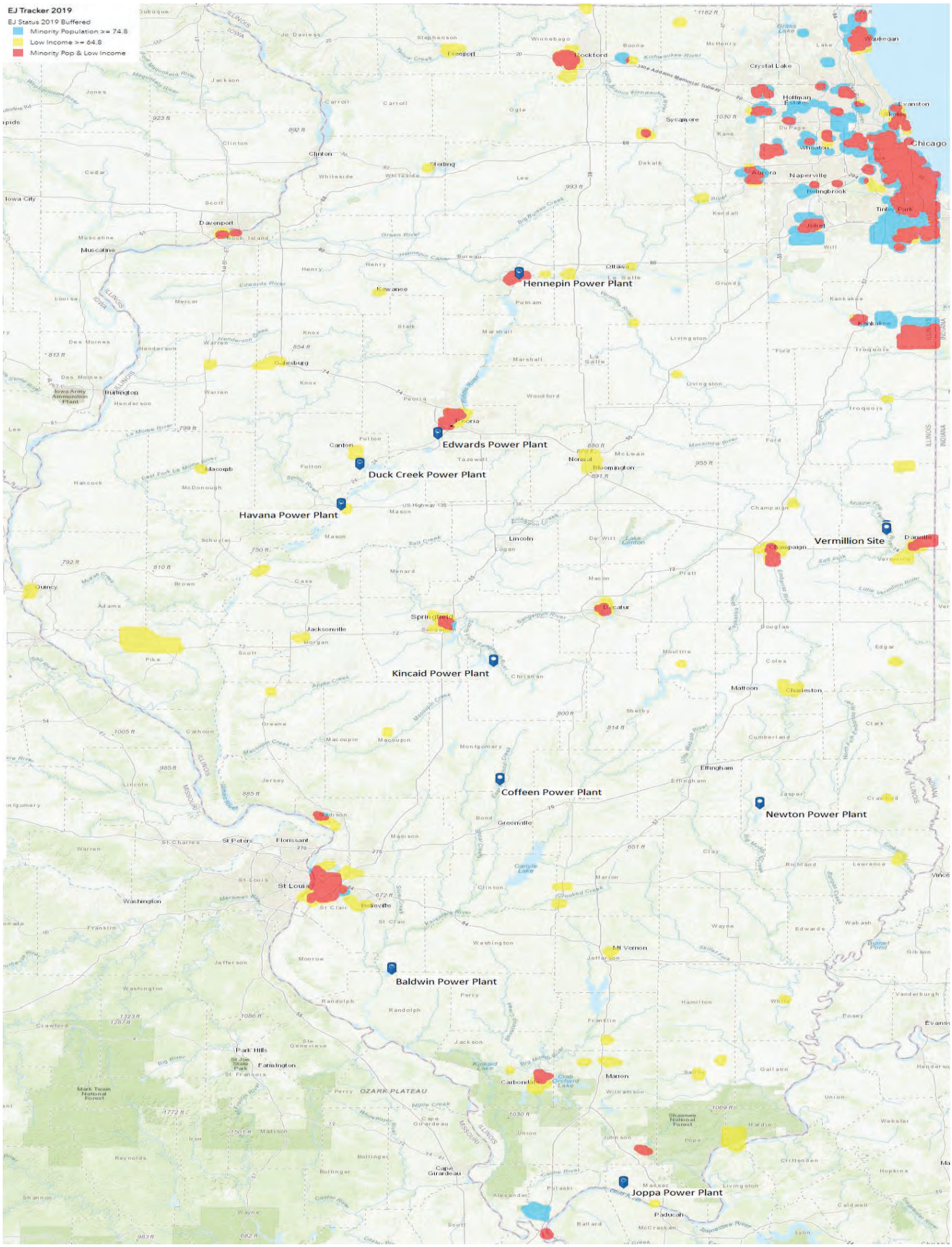
Attachment 2: EJ Mapping Denoting Facilities with Impoundments



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Geosyntec consultants

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Chesterfield, MO 63005
PH 636-812-0800
www.geosyntec.com

October 11, 2021

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, Illinois 61520

Subject: USEPA CCR Rule and IEPA Part 845 Rule Applicability Cross-Reference
2021 USEPA CCR Rule Periodic Certification Report
GMF Pond, Duck Creek Power Plant, Canton, Illinois

At the request of Illinois Power Resources Generating, LLC (IPRG), Geosyntec Consultants (Geosyntec) has prepared this letter to document how the attached 2021 United States Environmental Protection Agency (USEPA) CCR Rule Periodic Certification Report (Report) was prepared in accordance with both the Federal USEPA CCR Rule[1] and the state-specific Illinois Environmental Protection Agency (IEPA) Part 845 Rule[2]. Specific sections of the report and the applicable sections of the USEPA CCR Rule and Illinois Part 845 Rule are cross-referenced in **Table 1**. A certification from a Qualified Professional Engineer for each of the CCR Rule sections listed in **Table 1** is provided in Section 9 of the attached Report. This certification statement is also applicable to each section of the Part 845 Rule listed in **Table 1.**

Table 1 – USEPA CCR Rule and Illinois Part 845 Rule Cross-Reference

Report Section	USEPA CCR Rule		Illinois Part 845 Rule	
3	§257.73 (a)(2)	Hazard Potential Classification	845.440	Hazard Potential Classification Assessment[3]
4	§257.73 (c)(1)	History of Construction	845.220(a)	Design and Construction Plans (Construction History)
5	§257.73 (d)(1)	Structural Stability Assessment	845.450 (a) and (c)	Structural Stability Assessment
6	§257.73 (e)(1)	Safety Factor Assessment	845.460 (a-b)	Safety Factor Assessment
7	§257.82 (a)(1-3)	Adequacy of Inflow Design Control System Plan	845.510(a), (c)(1), (c)(3)	Hydrologic and Hydraulic Capacity Requirements / Inflow Design Flood Control System Plan
	§257.82 (b)	Discharge from CCR Unit	845.510(b)	Discharge from CCR Surface Impoundment

[1] United Stated Environmental Protection Agency, 2015. *40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule.*
[2] State of Illinois, Joint Committee on Administrative Rule, Administrative Code (2021). *Title 35: Environmental Protection, Subtitle G: Waste Disposal, Chapter I: Pollution Control Board, Subchapter j: Coal Combustion Waste Surface Impoundment, Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments.*
[3] "Significant" and "High" hazard, per the CCR Rule[1], are equivalent to Class II and Class I hazard potential, respectively, per Part 845[2].

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CLOSING

This letter has been prepared to demonstrate that the content and Qualified Professional Engineer Certification of the 2021 Periodic USEPA CCR Rule Certification Report fulfills the corresponding requirements of Part 845 of Illinois Administrative Code listed in **Table 1**.

Sincerely,





Lucas P. Carr, P.E.
Senior Engineer

John Seymour, P.E.
Senior Principal

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2021 USEPA CCR RULE PERIODIC CERTIFICATION REPORT §257.73(a)(2), (c), (d), (e) and §257.82 GMF POND Duck Creek Power Plant Fulton County, Illinois

Submitted to

Illinois Power Resources Generating, LLC

17751 North Cilco Road
Canton, Illinois 61520

Submitted by

Geosyntec consultants

engineers | scientists | innovators

1 McBride and Son Center Drive, Suite 202
Chesterfield, Missouri 63005

October 11, 2021

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EXECUTIVE SUMMARY

This Periodic United States Environmental Protection Agency (USEPA) Coal Combustion Residuals (CCR) Rule [1] certification report (Periodic Certification Report) for the GMF Pond[1] at the Duck Creek Power Plant (DCPP) has been prepared in accordance with Rule 40, Code of Federal Regulations (CFR) §257. herein referred to as the "CCR Rule" [1]. The CCR Rule requires that initial certifications for existing CCR surface impoundment, completed in 2016 and subsequently posted on the Illinois Power Resources Generating, LLC (IPRG) CCR Website ([2], [3], [4], [5], [6]) be updated on a five-year basis.

The initial certification reports developed in 2016 and 2017 ([2], [7], [3], [4], [5], [6], [8]) were independently reviewed by Geosyntec. Additionally, field observations, interviews with plant staff, and evaluations were performed to compare conditions in 2021 at the GMF Pond relative to the 2016 initial certifications. These tasks determined that updates are not required for the Initial Hazard Potential Classification or Inflow Design Flood Control Plan. However, due to changes at the site and technical review comments, updates were required and were performed for the:

- History of Construction Report,
- Initial Structural Stability Assessment, and
- Initial Safety Factor Assessment.

Geosyntec's evaluations of the initial certification reports and updated engineering evaluations determined that the GMF Pond meets all requirements for hazard potential classification, history of construction reporting, structural stability assessment, safety factor assessment, and hydrologic and hydraulic control. **Table 1** provides a summary of the initial 2016 certifications and the updated 2021 periodic certifications.

[1] The GMF Pond is also referred to as ID Number W05780100001-04, GMF Pond by the Illinois Environmental Protection Agency (IEPA); CCR unit ID 203 by IPRG, and IL50573 within the National Inventory of Dams (NID) maintained by the Illinois Department of Natural Resources (IDNR). Within this document it is referred to as the GMF Pond or the GMFP.

Table 1 – Periodic Certification Summary

	CCR Rule Reference	Requirement Summary	2016 Initial Certification		2021 Periodic Certification	
			Requirement Met?	Comments	Requirement Met?	Comments
Hazard Potential Classification						
3	§257.73(a)(2)	Document hazard potential classification	Yes	Impoundment was determined to have Significant hazard potential classification [2].	Yes	Updates were not determined to be necessary. Geosyntec recommends retaining the Significant hazard potential classification.
History of Construction						
4	§257.73(c)(1)	Compile a history of construction	Yes	A history of Construction report was prepared for the GMF Pond [3].	Yes	The Duck Creek Power Plant closed and CCR materials are no longer being placed in the GMF Pond. A letter listing updates to the History of Construction report is provided in **Attachment C.**
Structural Stability Assessment						
5	§257.73(d)(1)(i)	Stable foundations and abutments	Yes	Foundations and abutments were found to be stable [8].	Yes	Foundations and abutments were found to be stable after performing updated slope stability analyses.
	§257.73(d)(1)(ii)	Adequate slope protection	Yes	Slope protection was adequate [8].	Yes	No changes were identified that may affect this requirement.
	§257.73(d)(1)(iii)	Sufficiency of dike compaction	Yes	Dike compaction was sufficient for expected ranges in loading conditions [8].	Yes	Dike compaction found to be sufficient after performing updated slope stability analyses.
	§257.73(d)(1)(iv)	Presence and condition of slope vegetation	Yes	Vegetation was present on exterior slopes and is maintained. Interior slopes had alternate protection (geomembrane liner) [8].	Yes	No changes were identified that may affect this requirement.
	§257.73(d)(1)(v)(A) and (B)	Adequacy of spillway design and management	Yes	Spillways were adequately designed and constructed and were expected to adequately manage flow during 1,000-year flood [8].	Yes	No changes were identified that may affect this requirement.
	§257.73(d)(1)(vi)	Structural integrity of hydraulic structures	Not Applicable	Hydraulic structures penetrating the dikes or underlying the base of the GMF Pond were not present [8].	Not Applicable	No changes were identified that may affect this requirement.
	§257.73(d)(1)(vii)	Stability of downstream slopes inundated by water body.	Not Applicable	Inundation of exterior slopes was not expected; this requirement was not applicable [8].	Not Applicable	No changes were identified that may affect this requirement.
Safety Factor Assessment						
6	§257.73(e)(1)(i)	Maximum storage pool safety factor must be at least 1.50	Yes	Safety factors were calculated to be 4.27 and higher [8].	Yes	Safety factors from an updated slope stability analyses were calculated to be 3.47 and higher.
	§257.73(e)(1)(ii)	Maximum surcharge pool safety factor must be at least 1.40	Yes	Safety factors were calculated to be 4.26 and higher [8].	Yes	Safety factors from an updated slope stability analyses were calculated to be 3.47 and higher.
	§257.73(e)(1)(iii)	Seismic safety factor must be at least 1.00	Yes	Safety factors were calculated to be 2.37 and higher [8].	Yes	Safety factors from an updated slope stability analyses were calculated to be 1.88 and higher.
	§257.73(e)(1)(iv)	For dike construction of soils that have susceptible to liquefaction, safety factor must be at least 1.20	Not Applicable	Dike soils were not susceptible to liquefaction [8].	Not Applicable	No changes were identified that may affect this requirement.
Inflow Design Flood Control System Plan						
7	§257.82(a)(1), (2), (3)	Adequacy of inflow design control system plan.	Yes	Flood control system adequately managed inflow and peak discharge during the 1,000-year, 24-hour, Inflow Design Flood [8].	Yes	No changes were identified that may affect this requirement.
	§257.82(b)	Discharge from CCR Unit	Yes	Discharge into Waters of the United States is not expected during 1,000-year, 24-hour Inflow Design Flood conditions [8].	Yes	No changes were identified that may affect this requirement.

SECTION 1

INTRODUCTION AND BACKGROUND

This Periodic United States Environmental Protection Agency (USPA) Coal Combustion Residual (CCR) Rule [1] Certification Report was prepared by Geosyntec Consultants (Geosyntec) for Illinois Power Resources Generations, LLC (IPRG) to document the periodic certification of the GMF Pond at the Duck Creek Power Plant (DCPP) located at 17751 North Cilco Road in Canton, Illinois, 61520. The location of Duck Creek is provided in **Figure 1**, and a site plan showing the location of the GMF Pond, among other closed and open CCR units and non-CCR surface impoundments, is provided in **Figure 2**.

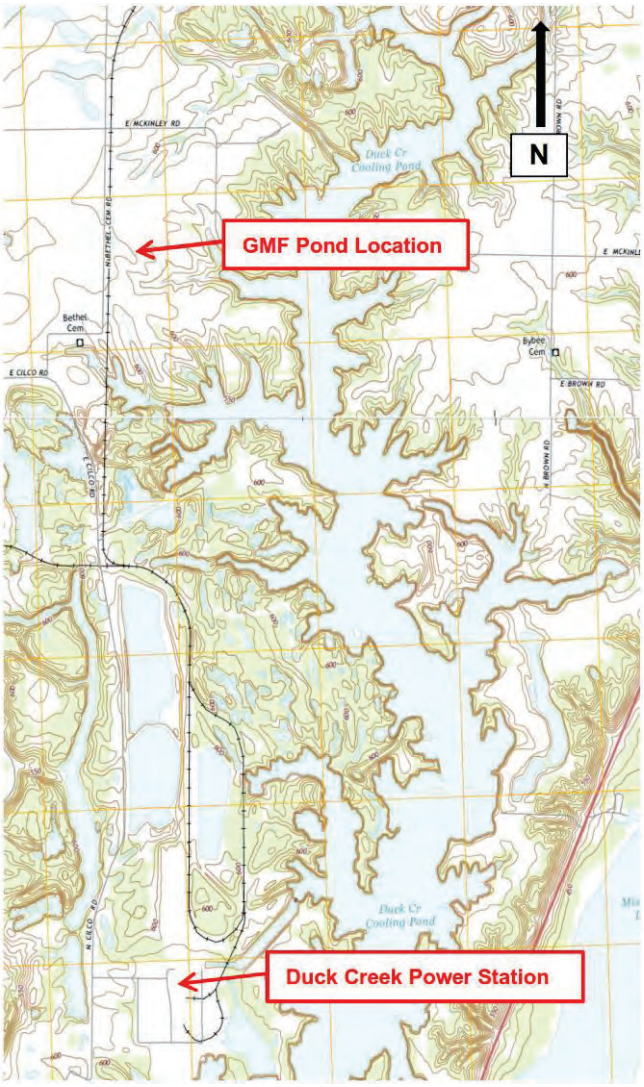

Figure 1 – Site Location Map (from AECOM, 2016)



Figure 2 – Site Plan

1.1 GMF Pond Description

DCPP was retired in 2019. Prior to retirement, two active CCR surface impoundments – the GMF Pond and the Bottom Ash Basin, and one CCR landfill, were used for managing CCRs generated at DCPP [8]. This certification report only pertains to the GMF Pond. The GMF Pond has a "Significant" hazard potential, based on the initial hazard potential classification assessment performed by Stantec in 2016 in accordance with §257.73(a)(2) ([2], [7]).

The GMF Pond served as the wet impoundment basin for gypsum proceeded by the emissions scrubbers at DCPP. The GMF Pond was constructed between 2008 and 2009 and received inflow from three pairs of 10-in diameter high-density polyethylene (HDPE) gypsum slurry pipes. Clear water discharge from the GMF Pond flows downstream into the approximately 8.5-acre GMF Recycle Pond, which is a non-CCR unit, via a lined channel (transfer channel). The transfer channel is approximately 150-ft long, trapezoidal in shape, lined with 60-mil HDPE, has 3H:1V (horizontal to vertical) side slopes, and a depth of 6 ft. Stoplogs are present within the transfer channel that would allow the pool level to be maintained as high as El. 616.0 ft[2]. The channel transitions from a 16-ft bottom width at an invert elevation of 614.0 ft at the upstream end to a 35-ft bottom width at an invert elevation of 609.0 ft at the downstream end. Outflow from the GMF Recycle Pond was formerly pumped back to DCPP to be recycled for use in the wet scrubber system [8]. Currently, the GMF Pond and GMF Recycle Pond are maintained in a zero-discharge configuration, where the only inflows are precipitation flowing directly into the impoundments and the only outflows are evaporation.

The GMF Pond has a composite liner system that is present underneath the entire footprint of the pond and extends up the interior slopes. The liner system includes, from bottom to top, a 3-ft thick layer of compacted clay that is overlain by a geosynthetic clay liner (GCL) and a 60-mil textured HDPE geomembrane, all of which serve as the lower liner. Above the lower liner, a 10-oz

[2] All elevations are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

geotextile is overlain by a 1-ft thick granular drainage layer and a 4-oz geotextile filter. The upper liner is comprised from bottom to top of a 1-ft thick soil cushion layer and a 60-mil textured HDPE geomembrane. The upper geomembrane liner is exposed at the pond bottom and side slopes [8].

As formerly operated, the normal pool of the GMF Pond was El. 615.0 ft, as controlled by the stoplog structure at the top of the transfer channel. The GMF Pond is approximately 31.6 acres in size and has a total perimeter embankment length of approximately 4,560 ft. The perimeter dike was constructed to include a crest width of approximately 30 ft and crest height ranging from approximately 5 to 10 ft along the eastern side of the pond. The interior of the ponds extends deeper than the exterior slopes; the maximum interior slope height is approximately 45 ft in the southwest corner of the pond. The design elevation of the embankment crest is 620 ft. Both interior and exterior slopes have an orientation of 3.5H:1V (horizontal to vertical).

Initial certifications for the GMF Pond for Hazard Potential Classification (§257.73(a)(2)), History of Construction (§257.73(c)), Structural Stability Assessment (§257.73(d)), Safety Factor Assessment (§257.73(e)(1)), and Inflow Design Flood Control System Plan (§257.82) were completed by Stantec and AECOM in 2016 and 2017 and subsequently posted to IPRG's CCR Website ([2], [3], [4], [5], [6]). Additional documentation for the initial certifications included a detailed operating record reports containing calculations and other information prepared for the hazard potential classification by Stantec [7] and for the structural stability assessment, safety factor assessment, and inflow design flood control system plan by AECOM [8]. These operating record reports were not posted to IPRG's CCR Website.

1.2 Report Objectives

The following objectives are associated with this report:

- Compare site conditions from 2015/2016, when the initial certifications were developed, to site conditions in 2020/2021, when data for the periodic certification was obtained, and evaluate if updates are required to the:
    - §257.73(a)(2) Hazard Potential Classification [2].
    - §257.73(c) History of Construction [3].
    - §257.73(d) Structural Stability Assessment [4].
    - §257.73(e) Safety Factor Assessment [5], and/or
    - §257.82 Inflow Design Flood Control System Plan [6].
- Independently review the Hazard Potential Classification ([2], [7]), Structural Stability Assessment ([4], [8]), Safety Factor Assessment ([5], [8]), and Inflow Design Flood

Control System Plan ([6], [8]) reports to determine if updates may be required based on technical considerations.

  - The History of Construction report [3] was not independently reviewed for technical considerations, as this report contained historical information primarily developed prior to promulgation of the CCR Rule [1] for the CCR units at DCPP, and did not include calculations or other information used to certify performance and/or integrity of the impoundments under §257.73(a)(2), §257.73(c)-(e), or §257.82.

- Confirm that the GMF Pond meets all of the requirements associated with §257.73(a)(2), (c), (d), (e), and §257.82, or, if the GMF Pond does not meet any of these requirements, provide recommendations for compliance with those sections of the CCR Rule [1].

SECTION 2

COMPARISION OF INITIAL AND PERIODIC SITE CONDITIONS

2.1 Overview

This section describes the comparison of conditions at the GMF Pond between the start of the initial CCR certification program in 2015 and 2016 (initial conditions) and subsequent collection of periodic certification site data in 2020 and 2021 (periodic conditions).

2.2 Review of Annual Inspection Reports

Annual onsite inspections for the GMF Pond were performed between 2016 and 2020 ([9], [10], [11], [12], [13]) were certified by a licensed professional engineer in accordance with §257.83(b). Each inspection report stated the following information, relative to the previous inspection:

- A statement that no changes in geometry of the impounding structure were observed since the previous inspection;
- A statement that no instrumentation was present;
- Approximate volumes of impounded water and CCR at the time of inspection;
- A statement that no appearances of actual or potential structural weakness or other disruptive conditions were observed; and
- A statement that no other changes which may have affected the stability or operation of the impounding structure were observed.

In summary, the reports did not indicate any significant changes to the GMF Pond between 2015 and 2020. No signs of instability, structural weakness, or changes which may have affected the operation or stability of the GMF Pond were noted in the inspection reports.

2.3 Review of Instrumentation Data

Multiple groundwater monitoring wells are present around the GMF Pond. Eight of the groundwater monitoring wells, G50S, G51S, G54C, G57C, G57S, G60S, G64S, and X301 have been monitored periodically since by IPRG. Water level readings were provided from December 2, 2015 through June 21, 2021 for most of the wells, with the exception of X301, for which water level readings were provided starting on March 2, 2015, and G54C, for which readings were provided starting on April 14, 2021. Geosyntec reviewed the water levels to evaluate if significant fluctuations, partially increases in phreatic levels, may have occurred between development of the

initial structural stability and factor of safety certifications ([4], [5], [8]) and June 21, 2021. Available monitoring well water levels are plotted in **Attachment A**.

In summary, only minor changes in phreatic conditions were observed in the available monitoring well level data. Phreatic levels typically exhibited consistent seasonal variations of 5 to 10 ft, with the exception of X301 and G54C, which varied by approximately 2 ft. These levels do not significantly differ from those utilized for the initial structural stability and factor of safety certifications ([4], [5], [8]).

2.4 Comparison of Initial to Periodic Surveys

The initial survey of the GMF Pond, conducted by Weaver Consultants (Weaver) in 2015 [14], was compared to the periodic survey of the GMF Pond, conducted by IngenAE, LLC (IngenAE) in 2020 [15], using AutoCAD Civil3D 2021 software. This comparison quantified changes in the volume of CCR placed within the GMF Pond and considered volumetric changes above and below the starting water surface elevation (SWSE) used for the 2016 §257.82 inflow design flood control plan hydraulic analysis [6]. Potential changes to embankment geometry were also evaluated. This comparison is presented in side-by-side comparison of the two surveys in **Drawing 1,** and a plan view isopach map denoting changes in ground surface elevation in **Drawing 2**. A summary of the water elevations and changes in CCR volumes is provided in **Table 2**.

Table 2 – Initial to Periodic Survey Comparison

Initial Surveyed Pool Elevation (ft)	614.2
Periodic Surveyed Pool Elevation (ft)	613.9
Initial §257.82 Starting Water Surface Elevation (SWSE) (ft)	616.0
Total Change in CCR Volume* (CY)	+ 8,000 (Fill)
Change in CCR Volume Above SWSE* (CY)	- 9,000 (Cut)
Change in CCR Volume Below SWSE* (CY)	+ 17,000 (Fill)

*All volumes rounded to the nearest 1,000 CY

The comparison indicated that approximately 8,000 CY of CCR was placed in the GMF Pond between the initial and periodic surveys. The CCR was placed entirely below the SWSE and a net cut occurred above the SWSE. CCR grades above the SWSE were generally similar to the initial survey (e.g., within +/- 2 ft). These changes are considered unlikely to result in increase in the peak water surface elevation (PWSE) during a flood event, as additional flood storage is present relative to conditions observed in 2015. No significant changes to embankment geometry appeared to have occurred between the initial and periodic surveys.

2.5 Comparison of Initial to Periodic Aerial Photography

Initial aerial photographs of the GMF Pond collected by Weaver in 2015 [14] were compared to periodic aerial photographs collected by IngenAE in 2020 [15] to visually evaluate if potential site changes (i.e., changes to the embankment, outlet structures, limits of CCR, other appurtenances)

may have occurred. A comparison of these aerial photographs is provided in **Drawing 3**. No significant changes were noted during this comparison.

2.6 Comparison of Initial to Periodic Site Visits

An initial site visit to the GMF Pond was conducted by AECOM in 2015 and documented with a Site Visit Summary and corresponding photographs [16]. A periodic site visit was conducted by Geosyntec on May 27, 2021, with Mr. Lucas P. Carr, P.E. conducting the site visit. The site visit was intended to evaluate potential changes at the site since the initial certifications were prepared (i.e., modification to the embankment, outlet structures or other appurtenances, limits of CCR, maintenance programs, repairs), in addition to performing visual observations of the GMF Pond to evaluate if the structural stability requirements (§257.73(d)) were still met. The stie visit included walking the perimeter of the GMF Pond, visually observing conditions, recording field notes, and collecting photographs. The site visit is documented in a photographic log provided in **Appendix A**. A summary of significant findings from the periodic site visit is provided below:

- Overall site maintenance appears to be similar to conditions observed in 2015.
- No signs or structural stability, erosion, or required maintenance items were observed during the stie visit.

2.7 Interview with Power Plant Staff

An interview with Mr. Daryl Johnson and Mr. Brandon Potter of the DCPP was conducted by Lucas P. Carr, P.E. of Geosyntec on May 27, 2021. Mr. Johnson, at the time of the interview, had been employed at the DCPP for 8 years and was responsible for environmental compliance and completed weekly CCR inspections on some years, including for the GMF Pond, in addition to managing vegetation maintenance. Mr. Potter, at the time of the interview, had been employed at DCPP for 10 years and assisted in the inspection and operation of the GMF Pond. The interview included a discussion of included a discussion of potential changes that that may have occurred at the GMF Pond since development of the initial certifications ([2], [7], [3], [4], [5], [6], [8]).

- Were any construction projects completed for the GMF Pond since 2015, and, if so, are design drawings and/or details available?
    - No.
- Were there any changes to the purpose of the GMF Pond since 2015?
    - The DCPP was closed in December of 2019. Sluicing into the GMF Pond and pumping of water from the GMF Recycle Pond was stopped at this time.
- Were there any changes to the to the instrumentation program and/or physical instruments for the GMF Pond since 2015?

- The GMF Pond does not have instrumentation, so no changes occurred.

- Have area-capacity curves for the GMF Pond been prepared since 2015?
  - No known area-capacity curves have been developed.
- Were there any changes to spillways and/or diversion features for the GMF Pond completed since 2015?
  - No.
- Were there any changes to construction specifications, surveillance, maintenance, and repair procedures for the GMF Pond since 2015?
  - No.
- Were there any instances of dike and/or structural instability for the GMF Pond since 2015?
  - No known instances occurred.

SECTION 3

HAZARD POTENTIAL CLASSIFICATION - §257.73(a)(2)

3.1 Overview of Initial HPC

The Initial Hazard Potential Classification (Initial HPC) was prepared by Stantec Consulting Services, Inc. (Stantec) in 2016 ([2], [7]), following the requirements of §257.73(a)(2). The Initial HPC included the following information:

- Visual analysis to evaluate potential hazards associated with a failure of the GMF Pond perimeter dike, along the north, south, east, and west embankments of the GMF Pond.
- Evaluation of potential breach flow paths using elevation data and aerial imagery to assess potential impacts to downstream structures, infrastructure, and waterways.
- While a breach map is not included within the Initial HPC, it included within the §257.73(a)(3) Initial Emergency Action Plan (Initial EmAP) [17].

The visual analysis indicated that only structures owned by DCPP were within the potential breach path, and that public impacts were limited to portions of North Bethel Cemetery Road and the railroad leading to the Power Plant. The reported noted that North Bethel Cemetery Road is intermittently used, and the at-risk population was considered transient. The Initial HPC concluded that breach of the GMF pond would be unlikely to result in a probable loss of human life, although the breach could cause CCR to be released into downstream waterways, thereby causing environmental damage. The Initial HPC therefore recommended a “Significant” hazard potential classification for the GMF Pond [2].

3.2 Review of Initial HPC

Geosyntec performed a review of the Initial HPC ([2], [7]), in terms of technical approach, assessment of the results, and applicable requirements of the CCR Rule [1]. No significant technical issues were noted within the technical review, although a detailed review (e.g., check) of the calculations was not performed as the initial HPC utilized a visual assessment.

3.3 Summary of Site Changes Affecting the Initial HPC

Geosyntec did not identify any changes at the site that may affect the HPC. No new structures, infrastructure, frequently occupied facilities/areas, or waterways were observed to be present in the probable breach area indicated in the Initial EmAP [17]. Additionally, no significant changes to the topography in the probable breach were identified.

3.4 Periodic HPC

Geosyntec recommends retaining the "Significant" hazard potential classification for the GMF Pond, per §257.73(A)(2), based on the lack of site changes potentially affecting the Initial HPC occurring since the initial HPC was developed, as described in **Section 3.3**, and the lack of significant review comments, as described in **Section 3.2**. Updates to the Initial HPC reports ([2], [7]) are not recommended at this time.

SECTION 4

HISTORY OF CONSTRUCTION REPORT - §257.73(c)

4.1 Overview of Initial HoC

The Initial History of Construction report (Initial HoC) was prepared by AECOM in 2016 [3] following the requirements of §257.73(c) and included information on all non-incised CCR surface impoundments at DCPP, including the GMF Pond, Ash Pond No. 1, and Ash Pond No. 2. This report only discusses the HoC as it pertains to the GMF Pond. The Initial HoC included the following information for the GMF Pond:

- The name and address of the owner/operator,
- Location maps,
- Statements of purpose,
- The names and size of the surrounding watershed,
- A description of the foundation and abutment materials,
- A description of the dike materials,
- Approximate dates and stages of construction,
- Available design and engineering drawings,
- A summary of instrumentation,
- Area-capacity curves for the GMF Pond,
- Information on spillway structures,
- Construction specifications,
- Inspection and surveillance plans,
- A statement that operations and maintenance plans are being generated or revised, and that the report will be updated when the new plans are available,
- A statement that no known historical structural instability has occurred at the CCR surface impoundments.

4.2 Summary of Site Affecting the Initial HoC

One significant change at the site that occurred after development of the initial HoC report [3] was identified and is described below:

- Electricity generation at the DCPP ceased in December of 2019 and the pumping of inflow and outflow into and from the GMF Recycle Pond ceased at this time.
    - An update to the HoC report was performed to state that the DCPP is no longer active and the GMF Pond is no lower receiving inflows and outflow is no longer pumped back to the DCPP. A letter documenting changes to the HoC report is provided in **Attachment C**.

SECTION 5

STRUCTURAL STABILITY ASSESSMENT - §257.73(d)

5.1 Overview of Initial SSA

The Initial Structural Stability Assessment (Initial SSA) was prepared by AECOM in 2016 ([4], [8]), following the requirements of §257.73(d)(1), and included the following evaluations:

- Stability of dike foundations, dike abutments, slope protection, dike compaction, and slope vegetation,
- Spillway stability including capacity, structural stability and integrity; and
- Downstream slope stability under sudden drawdown conditions for a downstream water body.

The Initial SSA ([4], [8]) concluded that the GMF Pond met all structural stability requirements for §257.73(d)(1)(i)-(vii). This included noting that the structural integrity of hydraulic structures (§257.73(d)(1)(vi)) was not applicable, due to no hydraulic structures penetrating or underlying the base of the GMF Pond. Additionally, it was noted that the stability of downstream slopes inundated by water bodies (§257.73(d)(1)(vii) was also not applicable, due to inundation of the downstream slopes not being expected.

5.2 Review of Initial SSA and Updated Periodic SSA

Geosyntec performed a review of the Initial SSA ([4], [8]) in terms of technical approach, calculation input parameters and methodology, recommendations, and completeness. The review included the following tasks:

- Reviewing photographs collected in 2015 and used to demonstrate compliance with §257.73(d)(1)(i)-(vii).
- Reviewing geotechnical calculations used to demonstrate the stability of foundations, per §257.73(d)(1)(i) and sufficiency of dike compaction, per §257.73(d)(1)(iii), in terms of supporting geotechnical investigation and testing data, input parameters, analysis methodology, selection of critical cross-sections, and loading conditions.
- Review of the methodology used to demonstrate that a downstream water body that could induce a sudden drawdown condition, per §257.73(d)(1)(vii), is not present.

One review comment and corresponding recommended technical update was identified during review of the geotechnical analyses supporting the sufficiency of dike compaction

(§257.73(d)(1)(i)) and foundation and abutment stability (§257.73(d)(1)(iii) portions of the Initial SSA. These analyses were performed for the Initial Safety Factor Assessment (SFA) but also utilized to support the initial SSA. The review comment and subsequent updates the Initial SFA, are discussed in **Section 6.**

5.3 Summary of Site Changes Affecting the Initial SSA

No changes since development of the Initial SSA were identified that would require updates to the Initial SSA ([4], [8]).

5.4 Periodic SSA

The updated Periodic SFA (**Section 7**) indicates that foundations and abutments are stable and dike compaction is sufficient for expected ranges in loading conditions, as slope stability factors of safety for slip surfaces passing through the dike and foundation were found to meet or exceed the requirements of §257.73(e)(1), including for static maximum storage pool conditions and post-earthquake (i.e., liquefaction) loading conditions considering seismically-induced strength loss in the foundation soils. Therefore, the requirements of §257.73(d)(1)(i) and §257.73(d)(1)(iii) are met for the Periodic SSA.

SECTION 6

SAFETY FACTOR ASSESSMENT - §257.73(e)(1)

6.1 Overview of Initial SFA

The Initial Safety Factor Assessment (Initial SFA) was prepared by AECOM in 2016 ([5], [8]) following the requirements of §257.73(e)(1). The Initial SFA included the following information:

- A geotechnical investigation program with in-situ and laboratory testing;
- An assessment of the potential for liquefaction in the dike and foundation soils;
- The development of a single slope stability cross-sections for limit equilibrium stability analysis utilizing GeoStudio SLOPE/W software; and
- The analysis of the cross-section for maximum storage pool, maximum surcharge pool, and seismic loading conditions.
    - Liquefaction loading conditions were not evaluated as liquefaction-susceptible soil layers were not identified in either the embankments or foundation soils.

The Initial SFA concluded that the GMF Pond met all safety factor requirements, per §257.73(e), as all calculated safety factors were equal to or higher than the minimum required values.

6.2 Review of Initial SFA

Geosyntec performed a review of the Initial SFA ([5], [8]) in terms of technical approach, calculation input parameters and methodology, recommendations, and completeness. The review included the following tasks:

- Reviewing geotechnical calculations used to demonstrate the acceptable safety factors, per §257.73(e)(1), in terms of:
    - Completeness and adequacy of supporting geotechnical investigation and testing data;
    - Completeness and approach of liquefaction triggering assessments; and
    - Input parameters, analysis methodology, selection of critical cross-sections, and loading conditions utilized for slope stability analyses.
    - Phreatic conditions based on piezometric data collected between March 2, 2015 June 21, 2021, as discussed in **Section 2.3**.

One review comment was identified during review of the Initial SFA. The comment and the is described below:

- The Initial SFA utilized a single cross-section (A-A') along the eastern embankment where the exterior slope is approximately 8 ft tall. However, the maximum height of the exterior slope is approximately 11 ft at the southwest corner of the embankment.

6.3 Summary of Site Changes Affecting the Initial SFA

No changes since development of the Initial SFA were identified that would require updates to the Initial SFA ([5], [8]).

6.4 Periodic SFA

Following review of the Initial SFA ([5], [8]), Geosyntec developed a new slope stability analysis cross-section (B-B') at the southwest corner of the GMF Pond embankment to account for the maximum embankment height of 11 ft. The model was developed utilizing the following approach and input data:

- Ground surface geometry was obtained from the 2020 survey of the GMF Pond [15].

- Subsurface stratigraphy was obtained from 2007 borings B-53 and B-67, as provided in the Initial SFA report [8]. Geosyntec reviewed the boring data and determined that subsurface conditions were similar to conditions at cross-section A-A'. Therefore, the soil properties (i.e., strength, unit weight) from the Initial SFA ([5], [8]) were utilized for cross-section B-B',

- Piezometric levels in the foundation soils were assumed to follow the ground surface past the embankment toe, per providing readings from monitoring wells G51S and G54C; and,

- All other analysis settings and input data from the Initial SFA ([5], [8]) was utilized, including, but not limited to, software package and version, slip surface search routines and methods, and pseudostatic seismic coefficients.

Factors of safety form the Periodic SFA (cross-section B-B') and Initial SFA (cross-section A-A') are summarized in **Table 3** and confirm that the GMF Pond meets the requirements of §257.73(e)(1). A location of the cross-section B-B' in plan and analysis output data for cross-section B-B' is provided in **Attachment D**.

Table 3 – Factors of Safety from Periodic SFA

	Structural Stability Assessment (§257.73(d)) and Safety Factor Assessment (§257.73(e))				Structural Stability Assessment (§257.73(d))
Cross-Section	**Maximum Storage Pool §257.73(e)(1)(i) Minimum Required = 1.50**	**Maximum Surcharge Pool §257.73(e)(1)(ii) Minimum Required = 1.40**	**Seismic §257.73(e)(1)(iii) Minimum Required = 1.00**	**Dike Liquefaction §257.73(e)(1)(iv) Minimum Required = 1.20**	**Foundation Liquefaction §257.73(d)(1)(i) Minimum Required = 1.20**
A-A'	4.27	4.26	2.37	N/A	N/A
B-B'	3.47*	3.47*	1.88*	N/A	N/A

Notes:
[1]Denotes cross-section where results from the Initial SFA are presented due to no observed changes relative to the Initial IDF.
[2]Denotes cross-section where changes are occurred, and results are presented from the updated Periodic SFA.
*Indicates critical cross-section (i.e., lowest calculated factor of safety out of the two cross-sections analyzed)
N/A – Loading condition is not applicable.

SECTION 7

INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN - §257.82

7.1 Overview of Initial IDF

The Initial Inflow Design Flood Control System Plan (Initial IDF) was prepared by AECOM in 2016 ([6], [8]) following the requirements of §257.82. The Initial IDF included the following information:

- A hydraulic and hydrologic analysis, performed for the 1,000-year design flood event because of the hazard potential classification of "significant", which corresponded to 9.37 inches of rainfall over a 24-hour period.
- The Initial IDF utilized a HydroCAD Version 8.5 model to evaluate spillway flows and pool level increases during the design flood, with a SWSE of 616.0 ft.

The Initial IDF ([6], [8]) concluded that the GMF Pond met the requirements of §257.82, as the peak water surface estimated by the HydroCAD model was El. 618.3 ft, relative to a minimum GMF Pond dike crest elevation of 620.0 ft. Therefore, overtopping was not expected. The Initial IDF also evaluated the potential for discharge from the CCR unit and determined that discharge into Waters of the United States and no overtopping was expected during the 1,000-year design flood.

7.2 Review of Initial IDF

Geosyntec performed a review of the Initial IDF ([6], [8]) in terms of technical approach, calculation input parameters and methodology, recommendations, and completeness. The review included the following tasks:

- Reviewing the return interval used vs. the hazard potential classification.
- Reviewing the rainfall depth and distribution for appropriateness.
- Performing a high-level review of the inputs to the hydrological modeling.
- Reviewing the hydrologic model parameters for spillway parameters, starting pool elevation, and storage vs. the reference data.
- Reviewing the overall Initial IDF vs. the applicable requirements of the CCR Rule [1].

No significant technical issues were noted within the technical review, although a detailed review (e.g., check) of the calculations was not performed.

7.3 Summary of Site Changes Affecting the Initial IDF

No changes since development of the Initial IDF were identified that would require updates to the Initial IDF ([6], [8]).

SECTION 8

CONCLUSIONS

The GMF Pond at DCPP was evaluated relative to the USEPA CCR Rule periodic assessment requirements for:

- Hazard potential classification (§257.73(a)(2)),
- History of Construction reporting (§257.73(d)),
- Structural stability assessment (§257.73(d)),
- Safety factor assessment (§257.73(e)), and
- Inflow design flood control system planning (§257.82).

Based on the evaluations presented herein, the referenced requirements are satisfied.

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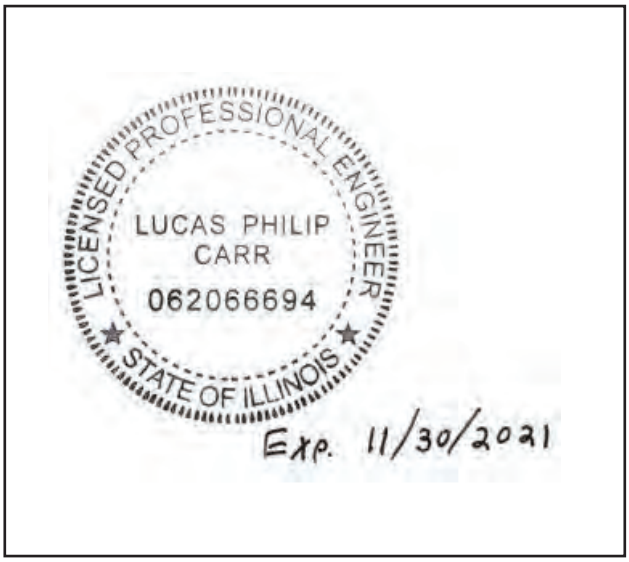
SECTION 9

CERTIFICATION STATEMENT

CCR Unit: Illinois Power Resources Generation, LLC; Duck Creek Power Plant, GMF Pond

I, Lucas P. Carr, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this 2021 USEPA CCR Rule Periodic Certification Report, has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the periodic assessment of the hazard potential classification, history of construction report, structural stability, emergency action plan, safety factors, and inflow design flood control system planning, dated October 2021, were conducted in accordance with the requirements of 40 CFR §257.73(a)(2), (c), (d), (e), and §257.82.



Lucas P. Carr

10/11/2021

Date

SECTION 10

REFERENCES

[1] United States Environmental Protection Agency, 40 CFR Parts 257 and 261; Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 2015.

[2] Stantec Consulting Services Inc., "Initial Hazard Potential Classification Assessment, EPA Final CCR Rule, GMF Pond, Duck Creek Power Station, Fulton County, Illinois," Fenton, MO, October 12, 2016.

[3] AECOM, "History of Construction, USEPA Final CFR Rule, 40 CFR §257.73(c), Duck Creek Power Station, Canton, Illinois," October 2016.

[4] AECOM, "CCR Rule Report: Initial Structural Stability Assessment for GMF Pond at Duck Creek Power Station," October 2016.

[5] AECOM, "CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station," St. Louis, MO, October 2016.

[6] AECOM, "CCR Rule Report: Initial Inflow Design Flood Control System Plan for GMF Pond at Duck Creek Power Station," October 2016.

[7] Stantec Consulting Services Inc., "Documentation of Initial Hazard Potential Classification Assessment, GMF Pond, Duck Creek Power Station, Fulton County, Illinois," October 12, 2016.

[8] AECOM, "CCR Certification Report: Initial Structural Stability Assessment, Initial Safety Factor Assessment, and Initial Inflow Design Flood Control System Plan for GMF Pond at Duck Creek Power Station," October 2016.

[9] J. Knutelski and J. Campbell, "Annual CCR Surface Impoundment Inspection Report (per 40 CFR 257.83(b)(2)), Duck Creek Power Station, GMF Pond," January 18, 2017.

[10] J. Knutelski and J. Campbell, "Annual CCR Surface Impoundment Inspection Report (per 40 CFR 257.83(b)(2)), Duck Creek Power Station, GMF Pond," February 7, 2018.

[11] J. Knutelski, "Annual Inspection by a Qualified Professional Engineer, 40 CFR §2357.83(b), Duck Creek Power Station, GMF Pond," January 10, 2019.

[12] J. Knutelski, "Annual Inspection by a Qualified Professional Engineer, 40 CFR §257.83(b), Duck Creek Power Station, GMF Pond," January 8, 2020.

[13] J. Knutelski, "Annual Inspection by a Qualified Professional Engineer, 40 CFR §257.83(b), Duck Creek Power Station, GMF Pond," January 6, 2021.

[14] Weaver Consultants Group, "Dynegy, Collinsville, Illinois, 2015 - Duck Creek Existing Topography," December 1, 2015.

[15] IngenAE, "Luminant, Illinois Power Resrouces Generating, LLC, Duck Creek Power Station, December 2020 Topography," February 9, 2021.

[16] AECOM, "Initial Site Visit CCR Unit Summary, Dynegy CCR Compliance Program - Duck Creek, Duck Creek GMF Primary Pond," June 23, 2015.

[17] Stantec Consulting Services Inc., "Duck Creek Power Station, Emergency Action Plan (EAP)," April 13, 2017.

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DRAWINGS

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INITIAL SURVEY
12-01-2015 TOPOGRAPHY



PERIODIC SURVEY
02-09-2021 TOPOGRAPHY

0 300
SCALE IN FEET

NOTES:

1. THE INITIAL SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "DYNEGY, COLLINSVILLE, ILLINOIS, 2015 - DUCK CREEK EXISTING TOPOGRAPHY", PREPARED BY WEAVER CONSULTANTS GROUP, DATED DECEMBER 1, 2015.
2. THE PERIODIC SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "LUMINANT, ILLINOIS POWER RESOURCES GENERATING, LLC, DUCK CREEK POWER STATION, DECEMBER 2020 TOPOGRAPHY", PREPARED BY INGENAE, DATED FEBRUARY 9, 2021.
3. ALL SURVEY DATA WAS COLLECTED IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) AND NORTH AMERICAN DATUM OF 1983 (NAD83) FOR VERTICAL AND HORIZONTAL COORDINATES, RESPECTIVELY.

INITIAL TO PERIODIC SURVEY COMPARISON
GMF POND
DUCK CREEK POWER STATION
CANTON, ILLINOIS

Geosyntec consultants

DRAWING 1

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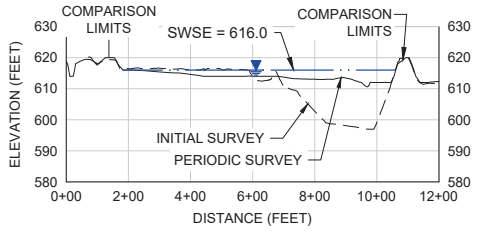
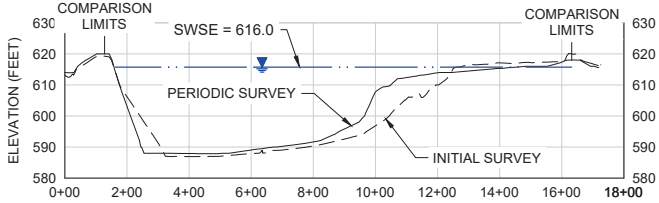
ISOPACH CONTOUR KEY		
COLOR	MIN ELEV	MAX ELEV
	-13	-10
	-10	-8
	-8	-6
	-6	-4
	-4	-2
	-2	0
	0	2
	2	4
	4	6
	6	8
	8	10
	10	17



SECTION A



SECTION B



INITIAL TO PERIODIC SURVEY COMPARISON SUMMARY			
SURFACE IMPOUNDMENT	CUT*	FILL*	NET (CU. YD.)*
GMF POND	54,000	62,000	8,000 (FILL)
ABOVE SWSE	10,000	1,000	9,000 (CUT)
BELOW SWSE	44,000	61,000	17,000 (FILL)

* ALL VOLUMES ROUNDED TO THE NEAREST 1,000 CY

NOTES:

1. THE INITIAL SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "DYNEGY, COLLINSVILLE, ILLINOIS, 2015 - DUCK CREEK EXISTING TOPOGRAPHY", PREPARED BY WEAVER CONSULTANTS GROUP, DATED DECEMBER 1, 2015.
2. THE PERIODIC SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "LUMINANT, ILLINOIS POWER RESOURCES GENERATING, LLC, DUCK CREEK POWER STATION, DECEMBER 2020 TOPOGRAPHY", PREPARED BY INGENAE, DATED FEBRUARY 9, 2021.
3. ALL SURVEY DATA WAS COLLECTED IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) AND NORTH AMERICAN DATUM OF 1983 (NAD83) FOR VERTICAL AND HORIZONTAL COORDINATES, RESPECTIVELY.
4. THE STARTING WATER SURFACE ELEVATION (SWSE) OF THE GMF POND IS EL. 616.0 FT, AS NOTED IN THE REPORT TITLED "CCR CERTIFICATION REPORT: INITIAL STRUCTURAL STABILITY ASSESSMENT, INITIAL SAFETY FACTOR ASSESSMENT, AND INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN FOR GMF POND AT DUCK CREEK POWER STATION", PREPARED BY AECOM, DATED OCTOBER, 2016.



GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

Geosyntec consultants

GLP8027.03 | AUGUST 2021

DRAWING 2

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INITIAL AERIAL
12-01-2015 IMAGERY



PERIODIC AERIAL
02-09-2021 IMAGERY

0 300
SCALE IN FEET

NOTES:

1. THE INITIAL IMAGERY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "DYNEGY, COLLINSVILLE, ILLINOIS, 2015 - DUCK CREEK EXISTING TOPOGRAPHY", PREPARED BY WEAVER CONSULTANTS GROUP, DATED DECEMBER 1, 2015.
2. THE PERIODIC IMAGERY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "LUMINANT, ILLINOIS POWER RESOURCES GENERATING, LLC, DUCK CREEK POWER STATION, DECEMBER 2020 TOPOGRAPHY", PREPARED BY INGENAE, DATED FEBRUARY 9, 2021.

INITIAL TO PERIODIC AERIAL IMAGERY COMPARISON
GMF POND
DUCK CREEK POWER STATION
CANTON, ILLINOIS

Geosyntec consultants

DRAWING 3

GLP8027.03 | MAY 2021

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ATTACHMENTS

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Attachment A

GMF Pond Piezometer Data Plots

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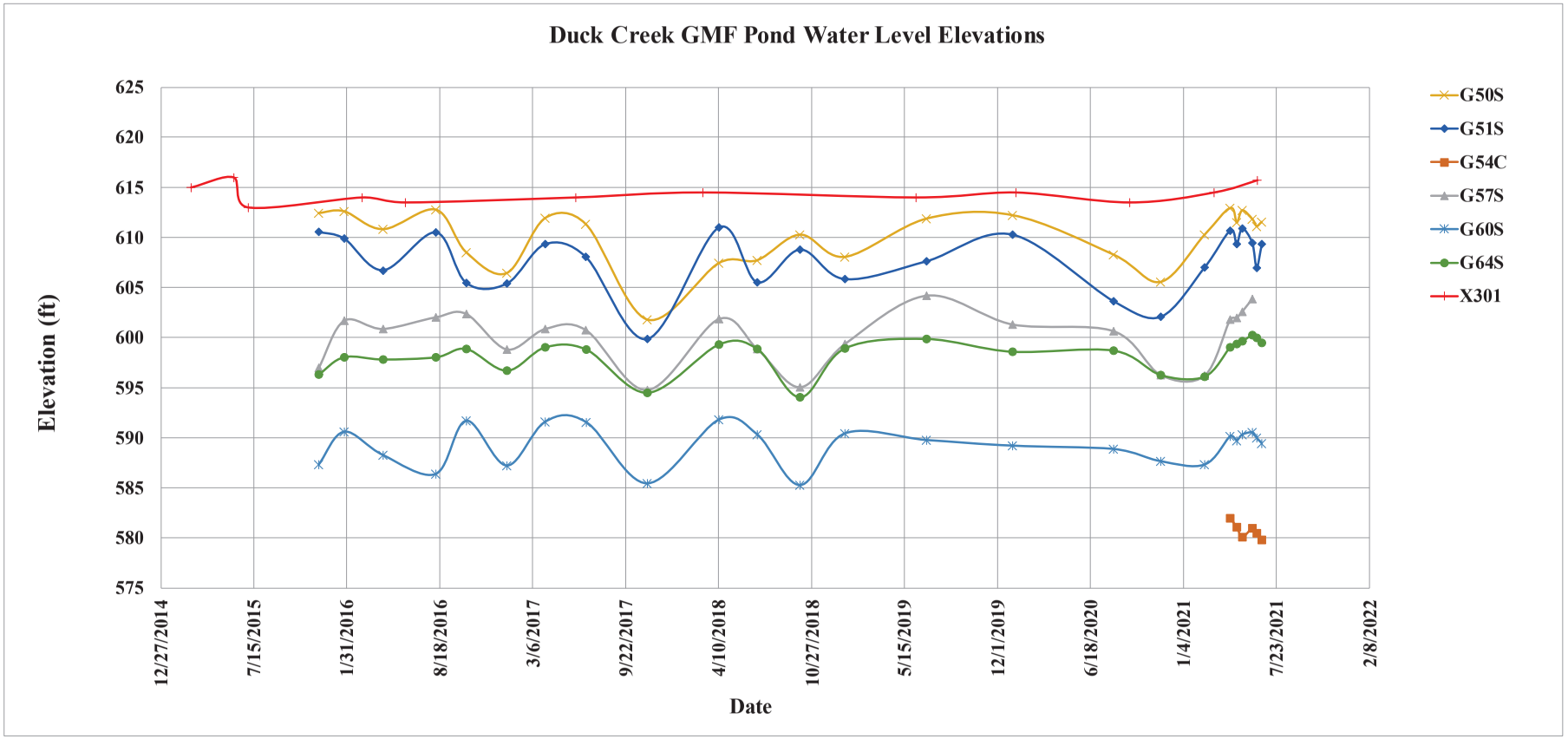

NOTES:
1. Piezometeric data was taken from the spreadsheet titled "DC_GW_Elev_Export_Vistra_20210722", provided by the Duck Creek Power Plant.

PIEZOMETER DATA PERIODIC CERTIFICATION DUCK CREEK POWER PLANT- GMF POND FULTON, ILLINOIS		
Geosyntec consultants		Figure 1
GLP8027	7/23/2021	

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Attachment B

GMF Pond Site Visit Photolog

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 01 **Date:** 05/27/2021 **Direction Facing:** SE **Comments:** GMFP north overview	
Photo: 02 **Date:** 05/27/2021 **Direction Facing:** S **Comments:** GMFP north overview	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 03 **Date:** 05/27/2021 **Direction Facing:** E **Comments:** GMFP north interior slope and crest.	
Photo: 04 **Date:** 05/27/2021 **Direction Facing:** E **Comments:** GMFP north exterior slope and crest.	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 05 **Date:** 05/27/2021 **Direction Facing:** S **Comments:** GMFP east exterior slope and crest.	
Photo: 06 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GMFP east exterior slope and crest.	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 07 **Date:** 05/27/2021 **Direction Facing:** S **Comments:** GMFP east interior slope and crest.	
Photo: 08 **Date:** 05/27/2021 **Direction Facing:** S **Comments:** GMFP east slope crest.	

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GEOSYNTEC CONSULTANTS Photographic Record	Geosyntec consultants
Site Owner: Illinois Power Resources Generating	**Project Number:** GLP8027
CCR Unit: GMF Pond (GMFP)	**Site:** Duck Creek Power Plant

Photo: 09 **Date:** 05/27/2021 **Direction Facing:** W **Comments:** GMFP south crest and transfer channel.	
Photo: 10 **Date:** 05/27/2021 **Direction Facing:** W **Comments:** GMFP transfer channel and weir. All stoplogs were installed.	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 11 **Date:** 05/27/2021 **Direction Facing:** W **Comments:** GMFP south dike interior slope.	
Photo: 12 **Date:** 05/27/2021 **Direction Facing:** NW **Comments:** GMFP southwest corner overview.	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 13 **Date:** 05/27/2021 **Direction Facing:** W **Comments:** GMFP southwest corner exterior dike overview.	
Photo: 14 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GMFP west dike overview.	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 15 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GMFP west interior dike overview.	
Photo: 16 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GMFP west exterior dike overview.	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 17 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GFMP west interior dike overview.	
Photo: 18 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GMFP west exterior dike overview.	

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 19 **Date:** 05/27/2021 **Direction Facing:** E **Comments:** GMFP northwest corner overview.	
Photo: 20 **Date:** 05/27/2021 **Direction Facing:** S **Comments:** GMFP west dike overview.	

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Attachment C

Periodic History of Construction Report Update Letter

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Geosyntec consultants

1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
PH 636-812-0800
www.geosyntec.com

October 11, 2021

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, Illinois 61520

Subject: Periodic History of Construction Report Update Letter
USEPA Final CCR Rule, 40 CFR §257.73(c)
Duck Creek Power Plant
Canton, Illinois

At the request of Illinois Power Resources Generating, LLC (IPRG), Geosyntec Consultants (Geosyntec) has prepared this Letter to documents updates to the Initial History of Construction (HoC) report for the Duck Creek Power Plant (DCPP), also known as the Duck Creek Power Station (DUC). The Initial HoC report was prepared by AECOM in October of 2016 [1] in accordance with 40 Code of Federal Regulations (CFR) §257.73(c) of the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals Rule, known as the CCR Rule [2]. This letter also includes information required by Section 845.220(a)(1)(B) (Design and Construction Plans) of the state-specific Illinois Environmental Protection Agency (IEPA) Part 845 CCR Rule [3] that is not expressly required by §257.73(c).

BACKGROUND

The CCR Rule required that, by October 17, 2016, Initial HoC reports to be compiled for existing CCR surface impoundments with: (1) a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) a height of 20 feet or more. The Initial HoC report was required to contain, to the extent feasible, the information specified in 40 CFR §257.73(c)(1)(i)-(xii). The Initial HoC report for DCPP, which included three existing CCR surface impoundments, the GMF Pond (GMFP), Ash Pond No. 1 (AP1), and Ash Pond No. 2 (AP2), was prepared and subsequently posted to IPRG's CCR Website prior to October 17, 2016.

The CCR Rule requires that Initial HoC to be updated if there is a significant change to any information complied in the Initial HoC report, as listed below:

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§ 257.73(c)(2): If there is a significant change to any information complied under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(9).

IPRG retained Geosyntec to review the Initial HoC report, review reasonably and readily available information for the GMFP, AP1, and AP2 generated since the Initial HoC report was prepared, and perform a site visit to DCPP to evaluate if significant changes may have occurred since the Initial HoC report was prepared.

This Letter contains the results of Geosyntec's evaluation and documents significant changes that have occurred at the GMFP, AP1, and AP2 at DCPP, as they pertain the requirements of §257.73(c)(1)(i)-(xii)

UPDATES TO HISTORY OF CONSTRUCTION REPORT

Geosyntec's evaluation for the DCPP GMFP, AP1, and AP2 determined that no known significant changes requiring updates to the information in the Initial HoC report pertaining to §257.73(c)(1)(i)-(ii), §257.73(c)(1)(iv)-(vii), §257.73(c)(1)(ix), and §257.73(c)(1)(xi)-(xii) of the CCR Rule had occurred since the Initial HoC report was developed.

However, Geosyntec's evaluation determined that significant changes at the DCPP GMFP, AP1, and AP2 pertaining to §257.73(c)(1)(iii), §257.73(c)(1)(viii), §257.73(c)(1)(x) of the CCR Rule had occurred since the Initial HoC report had been developed. Additionally, information how long the CCR surface impoundments have been operating and the types of CCR in the surface impoundments, as required by Section 845.220(a)(1)(B) of the Part 845 Rule were not included in the Initial HoC report, as this information is not required by the CCR Rule. Each change and the subsequent updates to the Initial HoC report is described within this section.

Section 845.220(a)(1)(B): A statement of … how long the CCR surface impoundment has been in operation, and the types of CCR that have been placed in the surface impoundment.

GMF Pond

GMFP is in operation since 2009. As of the date of this report, the GMFP has been present for approximately 12 years.

CCR placed in the GMFP is being used to store and dispose of gypsum and to clarify recycled process water for plant operations [4].

Ash Pond No. 1

AP1 was in operation from 1976 until November 2015, for a total of approximately 39 years.

CCR placed in AP1 was used to store and dispose of fly ash and bottom ash [4].

Ash Pond No. 2

AP2 was in operation from 1986 until November 2015, for a total of approximately 35 years.

CCR placed in AP2 was used to store and dispose of fly ash and bottom ash and to clarify CCR contact stormwater prior to discharge.

§257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

The state identification numbers (ID) for the GMFP, AP1 and AP2 have been assigned by the Illinois Environmental Protection Agency (IEPA). The IDs are listed in **Table 1**.

Table 1 – IEPA ID Numbers

CCR Surface Impoundment		State ID
Ash Pond No. 1		W0578010001-01
Ash Pond No. 2		W0578010001-02
GMF Pond		W0578010001-04

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

AP1 and AP2 were closed in 2021, in substantial compliance with the written closure plans posted to IPRG's CCR Website ([5], [6]), and as documented by a certified Notification of Completion of Closure posted to IPRG's CCR Website [7]. Therefore, AP1 and AP2 are no longer capable of storing CCR or free liquids.

The DCPP was retired in December of 2019, with the generation of electricity ceased at that time. Therefore, the GMFP is no longer being used to storge and disposed of gypsum or to clarify recycled process water for use in plant operations, as gypsum is no longer being generated and process water is no longer required by the DCPP.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Instrumentation monitoring at AP1 and AP2 is no longer required as both CCR surface impoundments were closed in accordance with §257.102 [7], and the instrumentation

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network was modified at that time. Therefore, the instrumentation locations shown in Appendix C of the Initial HoC report are no longer applicable to AP1 and AP2.

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

AP1 and AP2 no longer retain free water as both CCR surface impoundments were closed in 2021 [7]. Therefore, spillways are no longer present the information regarding the spillways of these structures, as presented in the Initial HoC report, is no longer applicable to AP1 and AP2.

CLOSING

This letter has been prepared to document Geosyntec's evaluation of changes that have occurred at the GMFP, AP1, and AP2 at the DCPP since the Initial HoC was developed, based on reasonably and readily available information provided by IPRG, observed by Geosyntec during the site visit, or generated by Geosyntec as part of subsequent calculations.

Sincerely,

Lucas P. Carr, P.E.
Senior Engineer

John Seymour, P.E.
Senior Principal

engineers | scientists | innovators

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REFERENCES

[1] AECOM, "History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Duck Creek Power Station, Canton, Illinois," October 2016.

[2] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[3] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[4] AECOM, "History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Hennepin Power Station, Hennepin, Illinois," October 2016.

[5] V. Modeer, "Closure Plan for Existing CCR Sruface Impoundment, 40 CFR 257.102(b), Duck Creek Power Station, Illinois Power Resoruces Generation, LLC, Ash Pond No. 1," December 17, 2020.

[6] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Duck Creek Power Station, Illinois Power Resoruces Generating, LLC, Ash Pond No. 2," December 17, 2020.

[7] D. Tickner, "Duck Creek Power Station; Ash Pond No.1 and No. 2, Notificaiton of Completion of Closure," Luminant, Collinsville, Illinois, January 22, 2021.

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Attachment D

Periodic Structural Stability and Safety Factor Assessment Analyses

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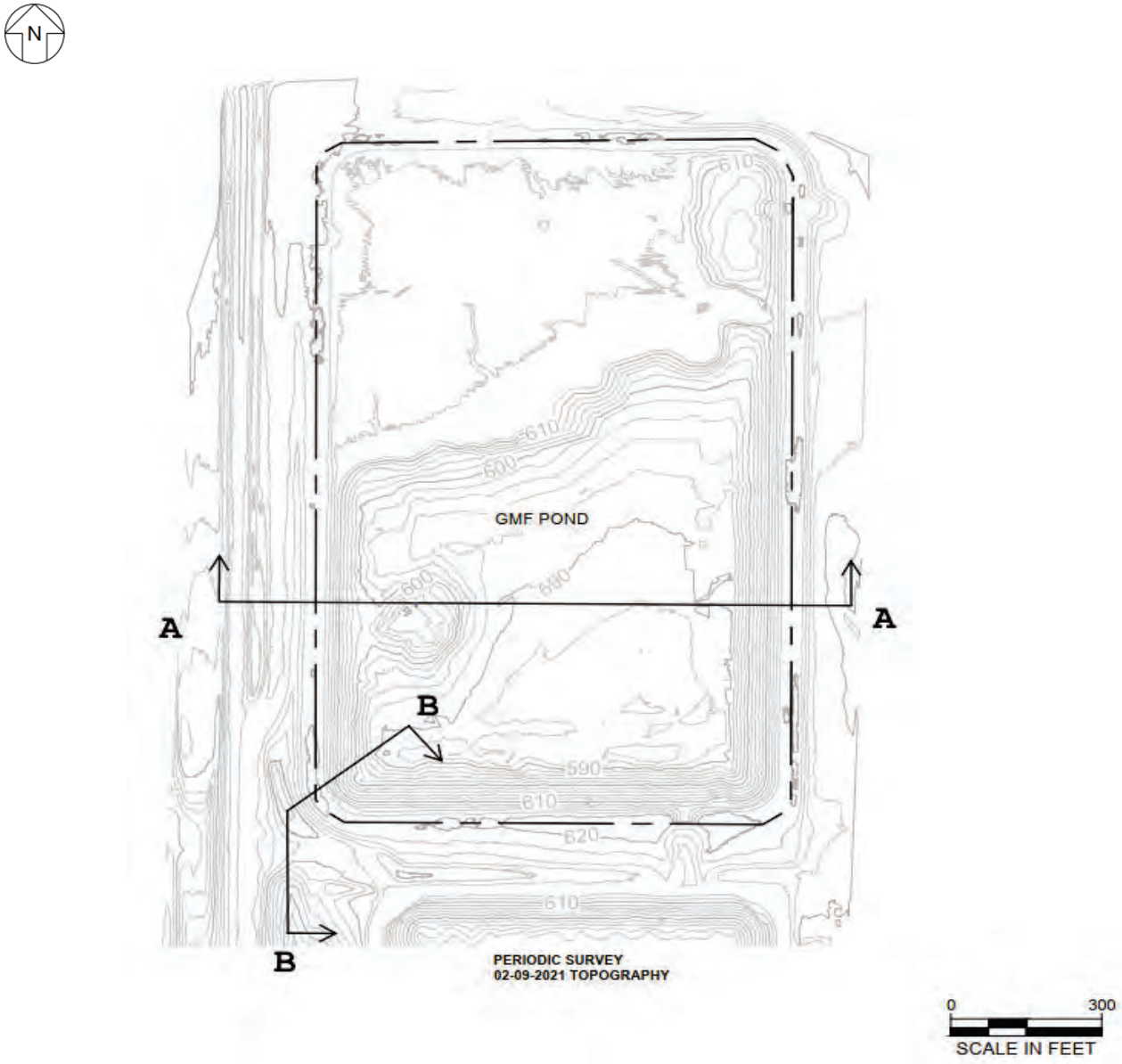

NOTES:

1. The cross-sections are shown on the periodic topography of GMF Pond, prepared by IngenAE, dated February 9, 2021.
2. A-A is the cross-section used in the 2016 AECOM initial SFA & SSA and cross-section B-B is the 2021 Geosyntec updated periodic SFA.

CROSS-SECTION LOCATIONS
PERIODIC CERTIFICATION
DUCK CREEK POWER PLANT- GMF POND
FULTON, ILLINOIS

Geosyntec consultants

Figure D-1

GLP8027 | 8/25/2021

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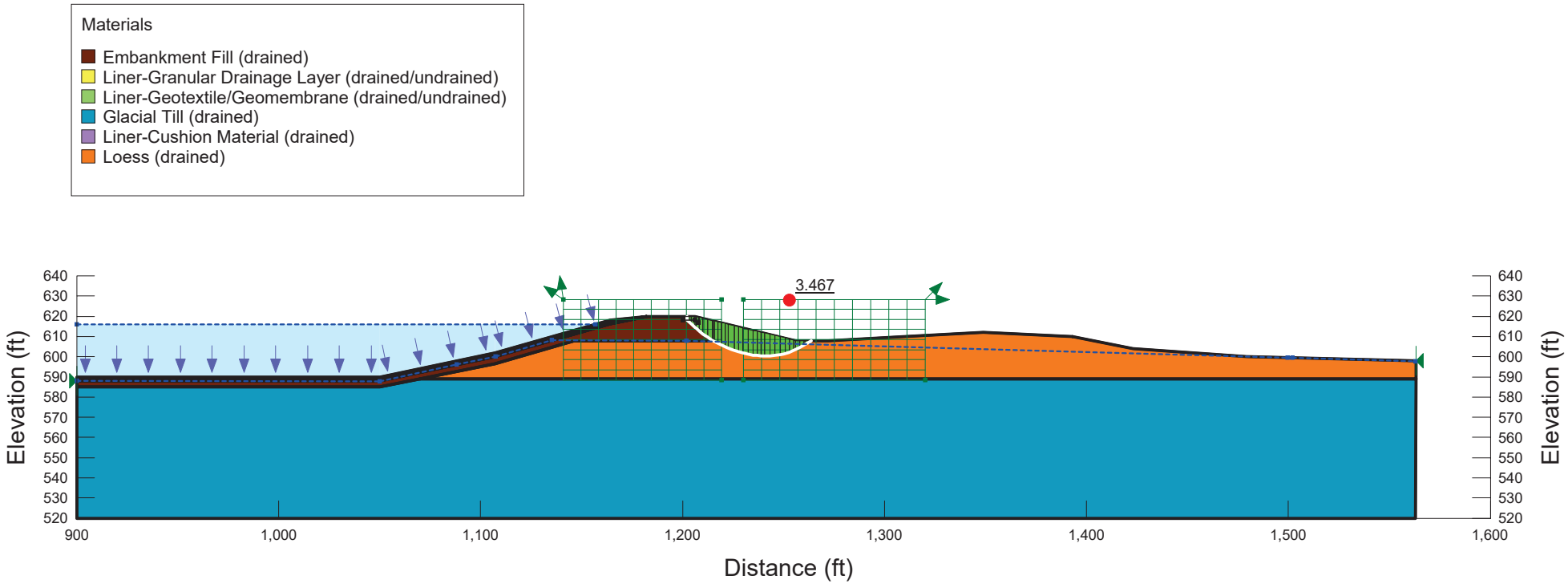
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Long-Term, Block Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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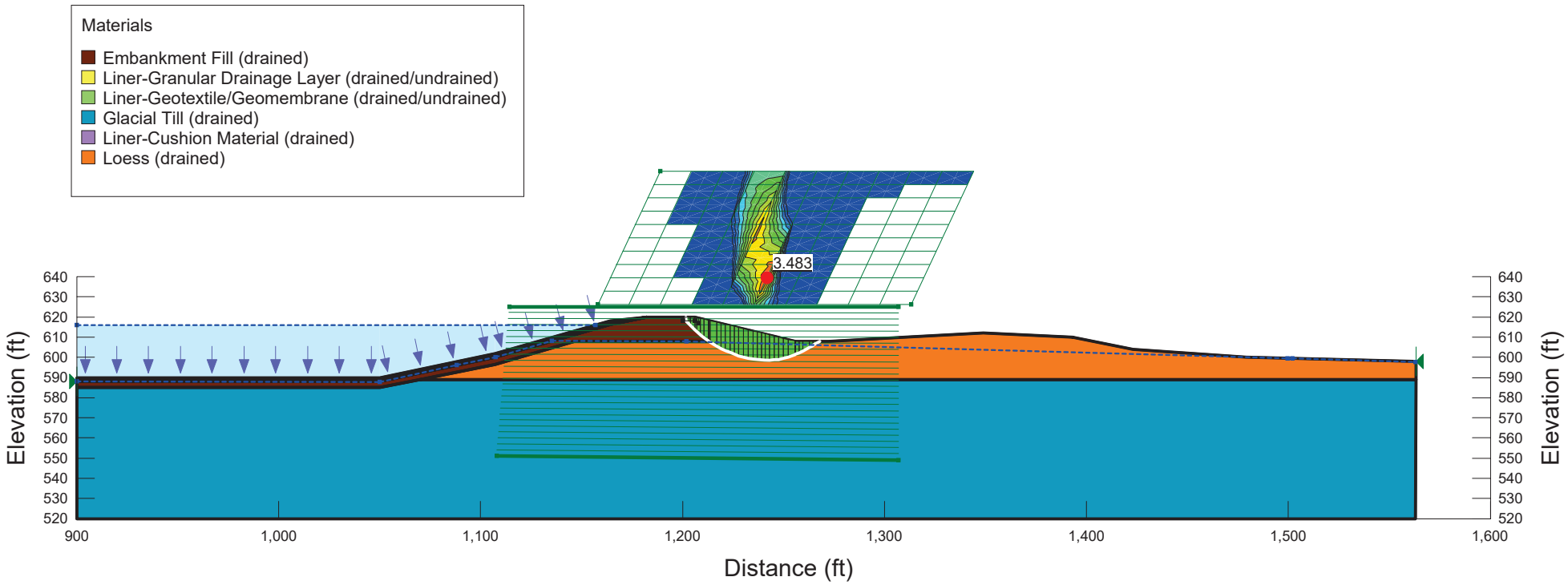
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Long-Term, Circular Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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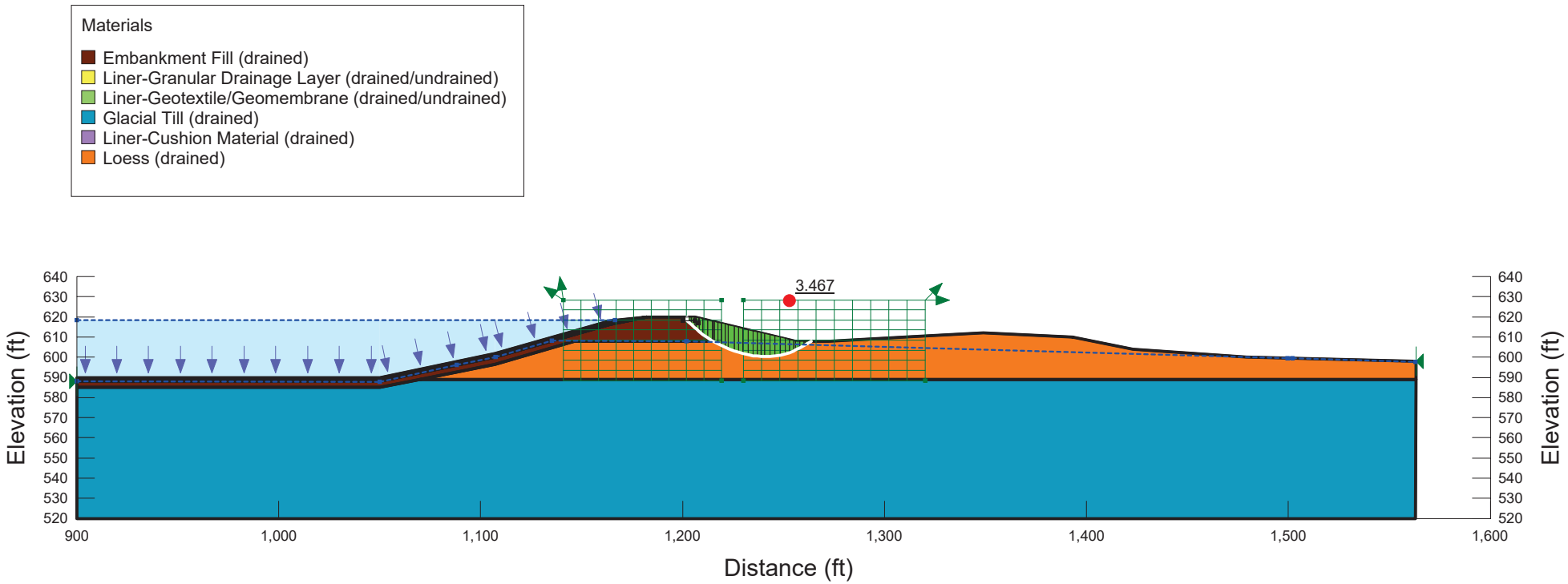
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Surchage Pool, Block Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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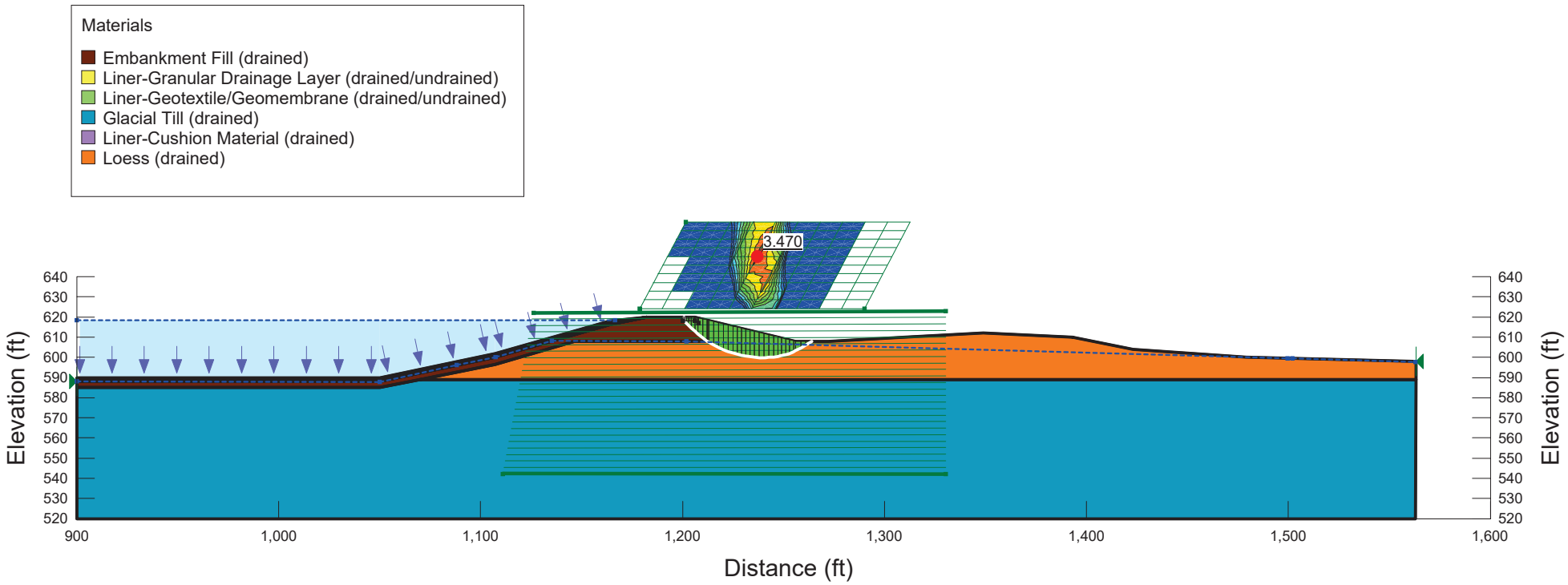
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Surcharge Pool, Circular Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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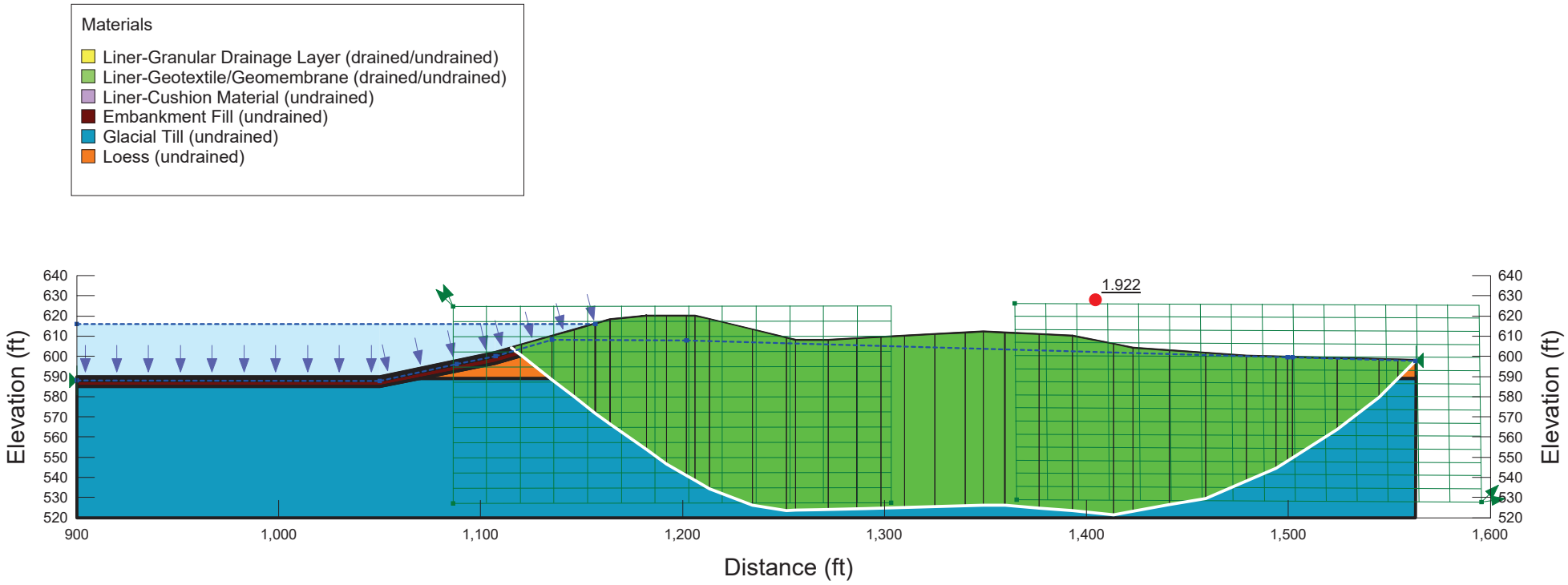
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Seismic, Block Failure Surface

Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Liner-Cushion Material (undrained) Unit Weight: 116 pcf Cohesion': 660 psf Phi': 0 °
Name: Embankment Fill (undrained) Unit Weight: 116 pcf Cohesion': 2,150 psf Phi': 0 °
Name: Glacial Till (undrained) Unit Weight: 125 pcf Cohesion': 1,900 psf Phi': 0 °
Name: Loess (undrained) Unit Weight: 116 pcf Cohesion': 1,250 psf Phi': 0 °

Horz Seismic Coef.: 0.116 g



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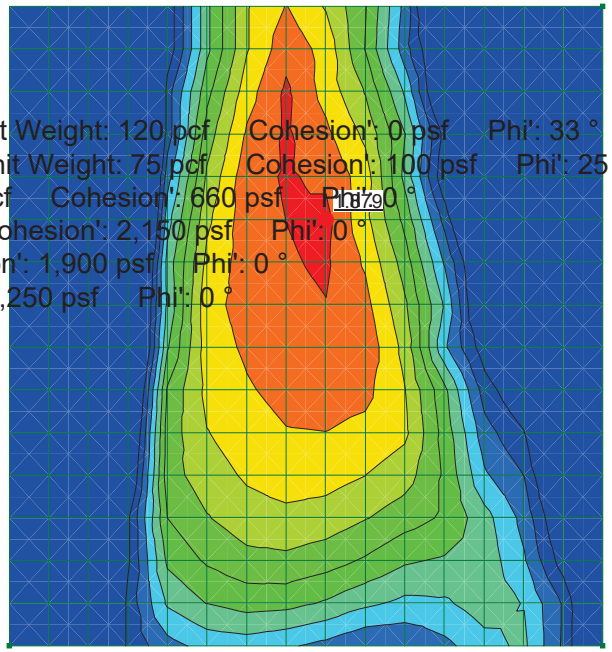
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

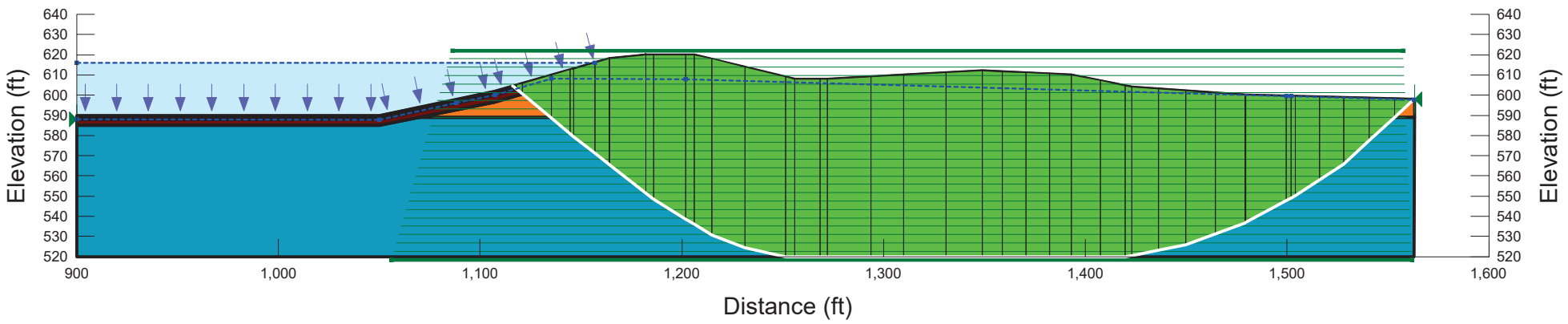
Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Seismic, Circular Failure Surface

Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Liner-Cushion Material (undrained) Unit Weight: 116 pcf Cohesion': 660 psf Phi': 0 °
Name: Embankment Fill (undrained) Unit Weight: 116 pcf Cohesion': 2,150 psf Phi': 0 °
Name: Glacial Till (undrained) Unit Weight: 125 pcf Cohesion': 1,900 psf Phi': 0 °
Name: Loess (undrained) Unit Weight: 116 pcf Cohesion': 1,250 psf Phi': 0 °

Horz Seismic Coef.: 0.116 g





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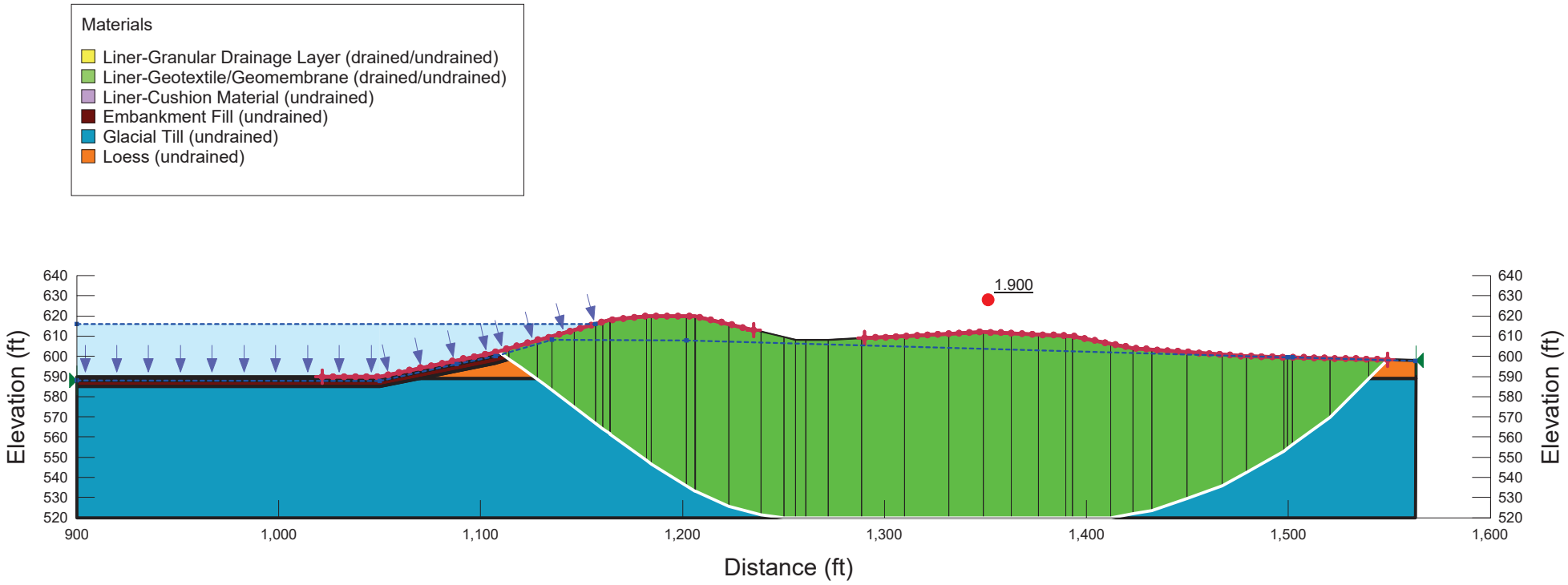
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Seismic, Entry-Exit Failure Surface

Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Liner-Cushion Material (undrained) Unit Weight: 116 pcf Cohesion': 660 psf Phi': 0 °
Name: Embankment Fill (undrained) Unit Weight: 116 pcf Cohesion': 2,150 psf Phi': 0 °
Name: Glacial Till (undrained) Unit Weight: 125 pcf Cohesion': 1,900 psf Phi': 0 °
Name: Loess (undrained) Unit Weight: 116 pcf Cohesion': 1,250 psf Phi': 0 °

Horz Seismic Coef.: 0.116 g



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Luminant

Illinois Power Resource Generating, LLC
1500 Eastport Plaza Dr.
Collinsville, IL 62234

January 28, 2022

Illinois Environmental Protection Agency
DWPC – Permits MC #15
Attn: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: Duck Creek Power Plant GMF Pond; IEPA ID # W0578010001-04

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.200, Illinois Power Resource Generating, LLC (IPRG) is submitting a construction permit application for the Duck Creek Power Plant GMF Pond (IEPA ID # W0578010001-04). One hardcopy is provided with this submittal.

The permit application was prepared in accordance with 35 I.A.C. § 845.220 (a) and (d). This submittal includes the completed permit forms as required by § 845.210.

Sincerely,

Cynthia Vodopivec
SVP-Environmental Health and Safety

Enclosures

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Form CCR 1	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 1 – General Provisions

Bureau of Water ID Number:
W0578010001

CCR Permit Number:
Initial Permit

Facility Name:
Duck Creek Power Plant

For IEPA Use Only

SECTION 1: FACILITY, OPERATOR, AND OWNER INFORMATION (35 Ill. Adm. Code 845.210(b))

Facility, Operator, and Owner Information

1.1	Facility Name		
	Illinois Power Resources Generating, LLC - Duck Creek Power Plant		
1.2	Illinois EPA CCR Permit Number (if applicable)		
	Initial Permit		
1.3	Facility Contact Information		
	Name (first and last) Phil Morris	Title Senior Director - Environmental	Phone Number 618-343-7794
	Email address phil.morris@vistracorp.com		
1.4	Facility Mailing Address		
	Street or P.O. box 1500 Eastport Plaza Dr		
	City or town Collinsville	State IL	Zip Code 62234
1.5	Facility Location		
	Street, route number, or other specific identifier 17751 North CILCO Road		
	County name Fulton	County code (if known)	
	City or town Canton	State IL	Zip Code 61520
1.6	Name of Owner/Operator		
	Illinois Power Resources Generating, LLC		

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Facility, Operator, and Owner Info

1.7 Owner/Operator Contact Information

Name (first and last)	Title	Phone Number
Phil Morris	Senior Director - Environmental	618-343-7794

Email address: phil.morris@vistracorp.com

1.8 Owner/Operator Mailing Address

Street or P.O. box: 1500 Eastport Plaza Dr

City or town	State	Zip Code
Collinsville	IL	62234

SECTION 2: LEGAL DESCRIPTION (35 Ill. Adm. Code 845.210(c))

Legal Description

2.1 Legal Description of the facility boundary

See Attachment A.

SECTION 3: PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS (35 Ill. Adm. Code 845.810)

Internet Site

3.1 Web Address(es) to publicly accessible internet site(s) (CCR website)

www.luminant.com/illinois-ccr/

3.2 Is/are the website(s) titled "Illinois CCR Rule Compliance Data and Information"

☑	Yes	☐	No

SECTION 4: IMPOUNDMENT IDENTIFICATION

Impoundment Identification

4.1 List all the impoundment identification numbers for your facility and check the corresponding box to indicate that you have attached a written description for each impoundment.

W0578010001-04 (see Attachment A)	☑	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description

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			☐	Attached written description
			☐	Attached written description
			☐	Attached written description
			☐	Attached written description

SECTION 5: CHECKLIST AND CERTIFICATION STATEMENT

Checklist and Certification Statement

5.1 In Column 1 below, mark the sections of Form 1 that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing.

Column 1		Column 2	
Section 1: Facility, Operator, and Owner Information	☑	w/attachments	☐
Section 2: Legal Description	☑	w/attachments	☑
Section 3: Publicly Accessible Internet Site Requirement	☑	w/attachments	☐
Section 4: Impoundment Identification	☑	w/attachments	☑

5.2 **Certification Statement**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name) of Owner/Operator	Official Title
Cynthia Vodopivec	SVP - Environmental
Signature	**Date Signed**
Cynthia J. Vodopivec	1/27/2022

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Form 2CC	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 2CC – Closure Construction

Bureau of Water ID Number:
W0578010001

CCR Permit Number:
Initial Permit

Facility Name:
Duck Creek Power Plant

For IEPA Use Only

SECTION 1: DESIGN AND CONSTRUCTION PLANS (35 Ill. Adm. Code 845.220)

Design and Construction Plans (Construction History)

1.1	CCR surface impoundment name.
	GMF Pond and GMF Recycle Pond
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).
	W0578010001-04
1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).
	See Attachment A.
1.4	State the purpose for which the CCR surface impoundment is being used.
	See Attachment B.
1.5	How long has the CCR surface impoundment been in operation?
	See Attachment B.
1.6	List the types of CCR that have been placed in the CCR surface impoundment.
	See Attachment B.

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Design and Construction Plans (Continued)

1.7	List the name of the watershed within which the CCR surface impoundment is located.				
	See Attachment B.				
1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?				
	See Attachment B.				
1.9	Check the corresponding boxes to indicate that you have attached the following:				
	☑	A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.			
	☑	A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR surface impoundment.			
	☑	A statement of the method of site preparation and construction of each zone of the CCR surface impoundment.			
	☑	A statement of the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.			
	☑	Drawings satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(1)(F).			
	☑	A description of the type, purpose, and location of existing instrumentation.			
	☑	Area capacity curves for the CCR impoundment.			
	☑	A description of each spillway and diversion design features and capacities and provide the calculations used in their determination.			
	☑	The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.			
1.10.1	Is there any record or knowledge of structural instability of the CCR surface impoundment?				
	☐	Yes	☑	No	
1.10.2	If you answered yes to Item 1.10.1, provide detailed explanation of the structural instability.				

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SECTION 2: NARRATIVE DESCRIPTION OF THE FACILITY (35 Ill. Adm. Code 845.220)

Narrative Description

2.1 List the types of CCR expected in the CCR surface impoundments.

See Attachment B.

2.2 Have you attached a chemical analysis of each type of expected CCR?

☑ Yes

2.3 Estimate of the maximum capacity of the surface impoundment in gallons or cubic yards.

See Attachment B.

2.4 The rate at which CCR and non-CCR waste streams currently enter the CCR impoundment in gallons per day and dry tons.

0	GPD	0	dTn

2.5 Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.

NA

2.6 Have you attached an on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment?

☑ Yes

SECTION 3: MAPS (35 Ill. Adm. Code 845.220)

Maps

3.1 Check the corresponding boxes to indicate that you have attached the following maps:

☑ A site location map on the most recent United Sates Geological Survey (USGS) quadrangle of the area from the 7 ½ minute series (topographic) or on another map whose scale clearly shows the information required in 35 Ill. Adm. Code 845.220(a)(3).

☑ Site plans maps satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(4).

SECTION 4: ATTACHMENTS

Attachments

4.1 Check the corresponding boxes to indicate that you have attached the following:

☑ A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.

☑ Plans and specifications fully describing the design, nature, function, and interrelationship of each individual component of the facility.

☑ The signature and seal of a qualified professional engineer.

☑ Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under 35 Ill. Adm. Code 845.240.

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Attachments (Continued)		☑	A summary of the issues raised by the public during the public notification and public meetings.
		☑	A summary of any revisions, determinations, or other considerations made in response to those issues raised by the public during the public notification and public meetings.
		☑	A list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.
		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in erosion control and environmental remediation.
		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in the operation of heavy equipment and excavation.
SECTION 5: GROUNDWATER MONITORING PROGRAM			
Groundwater Monitoring	5.1	Indicate that you have attached the following components of a new groundwater monitoring program or any modifications to an existing groundwater monitoring program by checking the corresponding boxes:	
		☑	A hydrogeologic site investigation meeting the requirements of 35 Ill. Adm. Code 845.620, if applicable.
		☑	Design and construction plans of a groundwater monitoring system meeting the requirements of 35 Ill. Adm. Code 845.630.
		☑	A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by 35 Ill. Adm. Code 845.640 and 845.650.
SECTION 6: CLOSURE (35 Ill. Adm. Code 845.220(d))			
Closure	6.1	What is the closure prioritization category under 35 Ill. Adm. Code 845.700(g), if applicable?	
		Category 3	
	6.2	Indicate that you have attached the following by checking the corresponding boxes:	
		☑	The final closure plan, as specified in 35 Ill. Adm. Code 845.720(b), which includes the closure alternatives analysis required by 35 Ill. Adm. Code 845.710.
		☑	Proposed schedule to complete closure.
		☑	Post-closure care plan as specified in 35 Ill. Adm. Code 845.780(d).
SECTION 7: GROUNDWATER MODELING (35 Ill. Adm. Code 845.220(d)(3))			
Groundwater	7.1	Indicate that you have attached the following by checking the corresponding boxes:	
		☑	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards.
		☑	All modeling inputs and assumptions.
		☑	Description of the fate and transport of contaminants with the selected corrective action over time.

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		☑	Capture zone modeling, if applicable.
		☑	Any necessary licenses and software needed to review and access both the model and the data contained within the model.

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GOLDER
MEMBER OF WSP

PERMIT APPLICATION

Part 845 Construction Permit Application for the Gypsum Management Facility Pond

Duck Creek Power Plant

Submitted to:

Illinois Environmental Protection Agency

1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Submitted by:

Illinois Power Resources Generating, LLC

1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Compiled by:

Golder Associates USA Inc.

701 Emerson Road, Suite 250
Creve Coeur, Missouri 63141

21454861-7-R-1

January 25, 2022

Executive Summary

Introduction

Illinois Power Resources Generating, LLC (IPRG) owns and operates the Gypsum Management Facility (GMF) Pond at the Duck Creek Power Plant in Fulton County, Illinois. The GMF Pond is a coal combustion residuals (CCR) surface impoundment that was used to manage gypsum produced at the Duck Creek Power Plant from the time construction of the GMF Pond was completed in early 2009 until the power plant was retired in December 2019. Since the retirement of the Duck Creek Power Plant, the GMF Pond has no longer received CCR or any other waste stream. IPRG is submitting this Part 845 Construction Permit Application for the GMF Pond to provide the Illinois Environmental Protection Agency (IEPA) with the information required under 35 Illinois Administrative Code (I.A.C.) 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) for closure of the GMF Pond.

Closure Method Selection

As required under 35 I.A.C. § 845.710, a closure alternatives analysis has been completed to identify the most appropriate closure method for the GMF Pond. The following closure alternatives were evaluated:

- closure by removal of CCR with disposal in an on-site landfill
- closure by removal of CCR with disposal in an off-site landfill
- closure with a final cover system constructed over the CCR

Based on the findings of the closure alternatives analysis, the GMF Pond will be closed with a final cover system (i.e., closure in place). The closed GMF Pond will contain approximately 400,000 cubic yards of CCR. Closure in place will be completed in accordance with 35 I.A.C. § 845.750.

Closure Method Description

The GMF Pond has a dual composite liner system with a leachate collection and removal system. These systems will remain in place below the closure footprint to minimize the release of CCR or leachate to groundwater or the atmosphere. Closure of the GMF Pond will begin with the removal of supernatant water contained in the GMF Pond. Water removed from the GMF Pond will be managed in accordance with the National Pollutant Discharge Elimination System (NPDES) permit for the Duck Creek Power Plant. The gypsum currently contained within an approximate 15-acre area in the northern portion of the GMF Pond will remain in place. The upper gypsum layer in this northern portion will be dewatered as necessary to allow mobile equipment traffic across the surface using a series of trenches and sumps, and free liquids will be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues. Water flowing to the sumps will be pumped out and managed in accordance with the NPDES permit for the Duck Creek Power Plant. An earthen containment berm will be constructed across the southern limit of the 15-acre area to enhance the structural stability of the closed GMF Pond and reduce the closure footprint. A composite liner system will be installed on the upstream face of the containment berm and tied into the existing liner system. Gypsum currently situated south of the containment berm will be loaded, hauled, and placed atop the existing gypsum north of the containment berm (i.e., within the closure footprint) to establish closure grades. After closure grades have been established, a final cover system meeting the requirements of 35 I.A.C. § 845.750 will be constructed over the gypsum to minimize the post-closure

infiltration of liquids into the waste. The liner system and the cover system will provide complete encapsulation of gypsum in the GMF Pond, physically isolating it from contact with surrounding soils, groundwater, surface water, and the atmosphere.

In portions of the GMF Pond that are outside of (i.e., generally south of) the closure footprint, the primary composite liner system, the leachate collection and removal system, and the geosynthetic components of the secondary composite liner system will be removed and disposed in the closure footprint or the existing permitted on-site landfill. Up to 1 foot of additional subsoil may also be removed. The existing permitted on-site landfill has sufficient capacity to accept the removed materials. The subsoils will be visually observed for signs of CCR staining. If subsoils with CCR staining are observed, they will be removed and disposed. A surface water channel will be excavated south of the GMF Pond to route stormwater flows away from the GMF Pond. Groundwater modeling indicates that the closure method described is expected to maintain compliance with the groundwater protection standards.

Document Organization

IEPA Application Form CCR 1 and IEPA Application Form CCR 2CC precede this Executive Summary. A checklist identifying the required elements of the Part 845 Construction Permit Application and the location in this document where each element can be found follows this Executive Summary. Supplemental information required under Part 845 is organized in a set of appendices that follow the checklist:

- Appendix A (History of Construction) provides general information about the GMF Pond and describes its design and construction.
- Appendix B (Narrative Description) describes the types and generation rates of CCR managed in the GMF Pond.
- Appendix C (Map Package) includes a Site Location Map and a Site Plan Map depicting important site features and information.
- Appendix D (Hydrogeologic Site Characterization) describes hydrogeologic conditions in the vicinity of the GMF Pond.
- Appendix E (Evaluation of Potential Exceedances of Groundwater Protection Standards) summarizes the potential exceedances of groundwater protection standards that have been detected at the GMF Pond and identifies the alternative sources that have caused them.
- Appendix F (Closure Priority Categorization) identifies the closure priority category assigned to the GMF Pond.
- Appendix G (Groundwater Modeling) describes the results of groundwater modeling that has been conducted to assess the expected fate and transport of chemical constituents following closure of the GMF Pond (a link to access the groundwater model files will be transmitted to the IEPA separately).
- Appendix H (Final Closure Plan) provides design information for closure of the GMF Pond, as well as the results of a closure alternatives analysis that has been conducted to determine the most effective approach for closure of the GMF Pond.
- Appendix I (Groundwater Monitoring Plan) describes the monitoring locations and procedures that will be used to assess groundwater quality after closure of the GMF Pond.

- Appendix J (Post-closure Care Plan) describes the procedures that will be followed to maintain the closed GMF Pond during the post-closure care period.
- Appendix K (Legal Description) provides the land description of the GMF Pond facility boundary.
- Appendix L (Public Meetings Information) provides the information pertaining to the public notification and public meetings required under Part 845.
- Appendix M (Training Program Statement) certifies that personnel utilized to construct, install, modify, or close the GMF Pond will participate in required training programs.

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Signature Page

Golder Associates USA Inc.

I, Mark Haddock, being a registered professional engineer in good standing in the State of Illinois, certify to the best of my knowledge that the information contained in this construction permit application has been prepared in accordance with recognized and generally accepted engineering practices.



Mark Haddock, PE
Principal

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https://golderassociates.sharepoint.com/sites/141778/project files/6 deliverables/reports/7-r-gmf_permit_app/7-r-1/21454861-7-r-1-gypsum_management_facility_permit_application_25jan22.docx

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Regulation	Requirement	Location in Permit Application
Section 845.220 - Construction Permits		
a)	All construction permit applications must contain the following information and documents.	
1)	Design and Construction Plans (Construction History)	Appendix A
A)	Identifying information	Appendix A
i)	The name and address of the person or persons owning or operating the CCR surface impoundment;	Appendix A
ii)	The name associated with the CCR surface impoundment;	Appendix A
iii)	The identification number of the CCR surface impoundment if one has been assigned by the Agency.	Appendix A
B)	A statement of the purpose for which the CCR surface impoundment is being used, how long the CCR surface impoundment has been in operation, and the types of CCR that have been placed in the CCR surface impoundment.	Appendix A
C)	The name and size in acres of the watershed within which the CCR surface impoundment is located.	Appendix A
D)	A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.	Appendix A
E)	A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR surface impoundment; the method of site preparation and construction of each zone of the CCR surface impoundment; and the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.	Appendix A
F)	At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR surface impoundment, detailed dimensional drawings of the CCR surface impoundment, including a plan view and cross-sections of the length and width of the CCR surface impoundment, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR surface impoundment due to malfunction or mis-operation.	Appendix A
G)	A description of the type, purpose, and location of existing instrumentation.	Appendix A
H)	Area-capacity curves for the CCR surface impoundment.	Appendix A
I)	A description of each spillway and diversion design features and capacities and calculations used in their determination.	Appendix A
J)	The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.	Appendix A
K)	Any record or knowledge of structural instability of the CCR surface impoundment.	Appendix A
2)	Narrative Description of the Facility. The permit application must contain a written description of the facility with supporting documentation describing the procedures and plans that will be used at the facility to comply with the requirements of this Part. The descriptions must include, but are not limited to, the following information:	Appendix B, Appendix H
A)	The types of CCR expected in the CCR surface impoundment, including a chemical analysis of each type of expected CCR;	Appendix B
B)	An estimate of the maximum capacity of each surface impoundment in gallons or cubic yards;	Appendix B
C)	The rate at which CCR and non-CCR waste streams currently enter the CCR surface impoundment in gallons per day and dry tons;	Appendix B
D)	The estimated length of time the CCR surface impoundment will receive CCR and non-CCR waste streams; and	Appendix B
E)	An on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment.	Appendix B
3)	Site Location Map. All permit applications must contain a site location map on the most recent United States Geological Survey (USGS) quadrangle of the area from the 7½ minute series (topographic), or on such other map whose scale clearly shows the following information:	Appendix C
A)	The facility boundaries and all adjacent property, extending at least 1000 meters (3280 feet) beyond the boundary of the facility;	Appendix C
B)	All surface waters;	Appendix C
C)	The prevailing wind direction;	Appendix C
D)	The limits of all 100-year floodplains;	Appendix C
E)	All natural areas designated as a Dedicated Illinois Nature Preserve under the Illinois Natural Areas Preservation Act [525 ILCS 30];	Appendix C
F)	All historic and archaeological sites designated by the National Historic Preservation Act (16 USC 470 et seq.) and the Illinois Historic Sites Advisory Council Act [20 ILCS 3410]; and	Appendix C
G)	All areas identified as critical habitat under the Endangered Species Act of 1973 (16 USC 1531 et seq.) and the Illinois Endangered Species Protection Act [520 ILCS 10].	Appendix C
4)	Site Plan Map. The application must contain maps, including cross-sectional maps of the site boundaries, showing the location of the facility. The following information must be shown:	Appendix C
A)	The entire facility, including any proposed and all existing CCR surface impoundment locations;	Appendix C
B)	The boundaries, both above and below ground level, of the facility and all CCR surface impoundments or landfills containing CCR included in the facility;	Appendix C
C)	All existing and proposed groundwater monitoring wells; and	Appendix C
D)	All main service corridors, transportation routes, and access roads to the facility.	Appendix C
5)	A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.	Appendix H
6)	Plans and specifications fully describing the design, nature, function and interrelationship of each individual component of the facility.	Appendix A, Appendix H
7)	A new groundwater monitoring program or any modification to an existing groundwater monitoring program that includes but is not limited to the following information:	
A)	A hydrogeologic site investigation meeting the requirements of Section 845.620, if applicable;	Appendix D
B)	Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630; and	Appendix I

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Regulation	Requirement	Location in Permit Application
Section 845.220 - Construction Permits (Continued)		
C)	A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data, as required by Sections 845.640 and 845.650.	Appendix I
8)	The signature and seal of a qualified professional engineer	Executive Summary
9)	Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under Section 845.240, a summary of the issues raised by the public, a summary of any revisions, determinations, or other considerations made in response to those issues, and a list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.	Appendix L
b)	New Construction. In addition to the requirements in subsection (a), all construction permit applications to build a new CCR surface impoundment, lateral expansion of a CCR surface impoundment, or retrofit of an existing CCR surface impoundment must also contain the following information and documents:	Not applicable - not new construction, lateral expansion, or retrofit
1)	Plans and specifications that demostrate the proposed CCR surface impoundment will meet the location standards in the following sections:	
A)	Section 845.300 (Placement Above the Uppermost Aquifer);	
B)	Section 845.310 (Wetlands);	
C)	Section 845.320 (Fault Areas);	
D)	Section 845.330 (Seismic Impact Zones); and	
E)	Section 845.340 (Unstable Areas and Floodplains).	
2)	Plans and specifications demonstrate the proposed CCR surface impoundment will meet the following design criteria:	
A)	The CCR surface impoundment will have a liner meeting the liner requirements of Section 845.400(b) or (c);	
B)	The CCR surface impoundment will have a leachate collection system meeting the requirements of Section 845.420; and	
C)	The CCR surface impoundment, if not incised, will be constructed with slope protection, as required by Section 845.430.	
3)	CCR fugitive dust control plan (see Section 845.500(b)).	
4)	Preliminary written closure plan (see Section 845.720(a)).	
5)	Initial written post-closure care plan, if applicable (see Section 845.780(d)).	
c)	Corrective Action Construction. In addition to the requirements in subsection (a), all construction permit applications that include any corrective action performed under Subpart F must also contain the following information and documents:	Not applicable - no corrective action included
1)	Corrective action plan (see Section 845.670);	
2)	Groundwater modeling, including:	
A)	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards;	
B)	All modeling inputs and assumptions;	
C)	Description of the fate and transport of contaminants, with the selected closure over time; and	
D)	Capture zone modeling, if applicable.	
3)	Any necessary licenses and software needed to review and access both the models and the data contained within the models required by subsection (c)(2);	
4)	Corrective action groundwater monitoring program, including identification of revisions to the groundwater monitoring system for corrective action; and	
5)	Any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors, including an analysis of the factors specified in Section 845.680(a)(3).	
d)	Closure Construction. In addition to the requirements in subsection (a), all construction permit applications for closure of the CCR surface impoundment under Subpart G must contain the following information and documents:	
1)	Closure prioritization category under Section 845.700(g), if applicable;	Appendix F
2)	Final closure plan, as specified in Section 845.720(b), which includes the closure alternatives analysis required by Section 845.710;	Appendix H
3)	Groundwater modeling, including:	Appendix G
A)	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards;	Appendix G
B)	All modeling inputs and assumptions;	Appendix G
C)	Description of the fate and transport of contaminants, with the selected closure over time;	Appendix G
D)	Capture zone modeling, if applicable; and	Not applicable
E)	Any necessary licenses and software needed to review and access both the model and the data contained within the model.	Provided separately if applicable
4)	Proposed schedule to complete closure; and	Appendix H
5)	Post-closure care plan as specified in Section 845.780(d), if applicable.	Appendix J
e)	*Owners or operators of CCR surface impoundments who submitted a closure plan to the agency before May 1, 2019, and who complete closure before July 30, 2021, shall not be required to obtain a construction permit for closure under subsection (d).* [415 ILCS 5/22.58(e)]	Not applicable - closure not completed before July 31, 2021
f)	A single construction permit application may be submitted for new construction, corrective action, and closure if the construction is related to the same multiphased project. The permit application for a project with multiple phases must contain all information required by subsections (a), (b), (c) and (d), as applicable.	Not applicable - not a multiphased project
g)	Duration of Construction Permits	
1)	For any construction permit that is not for the closure or retrofit of the CCR surface impoundment, the construction permit must be issued for fixed terms not to exceed 3 years.	Not applicable - permit application is for closure
2)	For any construction permit for the closure or retrofit of a CCR surface impoundment, the construction permit must be issued for an initial fixed term expiring within the timeframe approved by the Agency in the construction permit or five years, whichever is less. The Agency may renew a construction permit for closure or retrofit in two-year increments under Section 845.760(b).	Acknowledged

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Regulation	Requirement	Location in Permit Application
Section 845.620 - Hydrogeologic Site Characterization		
a)	The owner or operator of the CCR surface impoundment must design and implement a hydrogeologic site characterization.	Appendix D
b)	The hydrogeologic site characterization must include, but is not limited to, the following:	
1)	Geologic well logs/boring logs;	Appendix D
2)	Climatic aspects of the site, including seasonal and temporal fluctuations in groundwater flow;	Appendix D
3)	Identification of nearby surface water bodies and drinking water intakes;	Appendix D
4)	Identification of nearby pumping wells and associated uses of the groundwater;	Appendix D
5)	Identification of nearby dedicated nature preserves;	Appendix D
6)	Geologic setting;	Appendix D
7)	Structural characteristics;	Appendix D
8)	Geologic cross-sections;	Appendix D
9)	Soil characteristics;	Appendix D
10)	Identification of confining layers;	Appendix D
11)	Identification of potential migration pathways;	Appendix D
12)	Groundwater quality data;	Appendix D
13)	Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy;	Appendix D
14)	A map displaying any known underground mines beneath a CCR surface impoundment;	Appendix D
15)	Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface;	Appendix D
16)	Hydraulic characteristics of the geologic layers identified as migration pathways and geologic layers that limit migration, including:	Appendix D
A)	Water table depth;	Appendix D
B)	Hydraulic conductivities;	Appendix D
C)	Effective and total porosities;	Appendix D
D)	Direction and velocity of groundwater flow; and	Appendix D
E)	Map of the potentiometric surface;	Appendix D
17)	Groundwater classification under 35 Ill. Adm. Code 620; and	Appendix D
18)	Any other information requested by the Agency that is relevant to the hydrogeologic site characterization.	Appendix D
Section 845.630 - Groundwater Monitoring Systems (excerpts providing requirements for the construction permit application)		
g)	The owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of this Section. If the groundwater monitoring system includes the minimum number of monitoring wells specified in subsection (c)(1), the certification must document the basis supporting this determination. The certification must be submitted to the Agency with the appropriate permit application.	Appendix I
Section 845.640 - Groundwater Sampling and Analysis Requirements (excerpts providing requirements for the construction permit application)		
a)	The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells required by Section 845.630. The owner or operator of the CCR surface impoundment must develop a sampling and analysis program that includes procedures and techniques for:	Appendix I
b)	The groundwater monitoring program must include sampling and analysis methods that are appropriate for groundwater sampling and that accurately measure constituents and other monitoring parameters in groundwater samples.	Appendix I
1)	Sample collection;	Appendix I
2)	Sample preservation and shipment;	Appendix I
3)	Analytical procedures;	Appendix I
4)	Chain of custody control; and	Appendix I
5)	Quality assurance and quality control.	Appendix I
f)	Statistical Methods	Appendix I
1)	The owner or operator of the CCR surface impoundment must select one of the statistical methods specified in subsection (f)(1) to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen must be conducted separately for each constituent in each monitoring well.	Appendix I
2)	The owner or operator of the CCR surface impoundment must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR surface impoundment. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data. The certification must be submitted to the Agency with the appropriate permit application.	Appendix I
Section 845.710 - Closure Alternatives (excerpts providing requirements for the construction permit application)		
b)	Before selecting a closure method, the owner or operator of each CCR surface impoundment must complete a closure alternatives analysis. The closure alternatives analysis must examine the following for each closure alternative:	Appendix H
1)	The long- and short-term effectiveness and protectiveness of the closure method, including identification and analyses of the following factors:	Appendix H
A)	The magnitude of reduction of existing risks;	Appendix H
B)	The magnitude of residual risks in terms of likelihood of future releases of CCR;	Appendix H
C)	The the type and degree of long-term management required, including monitoring, operation, and maintenance;	Appendix H
D)	The short-term risks that might be posed to the community or the environment during implementation of such a closure, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants;	Appendix H
E)	The time until closure and post-closure care or the completion of groundwater monitoring under Section 845.740(b) is completed;	Appendix H
F)	The potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, containment or changes in groundwater flow;	Appendix H
G)	The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and	Appendix H
H)	Potential need for future corrective action of the closure alternative.	Appendix H

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Regulation	Requirement	Location in Permit Application
Section 845.710 - Closure Alternatives (excerpts providing requirements for the construction permit application) (Continued)		
2)	The effectiveness of the closure method in controlling future releases based on analyses of the following factors:	Appendix H
A)	The extent to which containment practices will reduce further releases; and	Appendix H
B)	The extent to which treatment technologies may be used.	Appendix H
3)	The ease or difficulty of implementing a potential closure method based on analyses of the following types of factors:	Appendix H
A)	Degree of difficulty associated with constructing the technology;	Appendix H
B)	Expected operational reliability of the technologies;	Appendix H
C)	Need to coordinate with and obtain necessary approvals and permits from other agencies;	Appendix H
D)	Availability of necessary equipment and specialists; and	Appendix H
E)	Available capacity and location of needed treatment, storage, and disposal services.	Appendix H
4)	The degree to which the concerns of the residents living within communities where the CCR will be handled, transported and disposed are addressed by the closure method.	Appendix H
c)	In the closure alternative analysis, the owner or operator of the CCR surface impoundment must:	Appendix H
1)	Analyze complete removal of the CCR as one closure alternative, along with the modes for transporting the removed CCR, including by rail, barge, low-polluting trucks, or a combination of these transportation modes;	Appendix H
2)	Identify whether the facility has an onsite landfill with remaining capacity that can legally accept CCR, and, if not, whether constructing an onsite landfill is possible; and	Appendix H
3)	Include any other closure method in the alternatives analysis if requested by the Agency.	Appendix H
d)	The analysis for each alternative completed under this Section must:	Appendix H
1)	Meet or exceed a class 4 estimate under the AACE Classification Standard, incorporated by reference in Section 845.150, or a comparable classification practice as provided in the AACE Classification Standard;	Appendix H
2)	Contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards;	Appendix H
3)	Include a description of the fate and transport of contaminants with the closure alternative over time including consideration of seasonal variations; and	Appendix H
4)	Assess impacts to waters in the state.	Appendix H
e)	At least 30 days before submission of a construction permit application for closure, the owner or operator of the CCR surface impoundment must discuss the results of the closure alternatives analysis in a public meeting with interested and affected parties as required by Section 845.240.	Appendix L
f)	After completion of the public meeting under subsection (e), the owner or operator of a CCR surface impoundment must select a closure method and submit a final closure plan to the Agency under Section 845.720(b). All materials demonstrating completion of the closure alternatives analysis specified in this Section must be submitted with the final closure plan.	Appendix H
Section 845.720 - Closure Plan (excerpts providing requirements for the construction permit application)		
b)	Final Closure Plan	Appendix H
1)	The owner or operator of a CCR surface impoundment must submit to the Agency, as a part of a construction permit application for closure, a final closure plan. The plan must be submitted before the installation of a final cover system or removal of CCR from the surface impoundment for the purpose of closure.	Appendix H
3)	The final closure plan must identify the proposed selected closure method, and must include the information required in subsection (a)(1) and the closure alternatives analysis as specified in Section 845.710.	Appendix H
5)	The owner or operator of the CCR surface impoundment must obtain and submit with its construction permit application for closure a written certification from a qualified professional engineer that the final written closure plan meets the requirements of this Part.	Appendix H
Section 845.750 - Closure with a Final Cover System (excerpts providing requirements for the construction permit application)		
c)	Final Cover System. If a CCR surface impoundment is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and, at a minimum, meets the requirements of this subsection (c). The final cover system must consist of a low permeability layer and a final protective layer. The design of the final cover system must be included in the preliminary and final written closure plans required by Section 845.720 and the construction permit application for closure submitted to the agency.	Appendix H
Section 845.780 - Post-Closure Care Requirements (excerpts providing requirements for the construction permit application)		
d)	Written Post-Closure Care Plan	Appendix J
1)	Content of the Plan. The owner or operator of a CCR surface impoundment must prepare a written post-closure care plan that includes, at a minimum, the information specified in this subsection (d)(1).	Appendix J
A)	A description of the monitoring and maintenance activities required in subsection (b) for the CCR surface impoundment and the frequency at which these activities will be performed;	Appendix J
B)	The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and	Appendix J
C)	A description of the planned uses of the property during the post- closure care period. Post-closure use of the property must not disturb the integrity of the final cover, liners, or any other component of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in this Part. Any other disturbance is allowed if the owner or operator of the CCR surface impoundment demonstrates that disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The demonstration must be certified by a qualified professional engineer and must be submitted to the Agency.	Appendix J
4)	The owner or operator of the CCR surface impoundment must obtain a written certification from a qualified professional engineer that the initial, and any amendment of the, written post-closure care plan meets the requirements of this Section.	Appendix J

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APPENDIX A

History of Construction

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October 2016

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, IL 61520

RE: History of Construction
USEPA Final CCR Rule, 40 CFR § 257.73(c)
Duck Creek Power Station
Canton, Illinois

On behalf of Illinois Power Resources Generating, LLC, AECOM has prepared the following history of construction for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the Duck Creek Power Station in accordance with 40 CFR § 257.73(c). The Bottom Ash Basin is an incised pond with a storage volume of less than 20 acre-feet. A history of construction is not required for the Bottom Ash Basin as specified in § 257.73(b).

BACKGROUND

40 CFR § 257.73(c)(1) requires the owner or operator of an existing coal combustion residual (CCR) surface impoundment that either (1) has a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) has a height of 20 feet or more to compile a history of construction by October 17, 2016 that contains, to the extent feasible, the information specified in 40 CFR § 257.73(c)(1)(i)–(xii).

The history of construction presented herein was compiled based on existing documentation, as reasonably and readily available (see 80 Fed. Reg. 21302, 21380 [April 17, 2015]), AECOM's site experience, and discussion with plant engineers. AECOM's document review included construction drawings, geotechnical investigations, observation reports, etc. for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the Duck Creek Power Station.

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HISTORY OF CONSTRUCTION

§ 257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

Owner: Illinois Power Resources Generating, LLC

Address: 1500 Eastport Plaza Drive
Collinsville, IL 62234

CCR Units: Ash Pond No. 1
Ash Pond No. 2, IDNR Dam ID No. IL50014
GMF Pond, IDNR Dam ID No. IL50573

Ash Pond No. 1 does not have a state assigned identification number.

§ 257.73(c)(1)(ii): The location of the CCR unit identified on the most recent USGS $7^1/_2$ or 15 minute topographic quadrangle map or a topographic map of equivalent scale if a USGS map is not available.

The locations of the Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond have been identified on an USGS 7-1/2 minute topographic quadrangle map in **Appendix A**.

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

The following captures the purpose of each CCR unit:

- The Ash Pond No. 1 (inactive) was used to store and dispose of fly ash and bottom ash.
- The Ash Pond No. 2 (inactive) was used to store and dispose of fly ash and bottom ash and to clarify CCR contact stormwater prior to discharge in accordance with the station's Water Pollution Control Permit (#2015-EO-59369).
- The GMF Pond is being used to store and dispose of gypsum and to clarify recycled process water for plant operations.

Notice of intent to close Ash Pond No. 1 and Ash Pond No. 2 was provided in November, 2015.[1]

[1] This history of construction report was prepared on a facility-wide basis for CCR surface impoundments at the Duck Creek Power Station. The inclusion of Ash Pond No. 1 and Ash Pond No. 2 in this history of construction report does not concede and should not be construed to concede that Ash Pond No. 1 and Ash Pond No. 2 are subject to the Design Criteria or all Operating Criteria in the CCR Rule.

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§ 257.73(c)(1)(iv): The name and size in acres of the watershed where the CCR unit is located.

Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are located at the western edge of the Rice Lake-Illinois River Watershed with a 12-digit Hydrologic Unit Code (HUC) of 071300030603 and a drainage area of 21,203 acres (USGS, 2016).

§ 257.73(c)(1)(v): A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

Physical properties of the foundation materials for Ash Pond No. 1 and Ash Pond No. 2 are primarily strip-mine spoils with variable thickness overlying shale bedrock. The mine spoils consist of a mixtures of native loess and glacial till and, to a lesser extent, the underlying (primarily shale) bedrock. The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

Physical properties of the foundation materials for the GMF Pond are (from top to bottom) native loess, glacial till, and bedrock (primarily shale). The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

An available summary of foundation material engineering properties for Ash Pond No.1, Ash Pond No. 2, and the GMF Pond is presented in **Table 1** below. The foundation material engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 1. Summary of Foundation Material Engineering Properties

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Loess	116	100	32	1,250	0
Glacial Till	125	200	30	1,900	0
Mine Spoils	120	100	30	250	15
Shale Bedrock	130	300	26	600	13

Ash Pond No.1, Ash Pond No. 2, and the GMF Pond are enclosed impoundments with embankments and do not have abutments.

§ 257.73(c)(1)(vi): A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

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The embankments of the Ash Pond No. 1 and Ash Pond No. 2 were constructed with mine spoils excavated from within the center of the existing pond footprints. The mine spoils consist of a mixtures of native loess and glacial till and, to a lesser extent, the underlying (primarily shale) bedrock. The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

The embankments of the GMF Pond generally consists of silty, low plastic clay and generally had a stiff to very stiff consistency and appeared to be well-compacted material. The liner system within the GMF Pond consists of (from top to bottom) a 60-mil textured high density polyethylene (HDPE) geomembrane, 1-foot-thick layer of “cushion dirt”, 4-ounce geotechnical filter fabric, 1-foot-thick drainage layer, 10-ounce geotextile cushion, 60-mil textured HDPE geomembrane, a Bentomat SDN reinforced geosynthetic clay liner (GCL), and 3-foot-thick layer of compacted clay. A typical cross section profile of the liner system is shown on drawing C180-C102-8 presented in **Appendix B**.

An available summary of construction material engineering properties is presented in **Table 2** below. The construction material engineering properties are based on previous geotechnical investigations and laboratory testing.

Table 2. Summary of Construction Material Engineering Properties

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c’ (psf)	Φ’ (°)	c (psf)	Φ (°)
Liner-Cushion Material	116	0	38	660	0
Liner-Granular Drainage Layer	120	0	33	0	33
Liner-Geotextile /Geomembrane	75	100	25	100	25
Embankment Fill	116	150	32	2,150	0

The methods used for preparation and construction of Ash Pond No. 1 and Ash Pond No. 2 are not reasonably and readily available.

The site preparation work for the GMF Pond included stripping and stockpiling the topsoil. The subsoil was then excavated to approximately 5.4 feet above the proposed foundation grade and stockpiled. Temporary and permanent erosion control measures were also installed. The site was later excavated to the proposed subgrade and proof rolled to inspect for unsuitable soils. Any unsuitable soils were either removed or reworked. A sheepsfoot roller was used to compact suitable backfill material placed in 8-inch lifts. Compaction testing was performed using a nuclear density gauge at a minimum rate of one test per 10,000 cubic yards (minimum one test per lift). Backfill was compacted to at least 95% of standard proctor maximum dry density and with a moisture content of -2% to +2% of optimum. Embankment

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construction was performed using similar compacting and testing techniques as for the subgrade preparation.

Prior to constructing the clay liner for the GMF Pond, two test pad liners were constructed using separate borrow material. Testing of both liners indicated that the construction practice and material used were acceptable. The full scale clay liner was constructed with fill placed in 8-inch lifts and compacted with a sheepsfoot roller. Placed fill was compacted to at least 95% of standard proctor maximum dry density and with a moisture content of optimum to +5%. Compaction testing was performed using a nuclear density gauge at a minimum rate of one test per 1,000 cubic yards (minimum one test per lift). After the minimum clay liner thickness was achieved, the surface was smooth rolled in preparation of the GCL. The GCL and lower geomembrane were then placed sequentially followed by the 10-ounce geotextile cushion. A leak detection/leachate collection and recovery system (LD/LCRS) was then installed which includes a 1-foot-thick sand drainage layer and collection pipes. The sand was graded to minimum thickness using a dozer. The LD/LCRS was completed by placing a 4-ounce geotechnical filter fabric on top of the sand. A 1-foot-thick “cushion dirt” layer was then placed using a dozer to spread general fill. The liner was completed by placing the upper geomembrane on top.

The approximate dates of each successive event stage of construction of Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are provided in **Table 3** below.

Table 3. Approximate dates of construction of each successive stage of construction.

Date	Event
1976	Ash Pond No. 1 was commissioned
1986	Ash Pond No. 2 was commissioned
2007	Surface preparation for GMF Pond began
2008-2009	Construction of GMF Pond

§ 257.73(c)(1)(vii): At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

Drawings that contain items pertaining to the requested information for Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are listed in **Table 4** below. Items marked as "Not Available" are items not found during review of reasonably and readily available record documentation

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Table 4. List of drawings containing items pertaining to the information requested in § 257.73(c)(1)(vii).

	Ash Pond No. 1	Ash Pond No. 2	GMF Pond
Dimensional plan view (all zones)	C180-G1916-3	C180-G1916-4, C180-G1916-6	C180-C102-8 thru -11
Dimensional cross sections	C180-G1916-3	C180-G1916-7	C180-C102-12 thru -14
Foundation Improvements	C180-G1916-3	C180-G1916-7	Not Applicable
Drainage Provisions	Not Applicable	C180-G1916-9 thru -11, M-1001	C180-C102-12 thru -14 C180-C102-30 thru -31
Spillways and Outlets	C180-G1916-3	C180-G1916-8	C180-C102-15, C180-C102-29
Diversion Ditches	Not Applicable	Not Applicable	Not Applicable
Instrument Locations	Figure in Appendix C, Plate 2	Figure in Appendix C, Plate 2	Not Applicable
Slope Protection	C180-G1916-3	Not Available	C180-C102-12
Normal Operating Pool Elevation	Not Available	Not Available	Not Available
Maximum Pool Elevation	C180-G1916	C180-G1916-7	Not Available
Approximate Maximum Depth of CCR in 2016	68 feet	59 feet	25 feet

All drawings referenced in the table above can be found in **Appendix B** and **Appendix C**.

Based on the review of the drawings listed above, no natural or manmade features that could adversely affect operation of these CCR units due to malfunction or mis-operation were identified.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Existing instrumentation at Ash Pond No. 1 and Ash Pond No. 2 consists of open-standpipe piezometers. The purpose of the piezometers is to measure the pore water pressures within and around the CCR units. Two (2) piezometers (B-2 and B-5) were installed in 2010 and the locations are presented on Plate 2 in **Appendix C**. Five (5) additional piezometers were installed in 2010 and the locations are presented in **Appendix C**.

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The GMF Pond does not contain existing instrumentation used for monitoring the operation of the CCR unit.

§ 257.73(c)(1)(ix): Area-capacity curves for the CCR unit.

Area-capacity curves for the Ash Pond No. 1 and Ash Pond No. 2 are not reasonably and readily available. The area-capacity curve for the GMF Pond is presented in **Figure 1** below. "Area-capacity curves", as defined by 40 CFR § 257.53, "means graphic curves which readily show the reservoir water surface area, in acres, at different elevations from the bottom of the reservoir to the maximum water surface, and the capacity or volume, in acre-feet, of the water contained in the reservoir at various elevations."

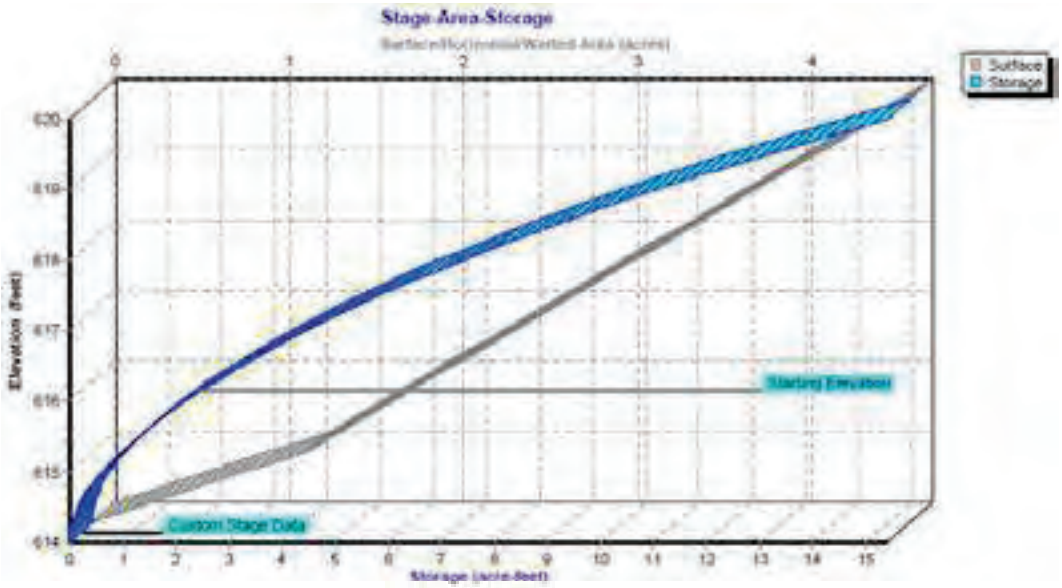

Figure 1. Area-capacity curve for GMF Pond prepared in 2016

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

Ash Pond No. 1 does not contain an active spillway or diversion feature. Stormwater collected in Ash Pond No. 1 is manually pumped to Ash Pond No. 2 at the judgement of plant personnel. Current discharge capacity and calculation information for Ash Pond No. 1 is not reasonably and readily available.

Stormwater collected in Ash Pond No. 2 is drained via a 36-inch diameter (dia.) steel morning glory spillway, formed by 2-foot tall stacked sections, located in the northeast corner of the pond. The spillway transitions to a 36-inch dia. reinforced concrete pipe (RCP) and drains towards the return water pumphouse and discharges in accordance with the station's Water Pollution Control Permit. Current discharge capacity and calculation information for Ash Pond No. 2 is not reasonably and readily available.

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The GMF Pond contains a transfer channel that discharges clear water into the GMF Recycle Pond. The transfer channel is trapezoidal in shape with 3H:1V side slopes. The channel transitions from a 16-foot bottom width at an invert elevation of 616 feet at the upstream end to a 35-foot bottom width at an invert elevation of 609 feet at the downstream end. In 2016 the discharge capacity of the GMF Pond was evaluated using HydroCAD 8.50 software modeling a 1,000-year, 24-hour rainfall event. The results of the HydroCAD 8.50 analysis are presented below in **Table 5**.

Table 5. Results of HydroCAD 8.50 analyses

	GMF Pond
Approximate Minimum Berm Elevation[1] (ft)	620.0
Approximate Emergency Spillway Elevation[1] (ft)	616.0
Starting Pool Elevation[1] (ft)	616.0
Peak Elevation[1] (ft)	618.3
Time to Peak (hr)	12.0
Surface Area (ac)	3.5
Storage[2] (ac-ft)	8.3

Notes: 1. Elevations are based on NAVD88 datum.
2. Storage given is from Starting Pool Elevation to Peak Elevation

§ 257.73(c)(1)(xi): The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

The construction specification for Ash Pond No. 1 is located in Technical Specification Section 21, however the construction specification is not reasonably and readily available. The construction specification for the Ash Pond No. 2 is not reasonably and readily available. The construction specification for the GMF Pond is located in *Project Manual; Specification No's.: C180-C102* (presented in **Appendix D**).

The provisions for surveillance, general maintenance, and repair of the GMF Pond are presented in **Appendix E**.

The operations and maintenance plans for Ash Pond No. 1, Ash Pond No. 2, and GMF Pond are currently either being generated or being revised by Illinois Power Resources Generating,

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LLC. This section will be updated when the new operations and maintenance plans are available.

§ 257.73(c)(1)(xii): Any record or knowledge of structural instability of the CCR unit.

There is no record or knowledge of structural instability of Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond at Duck Creek Power Station.

LIMITATIONS

The signature of AECOM's authorized representative on this document represents that to the best of AECOM's knowledge, information and belief in the exercise of its professional judgment, it is AECOM's professional opinion that the aforementioned information is accurate as of the date of such signature. Any recommendation, opinion or decisions by AECOM are made on the basis of AECOM's experience, qualifications and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data and that actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

Sincerely,

Claudia Prado
Project Manager

Victor Modeer, P.E., D.GE
Senior Project Manager

REFERENCES

United States Environmental Protection Agency (USEPA). (2015). *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.* 40 CFR Parts 257 and 261, 80 Fed. Reg. 21302, 21380 April 17, 2015.

United States Geological Survey (USGS). (2016). The National Map Viewer. http://viewer.nationalmap.gov/viewer/. USGS data first accessed in March of 2016.

APPENDICES

Appendix A: History of Construction Vicinity Map
Appendix B: Duck Creek Power Station Drawings
Appendix C: Duck Creek Power Station Boring and Piezometer Locations
Appendix D: Project Manual; Specification No's.: C180-C102 (excerpt)
Appendix E: Operation and Maintenance Manual, Duck Creek Energy Center, Gypsum Management Facility

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Appendix A: History of Construction Vicinity Map

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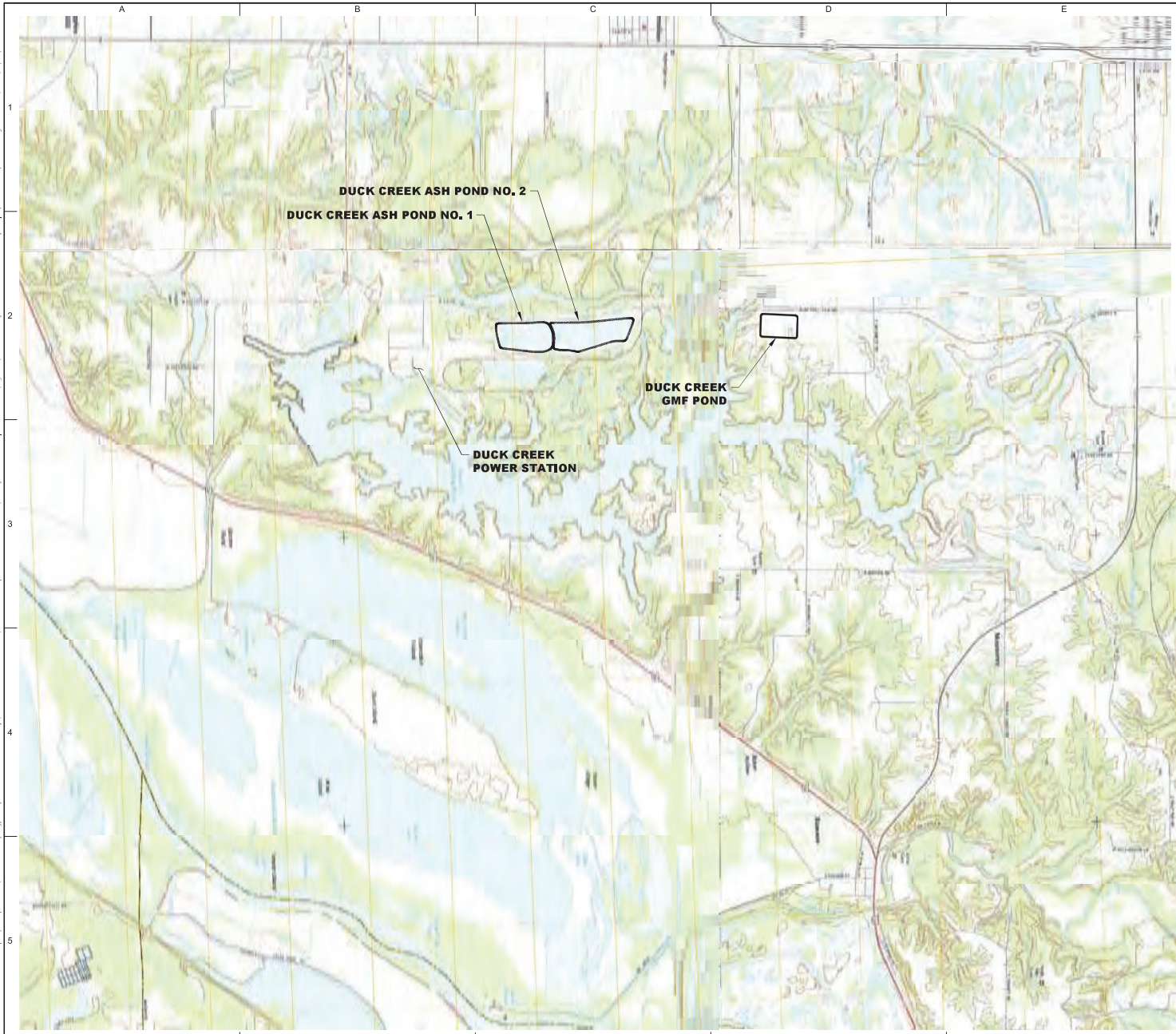

LEGEND

CCR UNITS

SOURCE:
MAP PROVIDED FROM ELECTRONIC USGS DIGITAL RASTER GRAPHIC 7.5 MINUTE TOPOGRAPHIC MAP OF SAINT DAVID ILLINOIS, DUCK CREEK ISLAND ILLINOIS, CANTON ILLINOIS AND BANNOR ILLINOIS, REVISED 2015.



QUADRANGLE LOCATION

N

0 2000 4000 6000

SCALE IN FEET

AECOM
1001 Highlands Plaza Drive, Suite 300
St. Louis, Mo. 63110
314 429-0100 (phone)
314-429-0462 (fax)

ILLINOIS POWER RESOURCES GENERATING, LLC
17751 North CILCO Rd.,
Canton, IL 61520

HISTORY OF CONSTRUCTION

DUCK CREEK POWER STATION
CANTON, ILLINOIS

ISSUED FOR BIDDING DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
1		
2		
3		
4		
5		

AECOM PROJECT NO:	60489731
DRAWN BY:	DJD
DESIGNED BY:	DJD
CHECKED BY:	MN
DATE CREATED:	2016-04-13
PLOT DATE:	
SCALE:	1" = 2000'
ACAD VER:	2014

SHEET TITLE

HISTORY OF CONSTRUCTION VICINITY MAP

01

AECOM DRAWING PATH: P:\Projects\Gentech\60473790_DynegyCCR\3_Construction History\04_Technical Production\2_Duck Creek\Reference Documents\Vicinity_Location Map_References\Figures\C-01 History of Construction Vicinity Map (Duck Creek) - MXD.dwg MANN, MATT, 6/21/2016 4:02 PM

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AECOM

Appendix B: Duck Creek Power Station Drawings

1. “Waste Storage System, Plan and Details of Dike Embankment”, Drawing No. C180-G1916-3, Revision D, 13 February, 1975, Commonwealth Associates Inc.
2. “Waste Disposal System, Site Plan”, Drawing No. C180-G1916-4, Revision C, 16 October, 1984, Commonwealth Associates Inc.
3. “Waste Disposal Area II, Site Plan”, Drawing No. C180-G1916-6, Revision G, 16 October, 1984, Commonwealth Associates Inc.
4. “Waste Disposal System, Dike Sections and Details”, Drawing No. C180-G1916-7, Revision D, 16 October, 1984, Commonwealth Associates Inc.
5. “Waste Disposal System, Inlet and Outlet Details”, Drawing No. C180-G1916-8, Revision E, 16 October, 1984, Commonwealth Associates Inc.
6. “Waste Disposal Area II, Outlet Pipe Plan & Profile”, Drawing No. C180-G1916-9, Revision E, 11 October, 1984, Commonwealth Associates Inc.
7. “Waste Disposal System, Pipe Profile and Details”, Drawing No. C180-G1916-10, Revision E, 10 October, 1984, Commonwealth Associates Inc.
8. “Waste Disposal System, Miscellaneous Details”, Drawing No. C180-G1916-11, Revision E, 10 October, 1984, Commonwealth Associates Inc.
9. “Pipe Plan & Profile, Recycle Pond Bypass”, Drawing No. M-1001, Revision 0, 30 July, 2004, Sargent & Lundy LLC.
10. “Gypsum Stack – Foundation Grade”, Drawing No. C180-C102-8, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
11. “Gypsum Stack – Clay Layer Grade”, Drawing No. C180-C102-9, Revision 4, 5 March, 2009, Hanson Professional Services, Inc.
12. “Gypsum Stack – LD/LCRS Drainage Layer Grade”, Drawing No. C180-C102-10, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
13. “PWRS-Ring Drain System Cushion Dirt Layer Grade”, Drawing No. C180-C102-11, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
14. “PWRS-Ring Drain Details”, Drawing No. C180-C102-12, Revision 5, 5 March, 2009, Hanson Professional Services, Inc.
15. “PWRS-Ring Drain Details”, Drawing No. C180-C102-13, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
16. “LD/LCRS Sections & Details”, Drawing No. C180-C102-14, Revision 3, 5 March, 2009, Hanson Professional Services, Inc.
17. “Recycle Pond Plan”, Drawing No. C180-C102-15, Revision 5, 5 March, 2009, Hanson Professional Services, Inc.
18. “Miscellaneous Details”, Drawing No. C180-C102-29, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
19. “LD/LCRS Underdrain Dewatering System-Seep 1”, Drawing No. C180-C102-30, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
20. “LD/LCRS Underdrain Dewatering System-Seep 2”, Drawing No. C180-C102-31, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.

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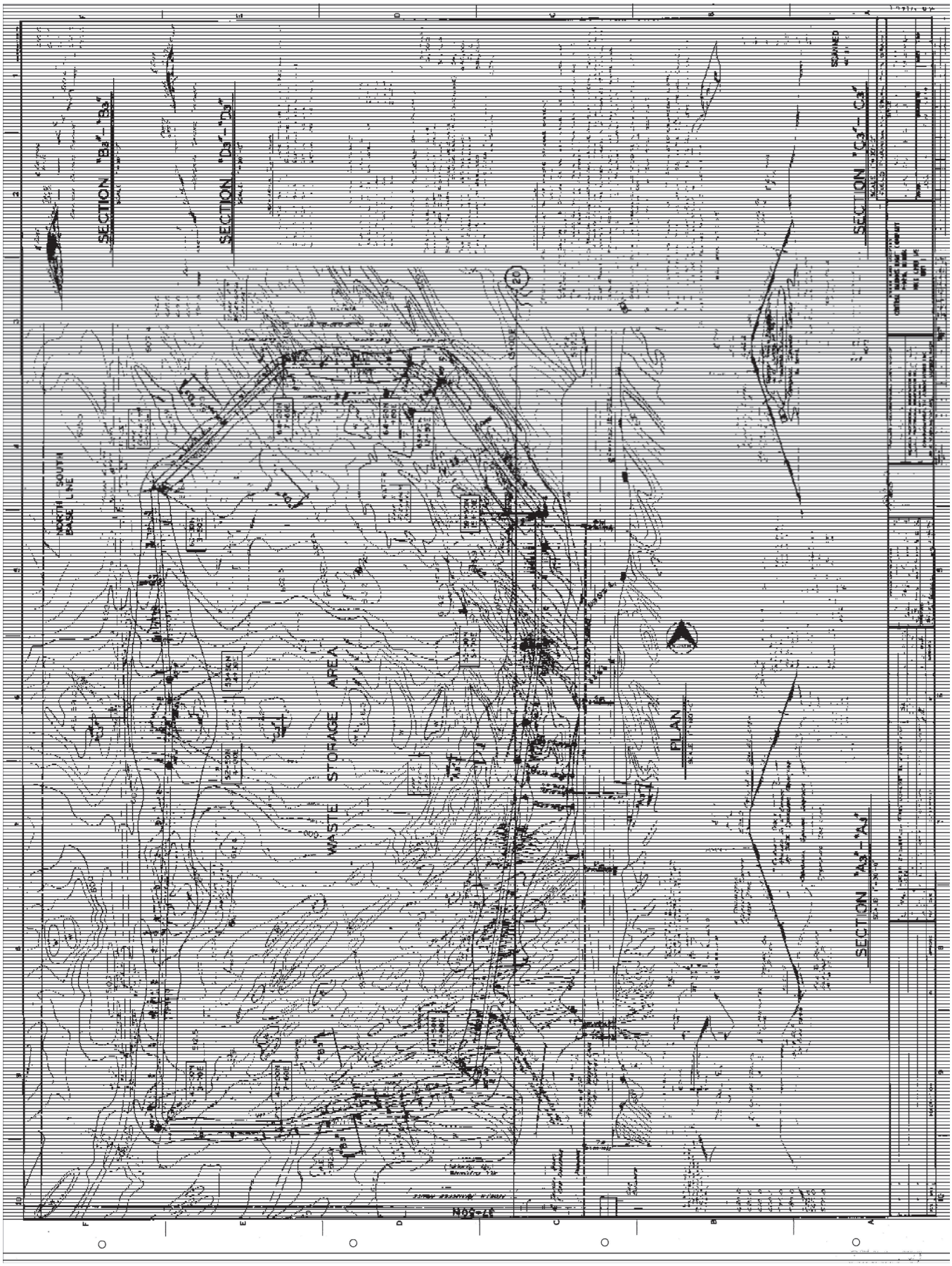

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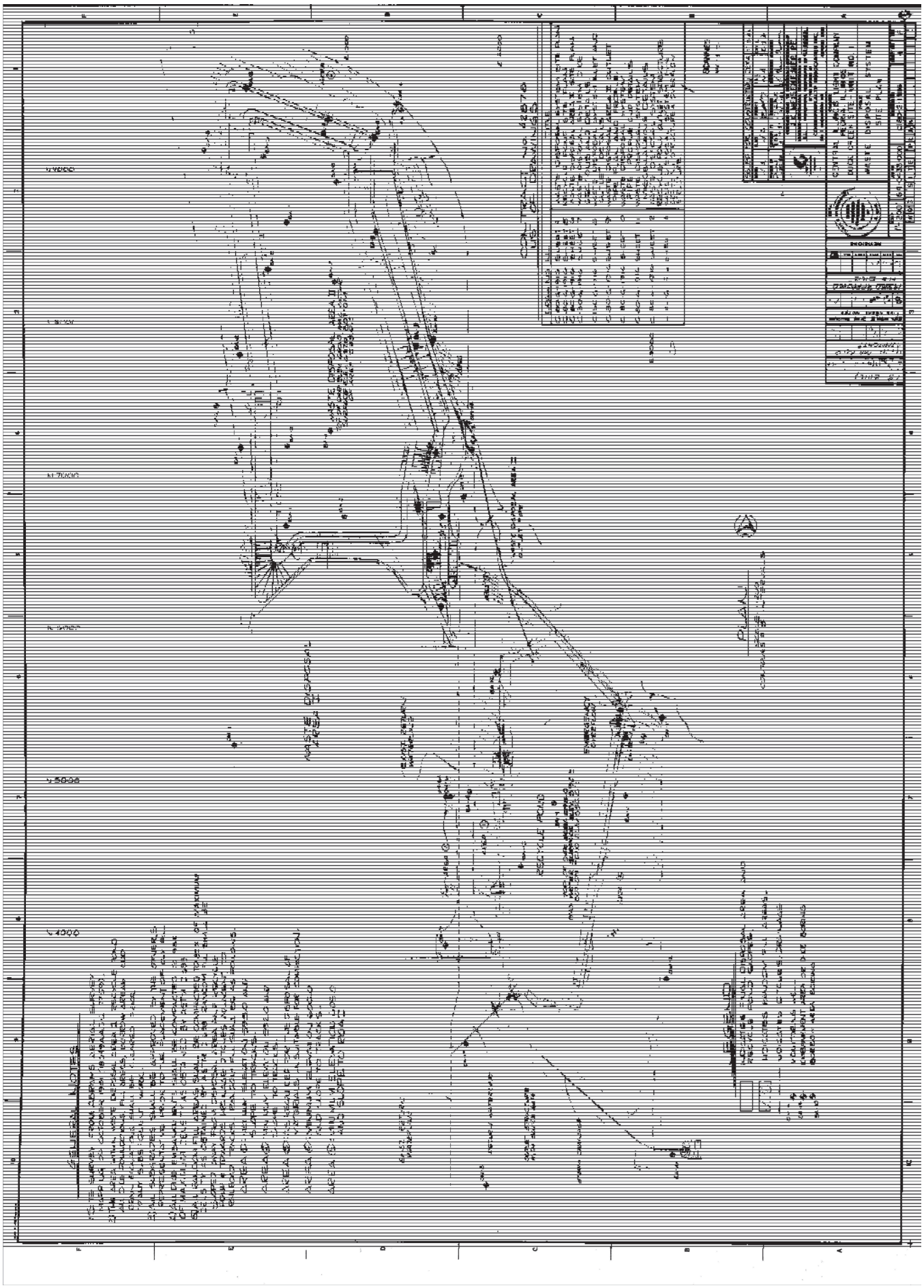

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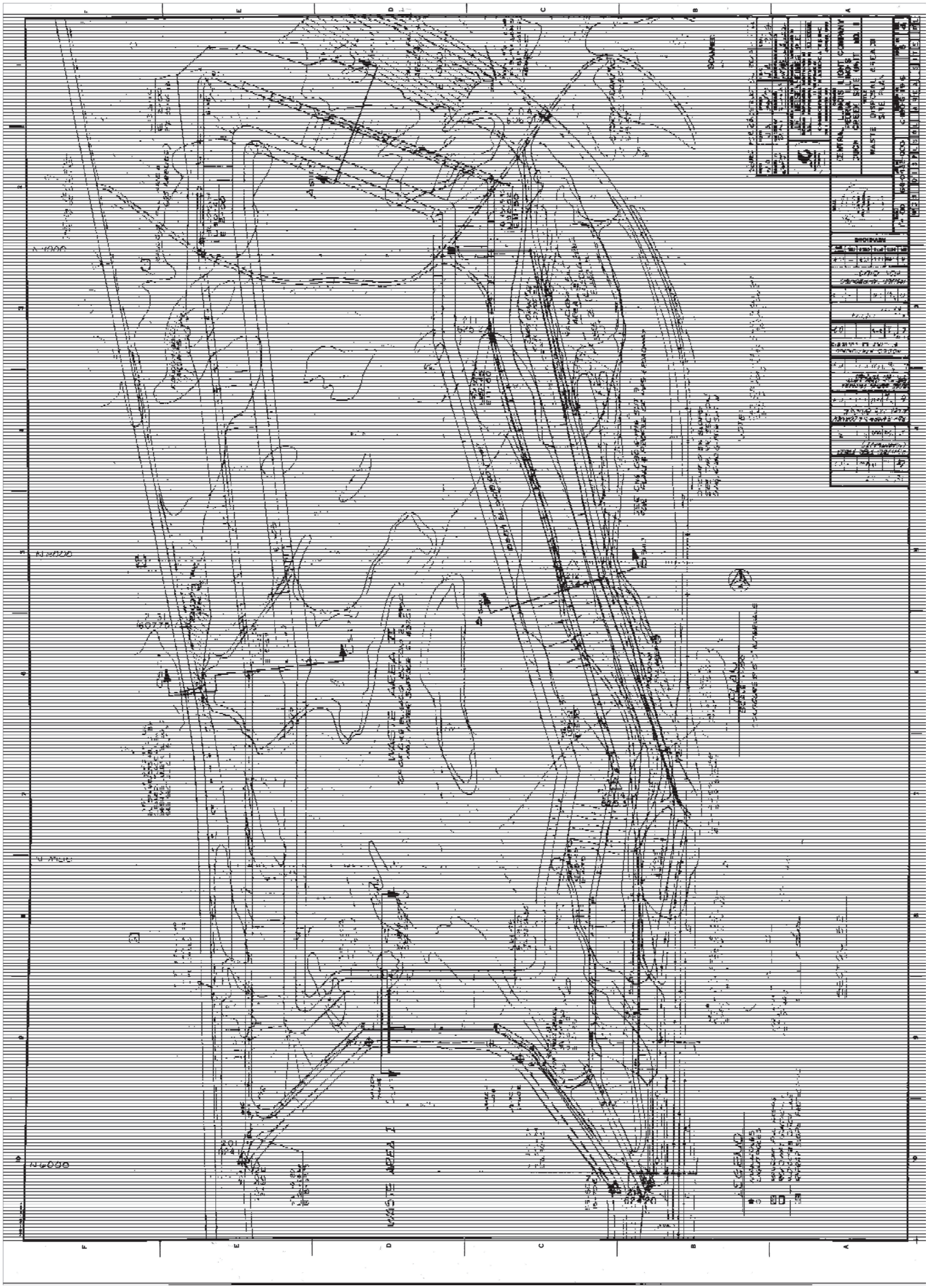

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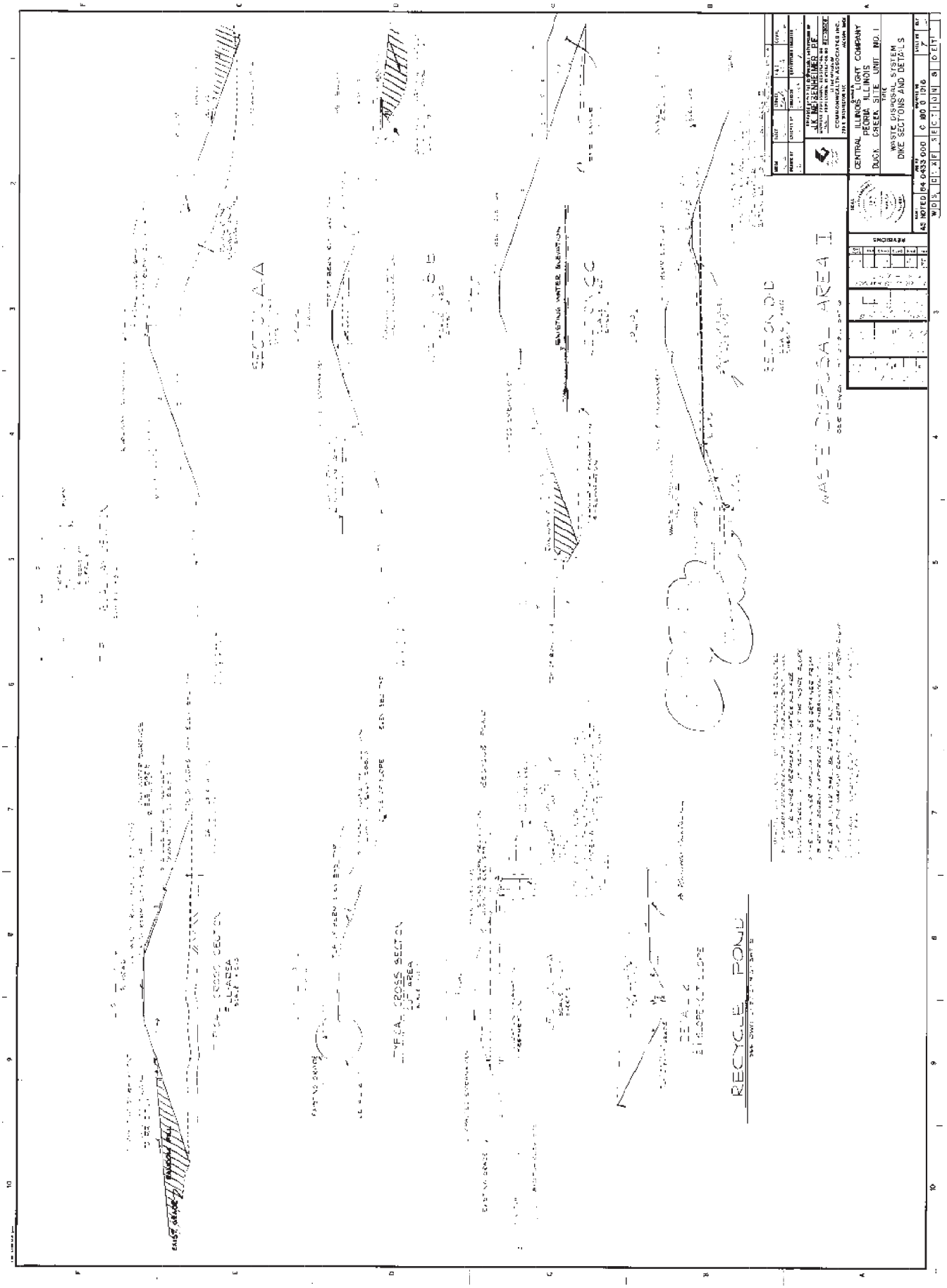

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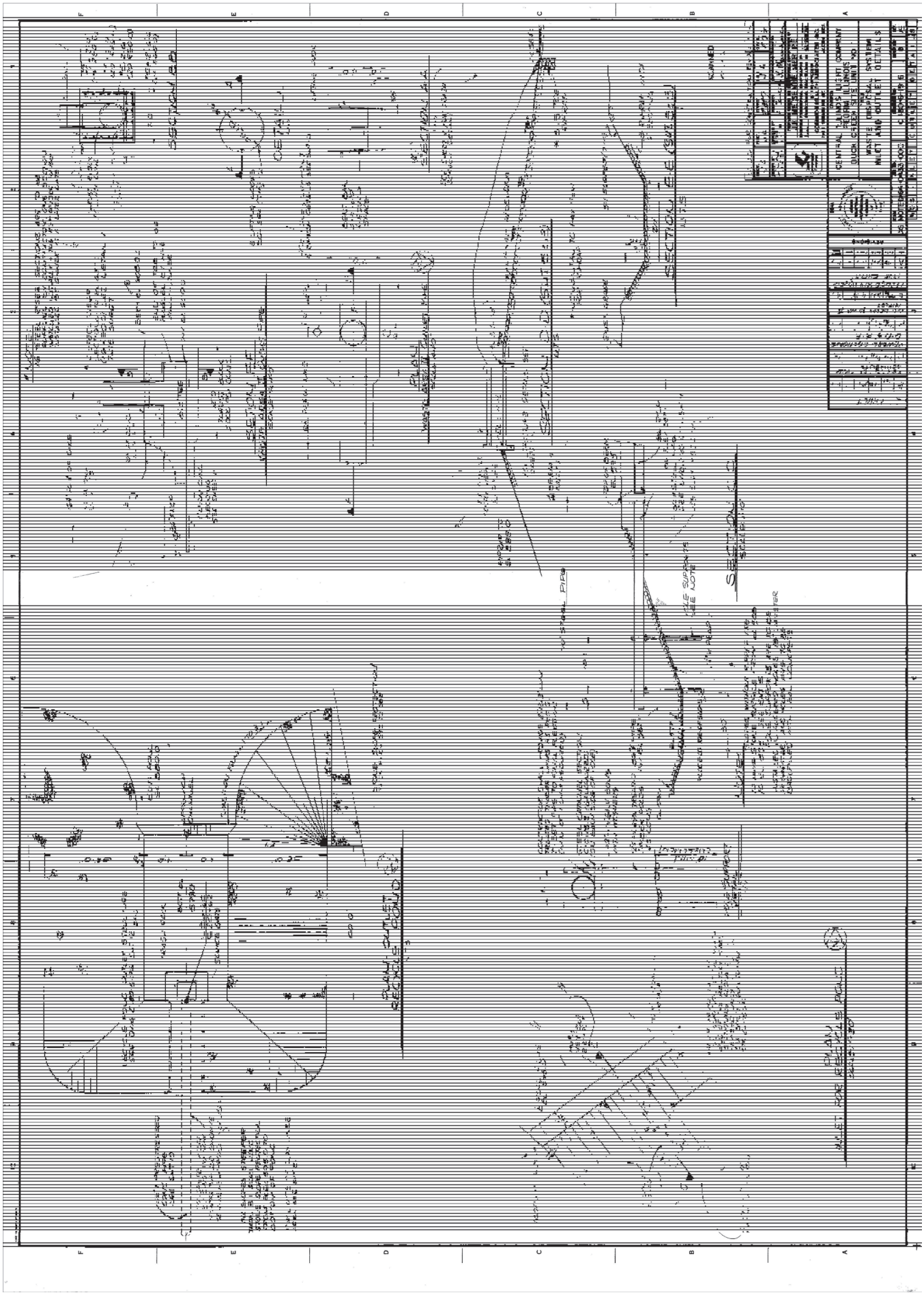

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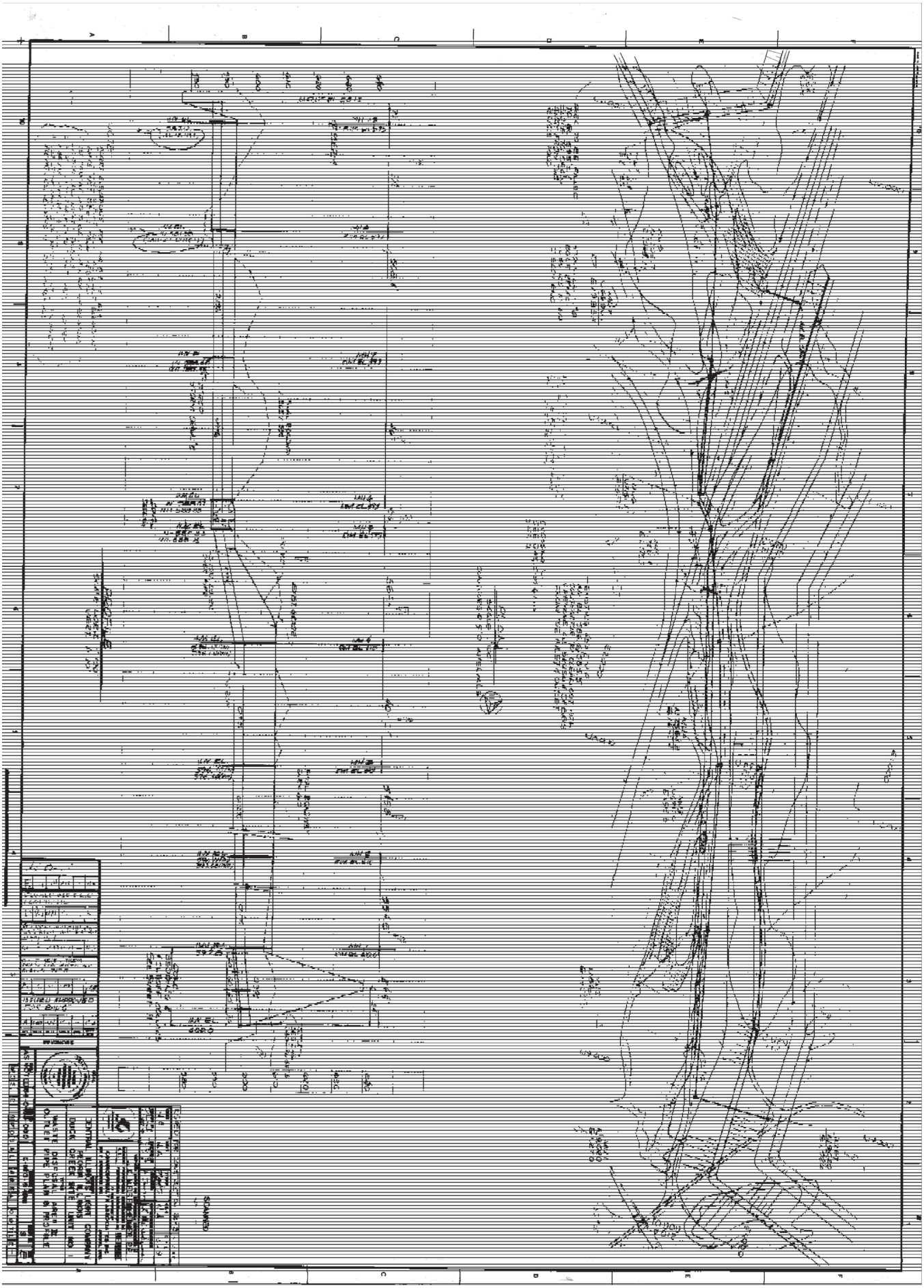

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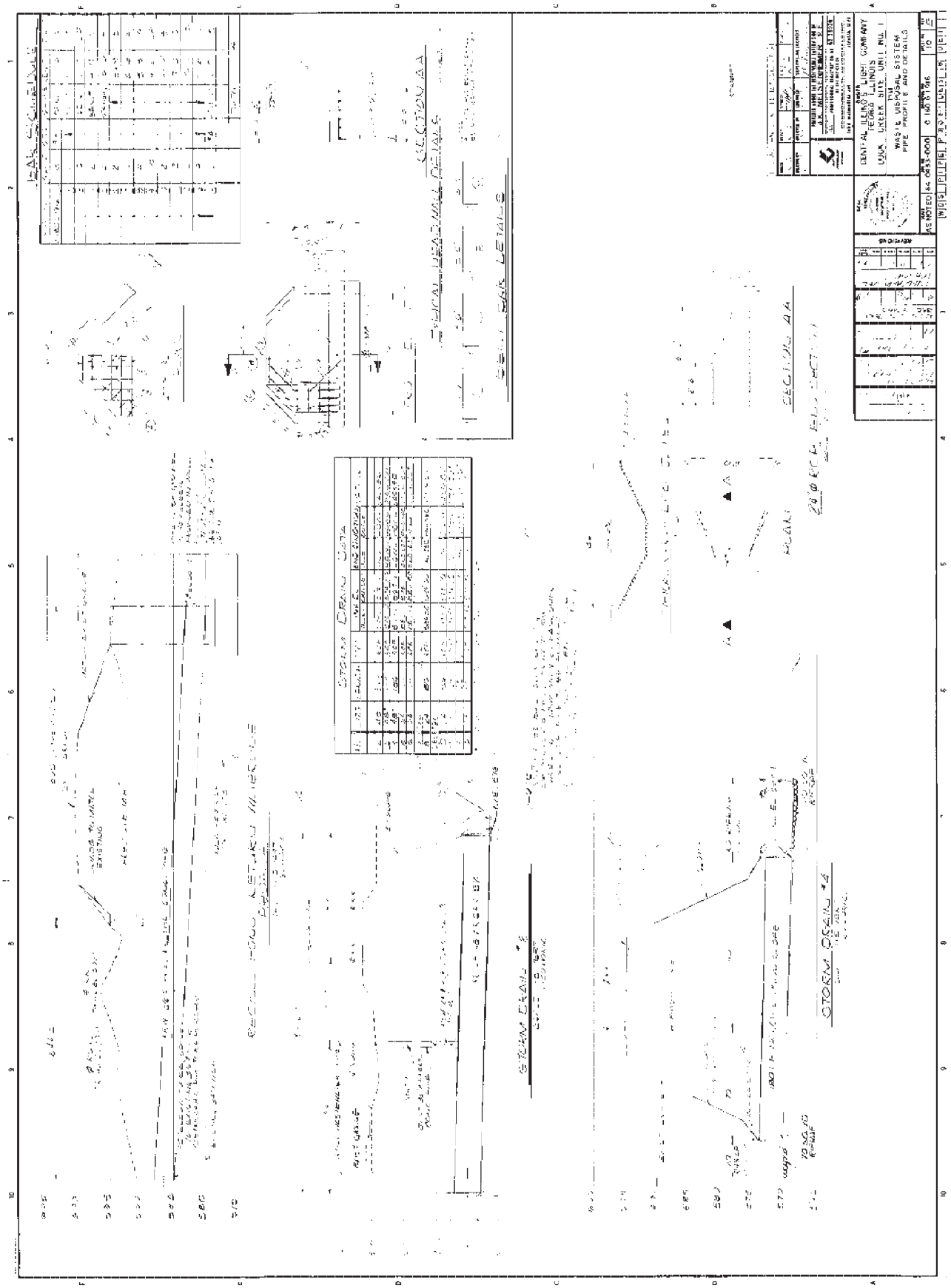

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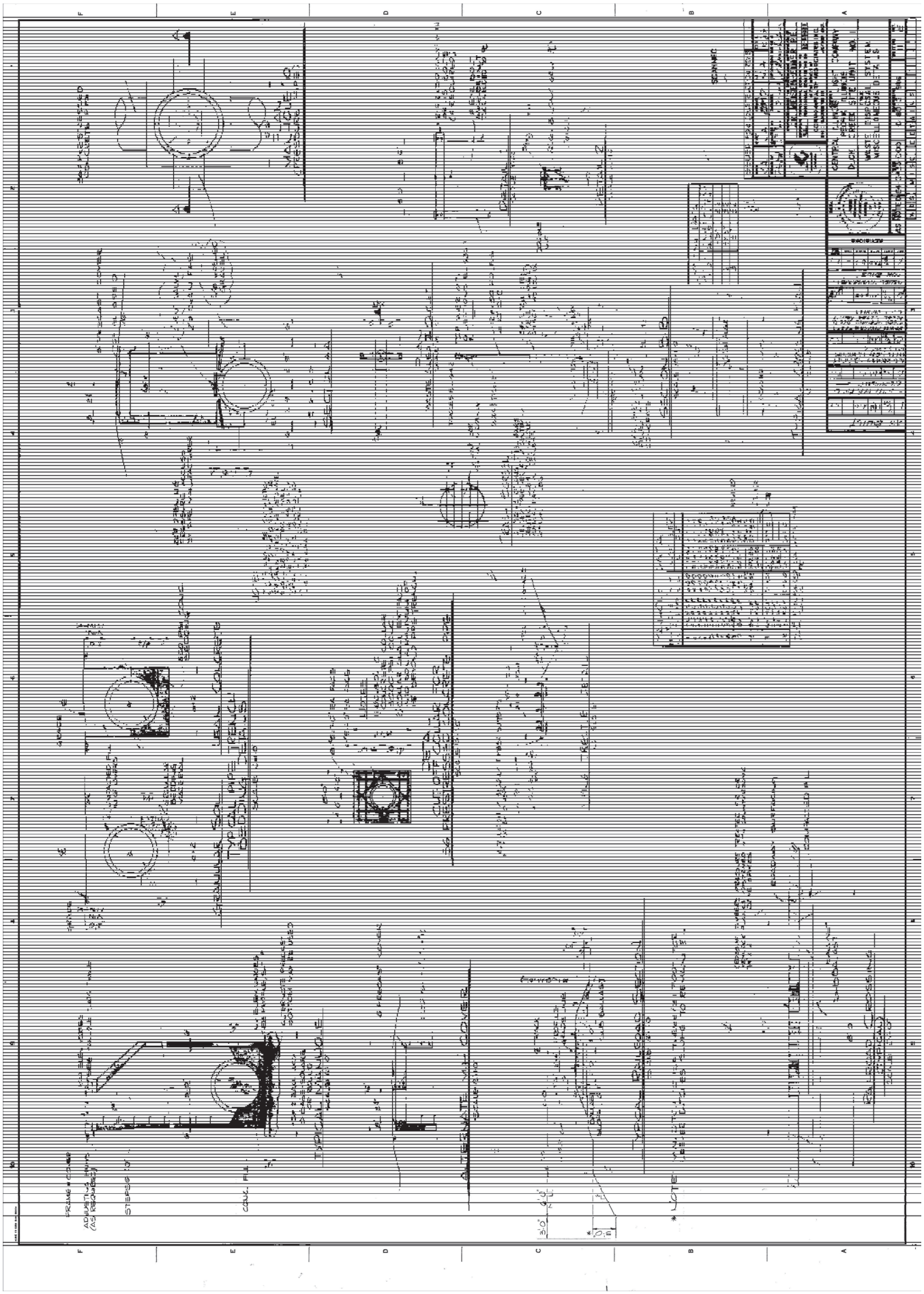

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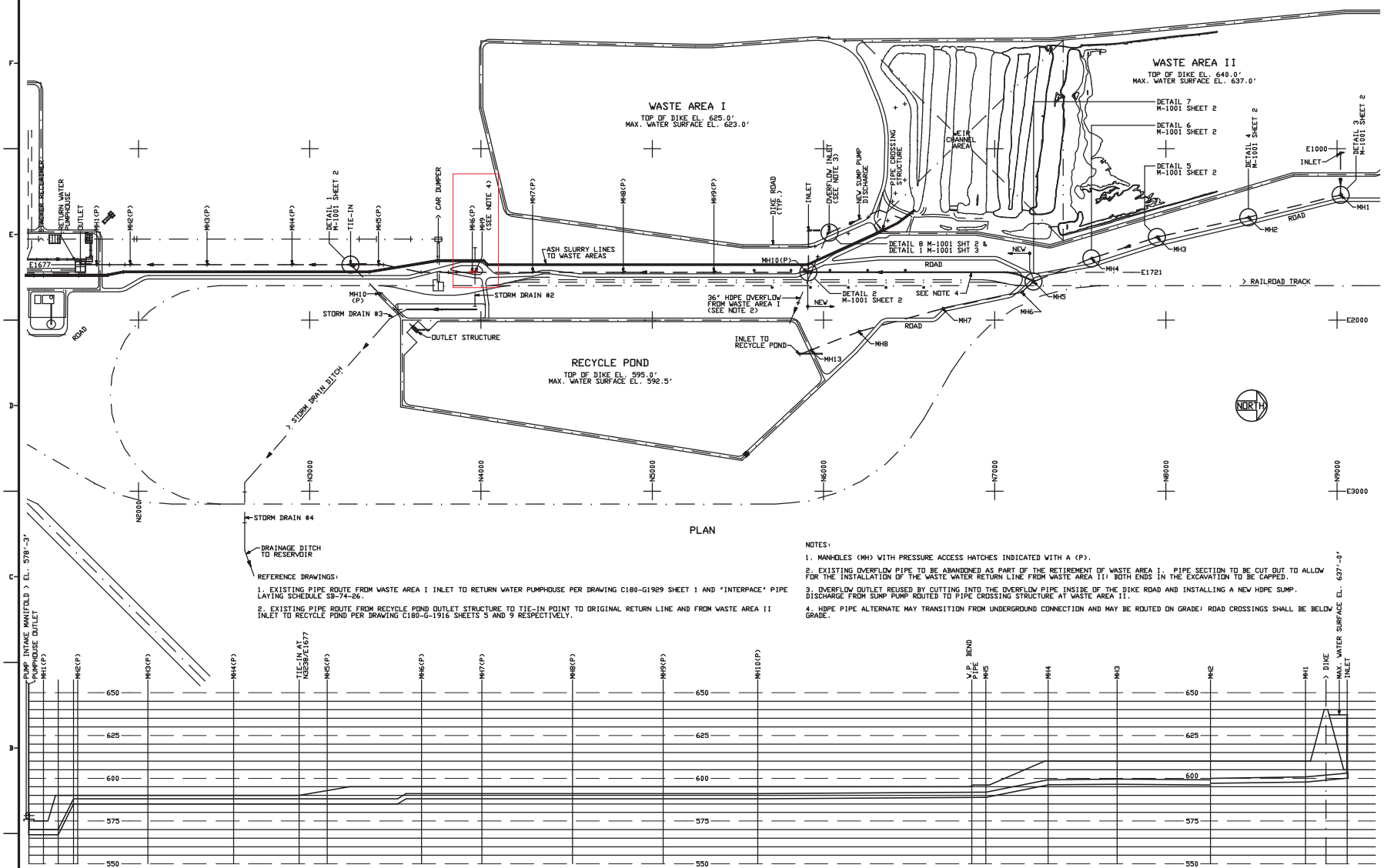

REFERENCE DRAWINGS:

1. EXISTING PIPE ROUTE FROM WASTE AREA I INLET TO RETURN WATER PUMPHOUSE PER DRAWING C180-G1929 SHEET 1 AND 'INTERPACE' PIPE LAYING SCHEDULE SB-74-26.

2. EXISTING PIPE ROUTE FROM RECYCLE POND OUTLET STRUCTURE TO TIE-IN POINT TO ORIGINAL RETURN LINE AND FROM WASTE AREA II INLET TO RECYCLE POND PER DRAWING C180-G-1916 SHEETS 5 AND 9 RESPECTIVELY.

NOTES:

1. MANHOLES (MH) WITH PRESSURE ACCESS HATCHES INDICATED WITH A (P).

2. EXISTING OVERFLOW PIPE TO BE ABANDONED AS PART OF THE RETIREMENT OF WASTE AREA I. PIPE SECTION TO BE CUT OUT TO ALLOW FOR THE INSTALLATION OF THE WASTE WATER RETURN LINE FROM WASTE AREA II. BOTH ENDS IN THE EXCAVATION TO BE CAPPED.

3. OVERFLOW OUTLET REUSED BY CUTTING INTO THE OVERFLOW PIPE INSIDE OF THE DIKE ROAD AND INSTALLING A NEW HDPE SUMP. DISCHARGE FROM SUMP PUMP ROUTED TO PIPE CROSSING STRUCTURE AT WASTE AREA II.

4. HDPE PIPE ALTERNATE MAY TRANSITION FROM UNDERGROUND CONNECTION AND MAY BE ROUTED ON GRADE. ROAD CROSSINGS SHALL BE BELOW GRADE.

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY

FILE I.D.: M1001 01.DGN

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
0	07/30/04	J.ALCANTARA	M.MAZZAFERRO		FOR RECORD/SENT TO CLIENT	

SCALE: 1"=200'

PROJECT NUMBER: 11478-006

PIPE PLAN & PROFILE RECYCLE POND BYPASS

DUCK CREEK SITE
UNIT 1
CANTON, ILLINOIS
AMEREN CILCO

Sargent & Lundy LLC

DRAWING NO. M-1001

REV. 0

SHEET 1 OF

R001789

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CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F0101	16094.44	600.00	591.92	591.92
F0102	16129.48	600.00	601.93	601.72
F0103	16171.72	600.00	614.00	613.76
F0104	16181.80	600.00	614.00	613.93
F0105	16181.80	600.00	618.50	618.41
F0106	16207.05	600.00	618.50	618.41
F0107	16212.92	599.97	616.81	617.46
F0201	16093.44	700.00	591.63	591.43
F0202	16128.99	700.00	601.78	601.57
F0203	16171.75	700.00	614.00	613.66
F0204	16181.83	700.00	614.00	613.83
F0205	16181.83	700.00	618.50	618.45
F0206	16207.08	700.00	618.50	618.39
F0207	16214.65	699.99	616.33	616.08
F0301	16095.59	800.00	592.23	592.10
F0302	16130.09	800.00	602.09	601.78
F0303	16171.78	800.00	614.00	613.92
F0304	16181.86	800.00	614.00	613.80
F0305	16181.86	800.00	618.50	618.40
F0306	16207.11	800.00	618.50	618.36
F0307	16231.93	800.00	611.41	613.77
F0401	16097.41	884.70	592.75	592.62
F0402	16131.01	884.69	602.34	601.96
F0403	16171.81	884.68	614.00	613.88
F0404	16181.89	884.67	614.00	613.95
F0405	16181.89	884.67	618.50	618.46
F0406	16207.14	884.67	618.50	618.49
F0407	16233.79	884.62	610.88	611.16
F0501	16084.47	897.40	592.72	592.61
F0502	16084.09	931.08	602.34	601.98
F0503	16083.63	971.90	614.00	613.82
F0504	16083.52	981.98	614.00	613.99
F0505	16083.52	981.98	618.50	618.42
F0506	16083.24	1007.23	618.50	618.27
F0507	16082.98	1032.66	611.24	612.16
F0601	16000.00	894.01	592.01	591.89
F0602	16000.00	928.91	601.99	601.71
F0603	16000.00	970.96	614.00	613.85
F0604	16000.00	981.05	614.00	613.91
F0605	16000.00	981.05	618.50	618.35
F0606	16000.00	1006.30	618.50	618.19
F0607	15999.99	1027.93	612.32	614.31
F0701	15900.00	889.98	591.18	591.13
F0702	15900.00	926.34	601.57	601.53
F0703	15900.00	969.85	614.00	613.72
F0704	15900.00	979.93	614.00	613.97
F0705	15900.00	979.93	618.50	618.32
F0706	15900.00	1005.18	618.50	618.28
F0707	15900.00	1090.84	594.03	610.36
F0801	15800.00	885.96	590.35	590.35
F0802	15800.00	923.77	601.15	601.09
F0803	15800.00	968.73	614.00	613.77
F0804	15800.00	978.81	614.00	613.82
F0805	15800.00	978.81	618.50	618.32
F0806	15800.00	1004.06	618.50	618.35
F0807	15799.99	1029.78	611.15	611.95
F0901	15700.00	881.93	589.52	589.33
F0902	15700.00	921.20	600.74	600.58
F0903	15700.00	967.62	614.00	613.65
F0904	15700.00	977.70	614.00	613.93
F0905	15700.00	977.70	618.50	618.36
F0906	15700.00	1002.95	618.50	618.42
F0907	15700.00	1023.57	612.61	613.54
F1001	15600.00	874.33	587.67	587.28
F1002	15600.00	918.63	600.32	600.30
F1003	15600.00	966.50	614.00	613.79
F1004	15600.00	976.58	614.00	613.81
F1005	15600.00	976.58	618.50	618.43
F1006	15600.00	1001.83	618.50	618.42
F1007	15600.00	1020.54	613.15	613.94
F1101	15500.00	866.73	585.81	585.69
F1102	15500.00	916.06	599.91	599.75
F1103	15500.00	965.38	614.00	613.70
F1104	15500.00	975.46	614.00	613.81
F1105	15500.00	975.46	618.50	618.40
F1106	15500.00	1000.72	618.50	618.37
F1107	15500.02	1020.41	612.87	613.37
F1201	15400.00	862.70	584.98	584.93
F1202	15400.00	913.48	599.49	599.29
F1203	15400.00	964.27	614.00	613.73
F1204	15400.00	974.35	614.00	613.78
F1205	15400.00	974.35	618.50	618.32
F1206	15400.00	999.60	618.50	618.32
F1207	15399.98	1028.62	610.20	611.46
F1301	15300.00	858.67	584.15	583.89
F1302	15300.00	910.91	599.08	598.88
F1303	15300.00	963.15	614.00	613.76
F1304	15300.00	973.23	614.00	613.83
F1305	15300.00	973.23	618.50	618.38
F1306	15300.00	998.48	618.50	618.12
F1307	15300.00	1032.07	608.91	610.62
F1401	15200.00	854.65	583.32	583.20
F1402	15200.00	908.34	598.66	598.57
F1403	15200.00	962.03	614.00	613.76
F1404	15200.00	972.12	614.00	613.80
F1405	15200.00	972.12	618.50	618.27
F1406	15200.00	997.37	618.50	618.45
F1407	15199.99	1026.69	610.12	611.00
F1501	15100.00	850.62	582.49	582.35
F1502	15100.00	905.77	598.24	598.08
F1503	15100.00	960.92	614.00	613.65
F1504	15100.00	971.00	614.00	613.79
F1505	15100.00	971.00	618.50	618.43
F1506	15100.00	996.25	618.50	618.33
F1507	15099.99	1029.67	608.96	611.29
F1601	15000.00	846.59	581.66	581.56
F1602	15000.00	903.20	597.83	597.75
F1603	15000.00	959.80	614.00	613.69
F1604	15000.00	969.88	614.00	613.88
F1605	15000.00	969.88	618.50	618.37
F1606	15000.00	995.13	618.50	618.28
F1607	15000.03	1043.53	604.67	611.24
F1701	14900.00	842.57	580.83	580.78
F1702	14900.00	900.63	597.41	597.33
F1703	14900.00	958.69	614.00	613.84
F1704	14900.00	968.77	614.00	613.82
F1705	14900.00	968.77	618.50	618.39

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F1706	14900.00	994.02	618.50	618.33
F1707	14900.00	1028.15	608.75	611.74
F1801	14813.44	839.08	580.21	579.97
F1802	14782.32	869.87	589.00	588.95
F1803	14781.16	957.36	614.00	613.89
F1804	14781.02	967.44	614.00	613.98
F1805	14781.02	967.44	618.50	618.33
F1806	14780.69	992.69	618.50	618.30
F1807	14780.28	1021.66	610.22	612.15
F1901	14813.44	839.08	580.21	579.95
F1902	14782.32	869.87	589.00	588.94
F1903	14694.82	870.06	614.00	613.79
F1904	14684.74	870.09	614.00	613.82
F1905	14684.74	870.09	618.50	618.35
F1906	14659.49	870.14	618.50	618.28
F1907	14631.04	870.23	610.37	618.75
F2001	14814.22	800.00	579.88	579.87
F2002	14754.51	800.00	596.94	596.83
F2003	14694.80	800.00	614.00	613.87
F2004	14684.72	800.00	614.00	613.81
F2005	14684.72	800.00	618.50	618.21
F2006	14659.47	800.00	618.50	618.43
F2007	14625.16	799.98	608.69	617.10
F2101	14816.20	700.00	579.31	579.28
F2102	14755.49	700.00	596.65	596.51
F2103	14694.78	700.00	614.00	613.87
F2104	14684.70	700.00	614.00	613.87
F2105	14684.70	700.00	618.50	618.46
F2106	14659.45	700.00	618.50	618.31
F2107	14604.09	699.98	602.68	617.45
F2201	14815.21	600.00	579.59	579.48
F2202	14754.98	600.00	596.79	596.47
F2203	14694.76	600.00	614.00	613.77
F2204	14684.68	600.00	614.00	613.90
F2205	14684.68	600.00	618.50	618.48
F2206	14659.43	600.00	618.50	618.47
F2207	14616.86	600.00	606.34	617.52
F2301	14813.75	500.00	580.00	579.84
F2302	14754.25	500.00	597.00	596.67
F2303	14694.74	500.00	614.00	613.66
F2304	14684.66	500.00	614.00	613.68
F2305	14684.66	500.00	618.50	618.35
F2306	14659.41	500.00	618.50	618.47
F2307	14628.55	499.97	609.69	617.85
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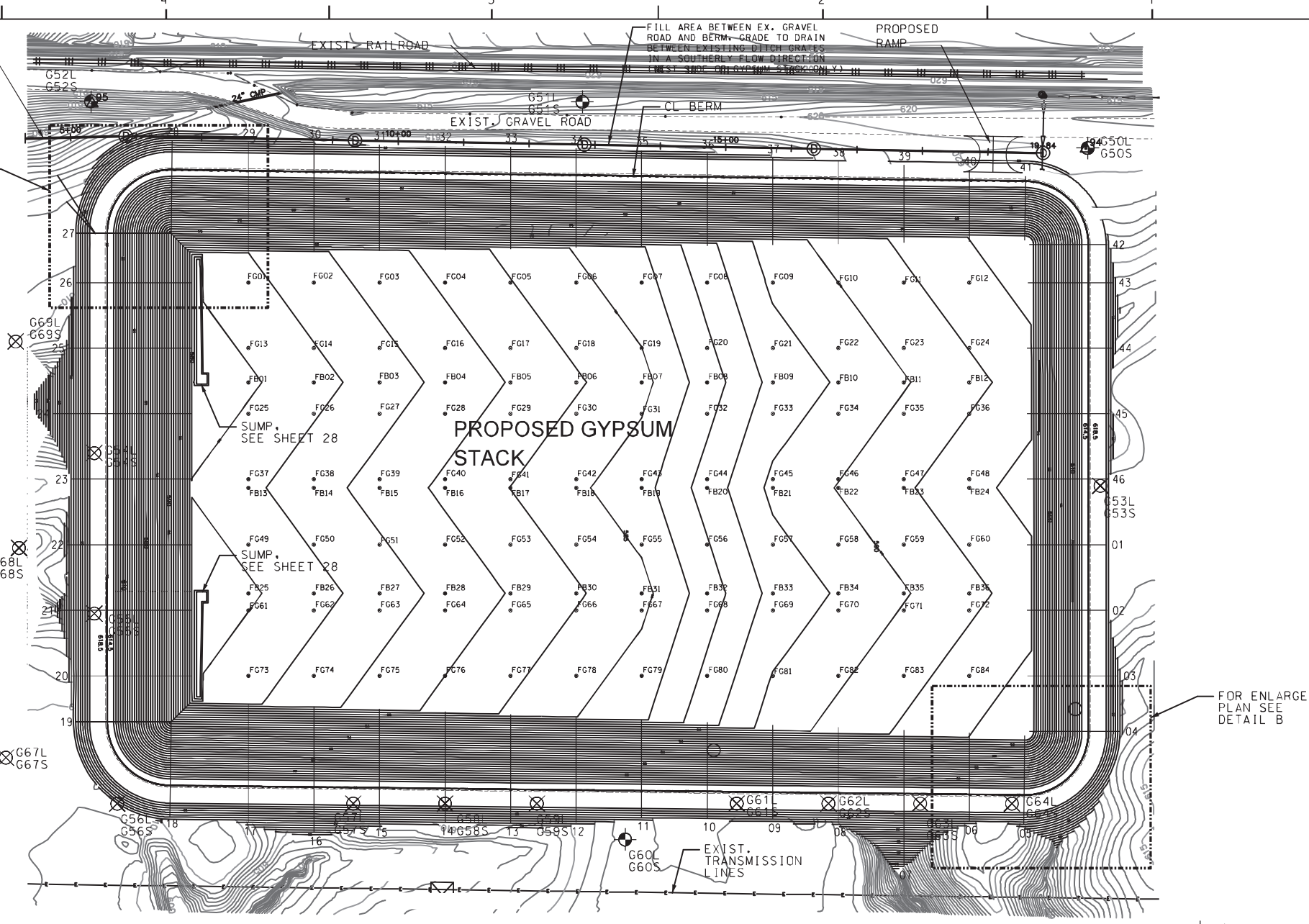
F2402	14755.21	400.00	596.72	596.41
F2403	14694.72	400.00	614.00	613.71
F2404	14684.64	400.00	614.00	613.74
F2405	14684.64	400.00	618.50	618.37
F2406	14659.39	400.00	618.50	618.39
F2407	14575.59	399.99	594.55	611.78
F2501	14815.59	300.00	579.46	579.37
F2502	14755.14	300.00	596.73	596.50
F2503	14694.70	300.00	614.00	613.66
F2504	14684.62	300.00	614.00	613.78
F2505	14684.62	300.00	618.50	618.43
F2506	14659.37	300.00	618.50	618.19
F2507	14620.64	299.98	607.44	616.64
F2601	14813.56	200.00	580.03	579.89
F2602	14754.12	200.00	597.02	596.76
F2603	14694.68	200.00	614.00	613.71
F2604	14684.60	200.00	614.00	613.92
F2605	14684.60	200.00	618.50	618.35
F2606	14659.35	200.00	618.50	618.27
F2607	14631.96	199.98	610.68	617.40
F2701	14812.67	156.13	580.28	580.17
F2702	14782.16	125.21	589.00	588.97
F2703	14694.66	125.04	614.00	613.87
F2704	14684.58	125.02	614.00	613.79
F2705	14684.58	125.02	618.50	618.43
F2706	14659.33	124.97	618.50	618.20
F2707	14635.10	124.92	611.57	614.44
F2801	14812.67	156.13	580.28	580.21
F2802	14782.16	125.21	589.00	588.96
F2803	14783.14	37.72	614.00	613.81
F2804	14783.25	27.64	614.00	613.79
F2805	14783.25	27.64	618.50	618.42
F2806	14783.53	2.39	618.50	618.22
F2807	14783.96	-34.35	608.00	610.18
F2901	14900.00	154.79	581.00	581.00
F2902	14900.00	97.03	597.50	597.36
F2903	14900.00	39.27	614.00	613.93
F2904	14900.00	29.19	614.00	613.98
F2905	14900.00	29.19	618.50	618.11
F2906	14900.00	3.94	618.50	618.45
F2907	14900.00	-23.80	610.57	613.06
F3001	15000.00	153.27	581.81	581.73
F3002	15000.00	96.94	597.91	597.64
F3003	15000.00	40.61	614.00	613.86
F3004	15000.00	30.53	614.00	613.95
F3005	15000.00	30.53	618.50	618.43
F3006	15000.00	5.28	618.50	618.36
F3007	14999.97	-14.01	613.00	614.78
F3101	15100.00	151.74	582.63	582.56
F3102	15100.00	96.84	598.32	598.32
F3103	15100.00	41.94	614.00	613.93
F3104	15100.00	31.86	614.00	613.87
F3105	15100.00	31.86	618.50	618.29
F3106	15100.00	6.61	618.50	618.15
F3107	15100.02	-8.95	614.06	614.92
F3201	15200.00	150.22	583.45	583.22
F3202	15200.00	96.75	598.72	598.64
F3203	15200.00	43.28	614.00	613.96
F3204	15200.00	33.19	614.00	613.93
F3205	15200.00	33.19	618.50	618.39
F3206	15200.00	7.94	618.50	618.30
F3207	15199.98	-7.68	614.03	615.32
F3301	15300.00	148.69	584.26	584.18
F3302	15300.00	96.65	599.13	599.11
F3303	15300.00	44.61	614.00	613.96
F3304	15300.00	34.53	614.00	613.96
F3305	15300.00	34.53	618.50	618.32
F3306	15300.00	9.28	618.50	618.15
F3307	15300.02	-5.09	614.39	615.54
F3401	15400.00	147.17	585.08	584.94
F3402	15400.00	96.55	599.54	599.46
F3403	15400.00	45.94	614.00	613.92

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F3404	15400.00	35.86	614.00	613.89
F3405	15400.00	35.86	618.50	618.35
F3406	15400.00	10.61	618.50	618.30
F3407	15299.99	-4.81	614.10	615.48
F3501	15500.00	145.64	585.90	585.79
F3502	15500.00	96.46	599.95	599.88
F3503	15500.00	47.28	614.00	613.88
F3504	15500.00	37.19	614.00	613.95
F3505	15500.00	37.19	618.50	618.35
F3506	15500.00	11.94	618.50	618.28
F3507	15399.98	-3.03	614.22	616.45
F3601	15600.00	140.54	587.74	587.67
F3602	15600.00	96.36	600.36	600.28
F3603	15600.00	48.61	614.00	613.87
F3604	15600.00	38.53	614.00	613.95
F3605	15600.00	38.53	618.50	618.43
F3606	15600.00	13.28	618.50	618.13
F3607	15600.01	0.68	614.90	617.26
F3701	15700.00	135.44	589.57	589.38
F3702	15700.00	96.27	600.77	600.75
F3703	15700.00	49.94	614.00	613.94
F3704	15700.00	39.86	614.00	613.84
F3705	15700.00	39.86	618.50	618.31
F3706	15700.00	14.61	618.50	618.16
F3707	15699.99	6.05	616.06	618.25
F3801	15800.00	133.92	590.39	590.28
F3802	15800.00	96.17	601.17	600.92
F3803	15800.00	51.28	614.00	613.73
F3804	15800.00	41.20	614.00	613.78
F3805	15800.00	41.20	618.50	618.39
F3806	15800.00	15.94	618.50	618.48
F3807	15799.99	13.41	617.77	619.70
F3901	15900.00	132.39	591.21	591.17
F3902	15900.00	96.07	601.58	601.40
F3903	15900.00	52.61	614.00	613.83
F3904	15900.00	42.53	614.00	613.99
F3905	15900.00	42.53	618.50	618.41
F3906	15900.00	17.28	618.50	618.27
F3907	15899.97	14.63	619.26	620.26
F4001	16000.00	130.87	592.02	591.82
F4002	16000.00	95.98	601.99	601.75
F4003	16000.00	53.94	614.00	613.93
F4004	16000.00	43.86	614.00	613.91
F4005	16000.00	43.86	618.50	618.37
F4006	16000.00	18.61	618.50	618.28
F4007	15999.98	13.17	620.06	620.37
F4101	16084.55	129.59	592.71	592.70
F4102	16085.00	95.91	602.34	602.23
F4103	16085.54	55.08	614.00	613.89
F4104	16085.68	45.00	614.00	613.91
F4105	16085.68	45.00	618.50	618.34
F4106	16086.02	19.76	618.50	618.11
F4107	16086.08	13.77	620.21	620.54
F4201	16097.17	142.27	592.74	592.52
F4202	16130.77	142.26	602.34	602.02
F4203	16171.58	142.25	614.00	613.64
F4204	16181.66	142.25	614.00	613.89
F4205	16181.66	142.25	618.50	618.49
F4206	16206.91	142.24	618.50	618.30
F4207	16214.67	142.24	616.28	619.55
F4301	16095.97	200.00	592.39	592.38
F4302	16130.18	200.00	602.17	601.94
F4303	16171.60	200.00	614.00	613.94
F4304	16181.68	200.00	614.00	613.93
F4305	16181.68	200.00	618.50	618.31
F4306	16206.93	200.00	618.50	618.44
F4307	16223.64	199.97	613.72	618.76
F4401	16093.88	300.00	591.79	591.57
F4402	16129.15	300.00	601.86	601.47
F4403	16171.63	300.00	614.00	613.88
F4404	16181.71	300.00	614.00	613.82
F4405	16181.71	300.00	618.50	618.42
F4406	16206.96	300.00	618.50	618.45
F4407	16223.86	300.00	613.66	618.51
F4501	16093.81	400.00	591.76	591.75
F4502	16129.13	400.00	601.85	601.64
F4503	16171.66	400.00	614.00	613.61
F4504	16181.74	400.00	614.00	613.62
F4505	16181.74	400.00	618.50	618.41
F4506	16206.99	400.00	618.50	618.48
F4507	16219.15	400.02	615.01	618.75
F4601	16095.96	500.00	592.36	592.32
F4602	16130.22	500.00	602.15	601.93
F4603	16171.69	500.00	614.00	613.80
F4604	16181.77	500.00	614.00	613.86
F4605	16181.77	500.00	618.50	618.39
F4606	16207.02	500.00	618.50	618.42
F4607	16214.87	500.01	616.27	617.97
FB01	14900.00	352.42	579.83	579.50
FB02	15000.00	352.42	580.64	580.45
FB03	15100.00	352.42	581.45	581.24
FB04	15200.00	352.42	582.26	582.22
FB05	15300.00	352.42	583.06	582.98
FB06	15400.00	352.42	583.87	583.69
FB07	15500.00	352.42	584.68	584.44
FB08	15600.00	352.42	586.49	586.24
FB09	15700.00	352.42	588.30	588.08
FB10	15800.00	352.42	589.10	588.95
FB11	15900.00	352.42	589.91	589.89
FB12	16000.00	352.42	590.72	590.64
FB13	14900.00	513.35	580.78	580.38
FB14	15000.00	513.35	581.59	581.25
FB15	15100.00	513.35	582.40	582.32
FB16	15200.00	513.35	583.21	583.08
FB17	15300.00	513.35	584.01	584.00
FB18	15400.00	513.35	584.82	584.74
FB19	15500.00	513.35	585.63	585.53
FB20	15600.00	513.35	587.44	587.26
FB21	15700.00	513.35	589.24	589.05
FB22	15800.00	513.35	590.05	589.78
FB23	15900.00	513.35	590.86	590.62
FB24	16000.00	513.35	591.67	591.39
FB25	14900.00	674.29	579.83	579.69
FB26	15000.00	674.29	580.64	580.47
FB27	15100.00	674.29	581.45	581.42
FB28	15200.00	674.29	582.26	582.06
FB29	15300.00	674.29	583.07	582.93

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
FB30	15400.00	674.29	583.87	583.66
FB31	15500.00	674.29	584.68	584.50
FB32	15600.00	674.29	586.49	586.28
FB33	15700.00	674.29	588.30	588.21
FB34	15800.00	674.29	589.10	588.95
FB35	15900.00	674.29	589.91	589.81
FB36	16000.00	674.29	590.72	590.51
FG01	14900.00	200.00	580.73	580.50
FG02	15000.00	200.00	581.54	581.17
FG03	15100.00	200.00	582.35	582.15
FG04	15200.00	200.00	583.15	583.01
FG05	15300.00	200.00	583.96	583.91
FG06	15400.00	200.00	584.77	584.43
FG07	15500.00	200.00	585.58	585.40
FG08	15600.00	200.00	587.39	587.18
FG09	15700.00	200.00	589.19	589.14
FG10	15800.00	200.00	590.00	589.85
FG11	15900.00	200.00	590.81	590.59
FG12	16000.00	200.00	591.62	591.40
FG13	14900.00	300.00	580.14	580.01
FG14	15000.00	300.00	580.95	580.68
FG15	15100.00	300.00	581.76	581.61
FG16	15200.00	300.00	582.57	582.52
FG17	15300.00	300.00	583.37	583.29
FG18	15400.00	300.00	584.18	584.10
FG19	15500.00	300.00	584.99	584.80
FG20	15600.00	300.00	586.80	586.62
FG21	15700.00	300.00	588.60	588.48
FG22	15800.00	300.00	589.41	589.33
FG23	15900.00	300.00	590.22	590.13
FG24	16000.00	300.00	591.03	591.03
FG25	14900.00	400.00	580.11	580.11
FG26	15000.00	400.00	580.92	580.78
FG27	15100.00	400.00	581.73	581.55
FG28	15200.00	400.00	582.54	582.42
FG29	15300.00	400.00	583.34	583.21
FG30	15400.00	400.00	584.15	584.05
FG31	15500.00	400.00	584.96	584.74
FG32	15600.00	400.00	586.77	586.65
FG33	15700.00	400.00	588.58	588.49
FG34	15800.00	400.00	589.38	589.32
FG35	15900.00	400.00	590.19	590.14
FG36	16000.00	400.00	591.00	590.87
FG37	14900.00	500.00	580.70	580.46
FG38	15000.00	500.00	581.51	581.30
FG39	15100.00	500.00	582.32	582.10
FG40	15200.00	500.00	583.13	583.07
FG41	15300.00	500.00	583.93	583.81
FG42	15400.00	500.00	584.74	584.39
FG43	15500.00	500.00	585.55	585.47
FG44	15600.00	500.00	587.36	587.35
FG45	15700.00	500.00	589.17	588.77
FG46	15800.00	500.00	589.97	589.84
FG47	15900.00	500.00	590.78	590.72
FG48	16000.00	500.00	591.59	591.28
FG49	14900.00	600.00	580.27	580.18
FG50	15000.00	600.00	581.08	580.89
FG51	15100.00	600.00	581.89	581.71
FG52	15200.00	600.00	582.70	582.56
FG53	15300.00	600.00	583.50	583.45
FG54	15400.00	600.00	584.31	584.25
FG55	15500.00	600.00	585.12	584.75
FG56	15600.00	600.00	586.93	586.75
FG57	15700.00	600.00	588.73	588.52
FG58	15800.00	600.00	589.54	589.41
FG59	15900.00	600.00	590.35	590.21
FG60	16000.00	600.00	591.16	590.91
FG61	14900.00	700.00	579.99	579.83
FG62	15000.00	700.00	580.79	580.44
FG63	15100.00	700.00	581.60	581.34
FG64	15200.00	700.00	582.41	582.31
FG65	15300.00	700.00	583.22	583.05
FG66	15400.00	700.00	584.02	583.64
FG67	15500.00	700.00	584.83	584.58
FG68	15600.00	700.00	586.64	586.37
FG69	15700.00	700.00	588.45	588.13
FG70	15800.00	700.00	589.26	588.99
FG71	15900.00	700.00	590.06	589.98
FG72	16000.00	700.00	590.87	590.75
FG73	14900.00	800.00	580.57	580.46
FG74	15000.00	800.00	581.38	581.22
FG75	15100.00	800.00	582.19	582.05
FG76	15200.00	800.00	583.00	582.86
FG77	15300.00	800.00	583.81	583.66
FG78	15400.00	800.00	584.61	584.46
FG79	15500.00	800.00	585.42	585.34
FG80	15600.00	800.00	587.23	587.14
FG81	15700.00	800.00	589.04	588.70
FG82	15800.00	800.00	589.84	589.50
FG83	15900.00	800.00	590.65	590.50
FG84	16000.00	800.00	591.46	591.42



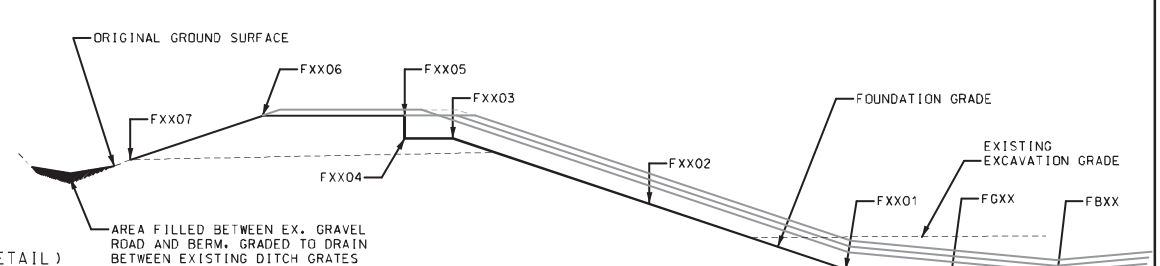
NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.

TYPICAL POINT NUMBER LOCATION

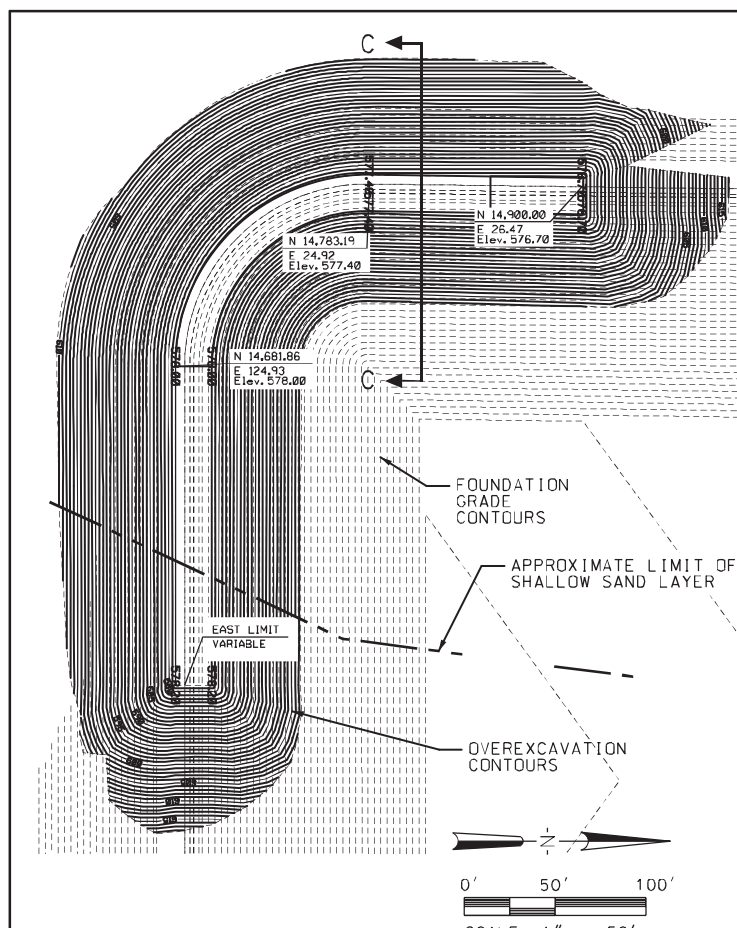
FB 00 — GRID POINT NUMBER; FOUNDATION GRADE (BREAK POINT)

FG 00 — GRID POINT NUMBER; FOUNDATION GRADE

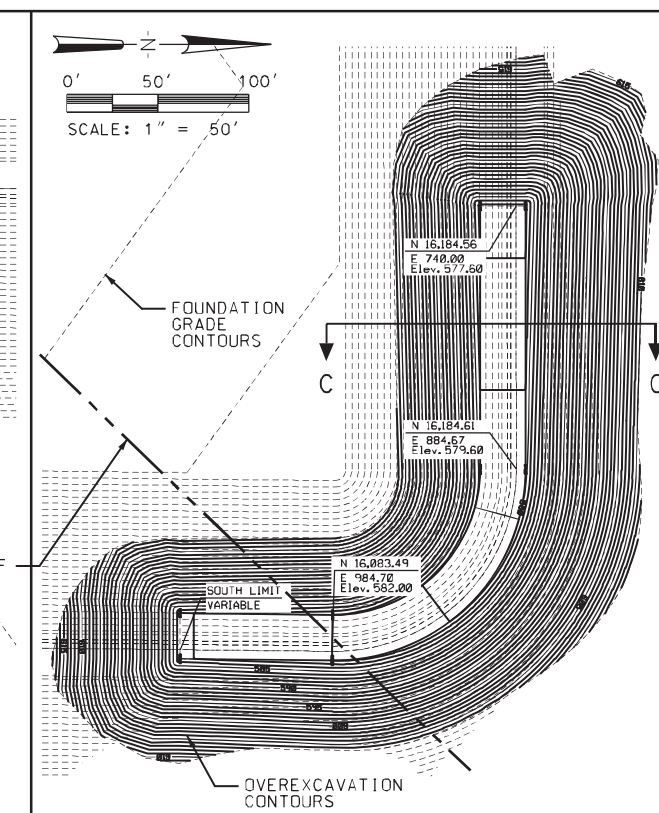
F 00 00 — POINT NUMBER (SEE POINT NUMBERING DETAIL); CONTROL LINE NUMBER; FOUNDATION GRADE



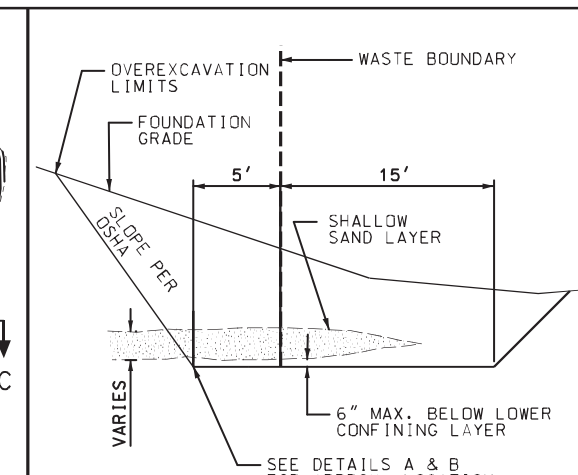
POINT NUMBERING DETAIL



DETAIL A



DETAIL B



DETAIL C

NOTES:

1. GRADES ARE APPROXIMATE BASED ON AVAILABLE GEOTECHNICAL DATA. ACTUAL GRADE TO FULLY EXCAVATE THE SHALLOW SAND LAYER SHALL BE APPROX. 6" BELOW THE LAYER AS SHOWN ABOVE.
2. CONTRACTOR SHALL EXCAVATE TO THE LATERAL LIMITS OF THE SHALLOW SAND LAYER. GRADE LOCATIONS MAY CHANGE BASED UPON THE ACTUAL EXCAVATION REQUIRED TO CUT OFF THE LAYER AS SHOWN ON THE DETAIL ABOVE.

RECORD DRAWING

FILE NO. -C180-C102-08.dgn

AEG CAD GENERATED DO NOT REVISE MANUALLY

REFER TO OTHER PLAN SHEETS FOR STANDARD LEGEND

Brans00939 09\4\2009 I:\03 Jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-08.dgn

LAYOUT	SMB	05/08/07
DRAWN	SKB	02-21-08
REVIEWED		

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	CORRECTIONS TO TABLE - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	04-18-08	SKB	SMB	SMB	REVISED OVER EXCAVATION LIMITS
4	07-17-08	SKB	SMB	SMB	REVISED ELEVATION FOR POINT F0304 TO BE 614.0
5	07-25-08	DBH	SMB	SMB	RAISED FOUNDATION FLOOR ELEV. TWO FEET AT ALL POINTS NORTH OF N15500
					INCLUDE REVISED CONTOURS AND POINT TABLE
6	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
–	–	–	–	–	

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

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SCALE –
DRAFTER –
DATE 03-26-09

DRAWING TITLE

GYPSUM STACK-FOUNDATION GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. –

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 6

30x42

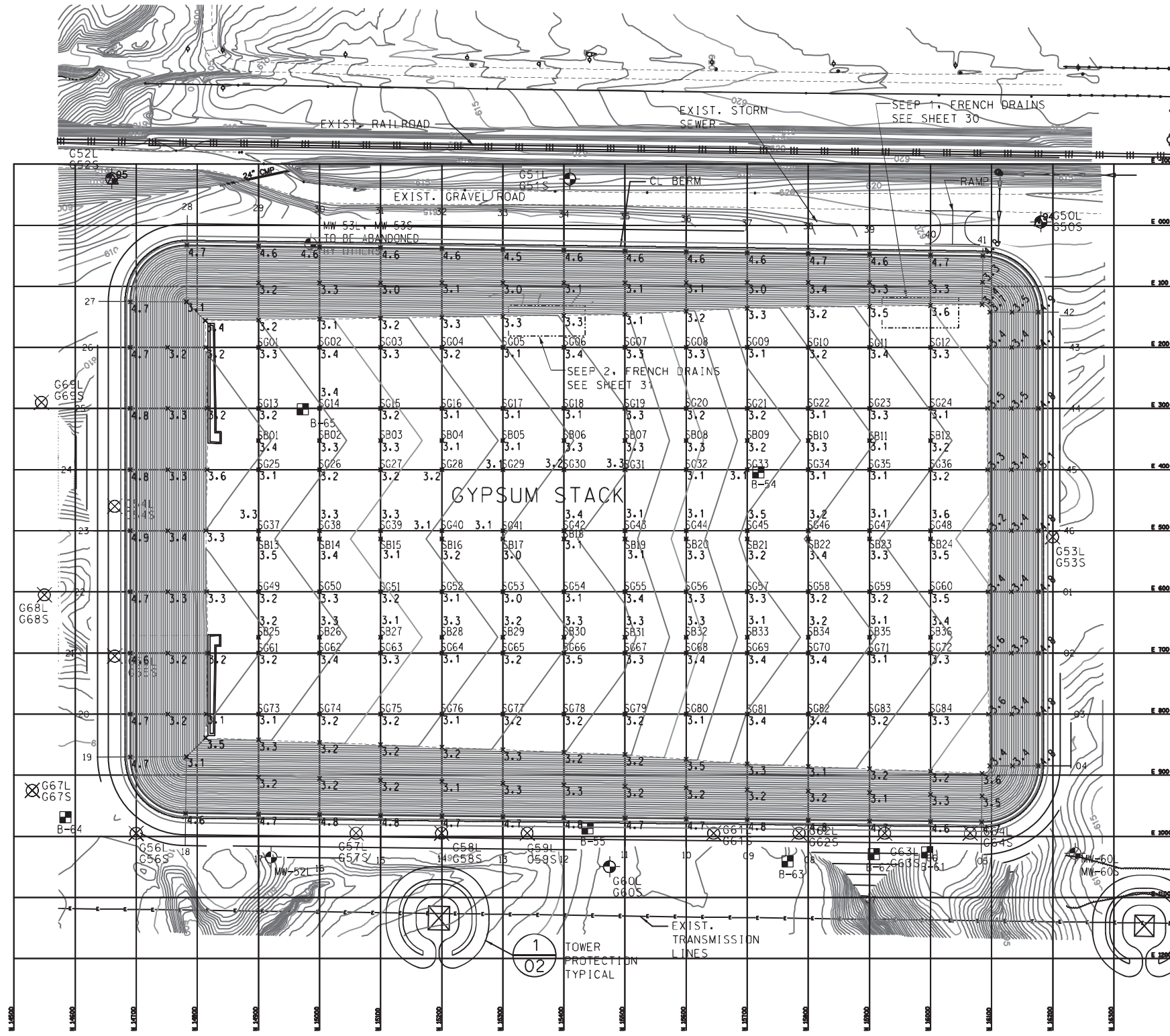
Electronic Filing: Received, Clerk's Office 06/20/2024

PAGE NO. - 09

C180-C102

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS	CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS	CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS
S0101	16094.01	600.00	594.92	595.29	3.4	S4001	16000.00	131.30	595.02	595.38	3.6	SG61	14900.00	700.00	582.99	582.99	3.2
S0102	16131.93	600.00	605.75	605.94	3.4	S4002	16000.00	93.78	605.74	605.83	3.3	SG62	15000.00	700.00	583.79	583.88	3.4
S0103	16176.55	600.00	618.50	618.66	4.8	S4003	16000.00	49.11	618.50	618.58	4.7	SG63	15100.00	700.00	584.60	584.62	3.3
S0201	16093.01	700.00	594.62	595.01	3.6	S4101	16084.55	130.01	595.71	596.11	3.4	SG64	15200.00	700.00	585.41	585.45	3.1
S0202	16131.96	700.00	605.75	605.83	3.3	S4102	16085.04	92.92	606.31	606.49	3.3	SG65	15300.00	700.00	586.22	586.24	3.2
S0203	16176.58	700.00	618.50	618.59	4.8	S4103	16085.61	50.25	618.50	618.66	4.8	SG66	15400.00	700.00	587.02	587.09	3.5
S0301	16095.16	800.00	595.23	595.72	3.6	S4201	16096.74	142.27	595.74	596.24	3.7	SG67	15500.00	700.00	587.83	587.92	3.3
S0302	16132.64	800.00	605.94	606.02	3.4	S4202	16133.75	142.26	606.31	606.47	3.5	SG68	15600.00	700.00	589.64	589.73	3.4
S0303	16176.61	800.00	618.50	618.68	4.8	S4203	16176.41	142.25	618.50	618.70	4.9	SG69	15700.00	700.00	591.45	591.50	3.4
S0401	16096.98	884.70	595.74	596.05	3.4	S4301	16095.54	200.00	595.39	595.74	3.4	SG70	15800.00	700.00	592.26	592.34	3.4
S0402	16133.97	884.69	606.31	606.33	3.4	S4302	16132.87	200.00	606.05	606.20	3.4	SG71	15900.00	700.00	593.06	593.07	3.1
S0403	16176.64	884.68	618.50	618.70	4.8	S4303	16176.43	200.00	618.50	618.61	4.7	SG72	16000.00	700.00	593.87	594.03	3.3
S0501	16084.47	896.97	595.71	596.24	3.6	S4401	16093.45	300.00	594.78	595.08	3.5	SG73	14900.00	800.00	583.57	583.57	3.1
S0502	16084.06	934.06	606.31	606.41	3.5	S4402	16131.83	300.00	605.75	605.94	3.5	SG74	15000.00	800.00	584.38	584.45	3.2
S0503	16083.58	976.73	618.50	618.65	4.7	S4403	16176.46	300.00	618.50	618.64	4.8	SG75	15100.00	800.00	585.19	585.20	3.2
S0601	16000.00	893.58	595.01	595.08	3.2	S4501	16093.38	400.00	594.75	595.01	3.3	SG76	15200.00	800.00	586.00	586.00	3.1
S0602	16000.00	931.11	605.73	605.74	3.3	S4502	16131.87	400.00	605.75	605.91	3.4	SG77	15300.00	800.00	586.81	586.82	3.2
S0603	16000.00	975.79	618.50	618.51	4.6	S4503	16176.49	400.00	618.50	618.68	5.1	SG78	15400.00	800.00	587.61	587.70	3.2
S0701	15900.00	889.55	594.18	594.28	3.2	S4601	16095.53	500.00	595.36	595.55	3.2	SG79	15500.00	800.00	588.42	588.52	3.2
S0702	15900.00	928.54	605.32	605.41	3.1	S4602	16131.90	500.00	605.75	605.92	3.4	SG80	15600.00	800.00	590.23	590.29	3.1
S0703	15900.00	974.68	618.50	618.50	4.7	S4603	16176.52	500.00	618.50	618.59	4.8	SG81	15700.00	800.00	592.04	592.13	3.4
S0801	15800.00	885.53	593.35	593.44	3.1	SB01	14900.00	352.42	582.83	582.85	3.4	SG82	15800.00	800.00	592.84	592.90	3.4
S0802	15800.00	925.97	604.90	604.98	3.2	SB02	15000.00	352.42	583.64	583.71	3.3	SG83	15900.00	800.00	593.65	593.69	3.2
S0803	15800.00	973.56	618.50	618.55	4.8	SB03	15100.00	352.42	584.45	584.49	3.3	SG84	16000.00	800.00	594.46	594.76	3.3
S0901	15700.00	881.50	592.52	592.61	3.3	SB04	15200.00	352.42	585.26	585.32	3.1						
S0902	15700.00	923.40	604.49	604.57	3.2	SB05	15300.00	352.42	586.06	586.06	3.1						
S0903	15700.00	972.45	618.50	618.57	4.8	SB06	15400.00	352.42	586.87	586.97	3.3						
S1001	15600.00	873.90	590.66	590.75	3.5	SB07	15500.00	352.42	587.68	587.76	3.3						
S1002	15600.00	920.83	604.07	604.16	3.2	SB08	15600.00	352.42	589.49	589.54	3.3						
S1003	15600.00	971.33	618.50	618.51	4.7	SB09	15700.00	352.42	591.30	591.31	3.2						
S1101	15500.00	866.30	588.81	588.90	3.2	SB10	15800.00	352.42	592.10	592.20	3.3						
S1102	15500.00	918.26	603.66	603.72	3.2	SB11	15900.00	352.42	592.91	593.03	3.1						
S1103	15500.00	970.21	618.50	618.50	4.7	SB12	16000.00	352.42	593.72	593.88	3.2						
S1201	15400.00	862.27	587.98	588.08	3.2	SB13	14900.00	513.35	583.78	583.86	3.5						
S1202	15400.00	915.68	603.24	603.30	3.3	SB14	15000.00	513.35	584.59	584.66	3.4						
S1203	15400.00	969.10	618.50	618.51	4.8	SB15	15100.00	513.35	585.40	585.41	3.1						
S1301	15300.00	858.25	587.15	587.19	3.3	SB16	15200.00	513.35	586.21	586.26	3.2						
S1302	15300.00	913.11	602.82	602.89	3.3	SB17	15300.00	513.35	587.01	587.04	3.0						
S1303	15300.00	967.98	618.50	618.51	4.7	SB18	15400.00	513.35	587.82	587.86	3.1						
S1401	15200.00	854.22	586.32	586.41	3.2	SB19	15500.00	513.35	588.63	588.65	3.1						
S1402	15200.00	910.54	602.41	602.41	3.1	SB20	15600.00	513.35	590.44	590.55	3.3						
S1403	15200.00	966.87	618.50	618.51	4.7	SB21	15700.00	513.35	592.24	592.26	3.2						
S1501	15100.00	850.19	585.49	585.59	3.2	SB22	15800.00	513.35	593.05	593.14	3.4						
S1502	15100.00	907.97	601.99	602.01	3.2	SB23	15900.00	513.35	593.86	593.91	3.3						
S1503	15100.00	965.75	618.50	618.52	4.8	SB24	16000.00	513.35	594.67	594.85	3.5						
S1601	15000.00	846.17	584.65	584.73	3.2	SB25	14900.00	674.29	582.83	582.91	3.2						
S1602	15000.00	905.40	601.58	601.65	3.2	SB26	15000.00	674.29	583.64	583.72	3.3						
S1603	15000.00	964.63	618.50	618.57	4.8	SB27	15100.00	674.29	584.45	584.47	3.1						
S1701	14900.00	842.14	583.82	584.08	3.3	SB28	15200.00	674.29	585.26	585.35	3.3						
S1702	14900.00	903.35	601.31	601.39	3.2	SB29	15300.00	674.29	586.07	586.09	3.2						
S1703	14900.00	963.52	618.50	618.50	4.7	SB30	15400.00	674.29	586.87	586.95	3.3						
S1801	14813.86	838.67	583.11	583.51	3.5	SB31	15500.00	674.29	587.68	587.75	3.3						
S1802	14782.32	869.87	592.12	592.18	3.1	SB32	15600.00	674.29	589.49	589.59	3.3						
S1803	14781.09	962.19	618.50	618.54	4.6	SB33	15700.00	674.29	591.30	591.34	3.1						
S1901	14813.86	838.67	583.11	583.51	3.5	SB34	15800.00	674.29	592.10	592.19	3.2						
S1902	14782.32	869.87	592.12	592.16	3.1	SB35	15900.00	674.29	592.91	592.92	3.1						
S1903	14689.99	870.07	618.50	618.52	4.7	SB36	16000.00	674.29	593.72	593.94	3.4						
S2001	14814.62	800.00	582.89	582.98	3.1	SG01	14900.00	200.00	583.73	583.84	3.3						
S2002	14752.10	800.00	600.75	600.82	3.2	SG02	15000.00	200.00	584.54	584.56	3.4						
S2003	14689.97	800.00	618.50	618.58	4.7	SG03	15100.00	200.00	585.35	585.42	3.3						
S2101	14816.61	700.00	582.31	582.51	3.2	SG04	15200.00	200.00	586.15	586.21	3.2						
S2102	14752.08	700.00	600.75	600.80	3.2	SG05	15300.00	200.00	586.96	587.04	3.1						
S2103	14689.95	700.00	618.50	618.50	4.6	SG06	15400.00	200.00	587.77	587.81	3.4						
S2201	14815.61	600.00	582.59	582.75	3.3	SG07	15500.00	200.00	588.58	588.66	3.3						
S2202	14752.06	600.00	600.75	600.76	3.3	SG08	15600.00	200.00	590.39	590.43	3.3						
S2203	14689.93	600.00	618.50	618.50	4.7	SG09	15700.00	200.00	592.19	592.26	3.1						
S2301	14814.16	500.00	583.00	583.15	3.3	SG10	15800.00	200.00	593.00	593.07	3.2						
S2302	14752.03	500.00	600.75	600.78	3.4	SG11	15900.00	200.00	593.81	594.03	3.4						
S2303	14689.91	500.00	618.50	618.52	4.9	SG12	16000.00	200.00	594.62	594.69	3.3						
S2401	14816.11	400.00	582.44	582.87	3.6	SG13	14900.00	300.00	583.14	583.21	3.2						
S2402	14752.01	400.00	600.75	600.77	3.3	SG14	15000.00	300.00	583.95	584.05	3.4						
S2403	14689.89	400.00	618.50	618.51	4.8	SG15	15100.00	300.00	584.76	584.77	3.2						
S2501	14815.99	300.00	582.46	582.58	3.2	SG16	15200.00	300.00	585.57	585.67	3.1						
S2502	14751.99	300.00	600.75	600.78	3.3	SG17	15300.00	300.00	586.37	586.41	3.1						
S2503	14689.87	300.00	618.50	618.52	4.8	SG18	15400.00	300.00	587.18	587.22	3.1						
S2601	14813.97	200.00	583.04	583.13	3.2	SG19	15500.00	300.00	587.99	588.09	3.3						
S2602	14751.57	200.00	600.86	600.86	3.2	SG20	15600.00	300.00	589.80	589.81	3.2						
S2603	14689.85	200.00	618.50	618.53	4.7	SG21	15700.00	300.00	591.60	591.65	3.2						
S2701	14813.09	156.55	583.29	583.56	3.4	SG22	15800.00	300.00	592.41	592.45	3.1						
S2702	14782.16	125.21	592.12	592.22	3.1	SG23	15900.00	300.00	593.22	593.41	3.3						
S2703	14689.83	125.03	618.50	618.52	4.7	SG24	16000.00	300.00	594.03	594.10	3.1						
S2801	14813.09	156.55	583.29	583.54	3.4	SG25	14900.00	400.00	583.11	583.23	3.1						
S2802	14782.16	125.21	592.12	592.20	3.1	SG26	15000.00	400.00	583.92	584.00	3.2						
S2803	14783.19	32.89	618.50	618.51	4.7	SG27	15100.00	400.00	584.73	584.75	3.2						
S2901	14900.00	155.22	583.99	584.23	3.2	SG28	15200.00	400.00	585.54	585.61	3.2						
S2902	14900.00	94.62	601.31	601.36	3.2	SG29	15300.00	400.00	586.34	586.35	3.1						
S2903	14900.00	34.44	618.50	618.51	4.6	SG30	15400.00	400.00	587.15	587.23	3.2						
S3001	15000.00	153.70	584.81	584.85	3.1	SG31	15500.00	400.00	587.96	588.05	3.3						
S3002	15000.00	94.74	601.66	601.72	3.3	SG32	15600.00	400.00	589.77	589.80	3.1						
S3003	15000.00	35.78	618.50	618.55	4.6	SG33	15700.00	400.00	591.58	591.64	3.1						
S3101	15100.00	152.17	585.63	585.72	3.2	SG34	15800.00	400.00	592.38	592.45	3.1						
S3102	15100.00	94.64	602.06	602.09	3.0	SG35	15900.00	400.00	593.19	593.26	3.1						
S3103	15100.00	37.11	618.50	618.51	4.6	SG36	16000.00	400.00	594.00	594.07	3.2						
S3201	15200.00	150.65	586.45	586.54	3.3	SG37	14900.00	500.00	583.70	583.77	3.3						
S3202	15200.00	94.55	602.47	602.47	3.1	SG38	15000.00	500.00	584.51	584.58	3.3						
S3203	15200.00	38.44	618.50	618.57	4.6	SG39	15100.00	500.00	585.32	585.36	3.3						
S3301	15300.00	149.12	587.26	587.46	3.3	SG40	15200.00	500.00	586.13	586.19	3.1						
S3302	15300.00	94.45	602.88	602.93	3.0	SG41	15300.00	500.00	586.93	586.95	3.1						
S3303	15300.00	39.78	618.50	618.51	4.5	SG42	15400.00	500.00	587.74	587.82	3.4						
S3401	15400.00	147.60	588.08	588.26	3.3	SG43	15500.00	500.00	588.55	588.60	3.1						
S3402	15400.00	94.35	603.29	603.37	3.1	SG44	15600.00	500.00	590.36	590.43	3.1						
S3403	15400.00	41.11	618.50	618.51	4.6	SG45	15700.00	500.00	592.17	592.23	3.5						
S3501	15500.00	146.07	588.90	588.93	3.1	SG46	15800.00	500.00	592.97	593.05	3.2						
S3502	15500.00	94.26	603.70	603.69	3.1	SG47	15900.00	500.00	593.78	593.79	3.1						
S3503	15500.00	42.45	618.50	618.49	4.6	SG48	16000.00	500.00	594.59	594.83	3.6						
S3601	15600.00	140.97	590.73	590.85	3.2	SG49	14900.00	600.00	583.27	583.37	3.2						
S3602	15600.00	94.16	604.11	604.16	3.1	SG50	15000.00	600.00	584.08	584.17	3.3						
S3603	15600.00	43.78	618.50	618.50	4.6	SG51	15100.00	600.00	584.89	584.95	3.2						
S3701	15700.00	135.87	592.57	592.65	3.3	SG52	15200.00	600.00	585.70	585.70	3.1						
S3702	15700.00	94.07	604.51	604.53	3.0	SG53	15300.00	600.00	586.50	586.50	3.0						
S3703	15700.00	45.11	618.50	618.49	4.6	SG54	15400.00	600.00	587.31	587.39	3.1						
S3801	15800.00	134.35	593.39	593.44	3.2	SG55	15500.00	600.00	588.12	588.18	3.4						
S3802	15800.00	93.97	604.92	604.99	3.4	SG56	15600.00	600.00	589.93	590.03	3.3						
S3803	15800.00	46.45	618.50	618.50	4.7	SG57	15700.00	600.00	591.73	591.81	3.3						
S3901	15900.00	132.82	594.20	594.71	3.5	SG58	15800.00	600.00	592.54	592.57	3.2						
S3902	15900.00	93.87	605.33	605.43	3.3	SG59	15900.00	600.00	593.35	593.44	3.2						
S3903	15900.00	47.78	618.50	618.54	4.6	SG60	16000.00	600.00	594.16	594.43	3.5						

NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.

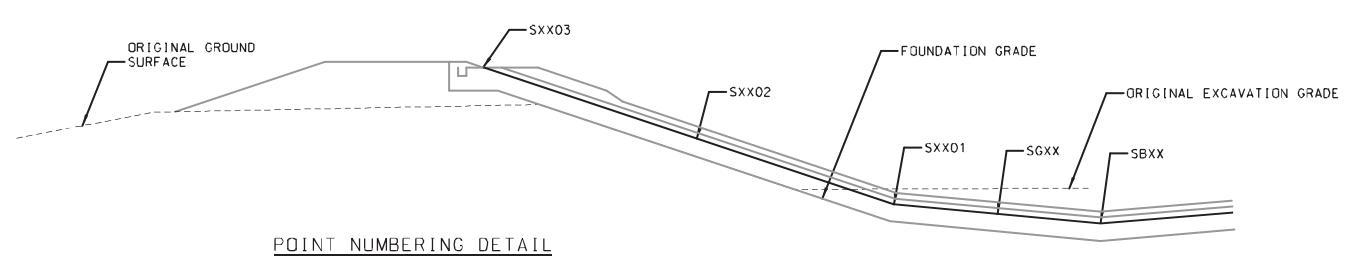


TYPICAL POINT NUMBER LOCATION

SB 00
- GRID POINT NUMBER
- CLAY LAYER GRADE (BREAK POINT)

SG 00
- GRID POINT NUMBER
- CLAY LAYER GRADE

S 00 00
- POINT NUMBER (SEE POINT NUMBERING DETAIL)
- CONTROL LINE NUMBER
- CLAY LAYER GRADE



POINT NUMBERING DETAIL

STANDARD LEGEND

(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- 3.1 CLAY LAYER THICKNESS (IN FEET)

N

0' 100' 200'

SCALE: 1" = 100'

AEG CAD GENERATED
DO NOT REVISE MANUALLY

Brans00939
09\4\2009
I:\03 Jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-09.dgn

LAYOUT	SMB	05/08/07
DRAWN	SKB	03-05-08
REVIEWED		

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-21-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED POINT NO. DETAIL - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	08-29-08	DBH	SMB	SMB	RAISE BOTTOM ELEV. OF NORTH 400' OF CELL-UPDATE CONTOURS & POINT TABLE
4	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	

30x42

RECORD DRAWING

FILE NO. -C180-C102-09.dgn

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

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SCALE -
DRAFTER -
DATE 03-26-09

DRAWING TITLE

GYPSUM STACK - CLAY LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

DRAWING NUMBER C180-C102 REV. 4

SHEET NO. 09 OF 33

Electronic Filing: Received, Clerk's Office 06/20/2024

PAGE NO. - 10

C180-C102

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
D0101	16093.86	600.00	595.92	596.32	1.0
D0102	16131.65	600.00	606.71	606.92	0.9
D0103	16172.91	600.00	618.50	618.67	1.0
D0201	16092.87	700.00	595.62	596.04	1.0
D0202	16131.68	700.00	606.71	606.88	1.1
D0203	16172.94	700.00	618.50	618.70	1.1
D0301	16095.02	800.00	596.23	596.74	1.0
D0302	16132.36	800.00	606.90	607.10	1.1
D0303	16172.97	800.00	618.50	618.71	1.1
D0401	16096.83	884.70	596.74	597.14	1.1
D0402	16133.70	884.69	607.27	607.31	1.0
D0403	16173.00	884.68	618.50	618.72	1.0
D0501	16084.47	896.82	596.71	597.34	1.1
D0502	16084.06	933.79	607.27	607.40	1.0
D0503	16083.62	973.09	618.50	618.69	1.0
D0601	16000.00	893.44	596.01	596.18	1.1
D0602	16000.00	930.84	606.70	606.89	1.2
D0603	16000.00	972.15	618.50	618.58	1.1
D0701	15900.00	889.41	595.18	595.38	1.1
D0702	15900.00	928.27	606.28	606.46	1.1
D0703	15900.00	971.04	618.50	618.56	1.0
D0801	15800.00	885.38	594.35	594.55	1.1
D0802	15800.00	925.70	605.86	606.04	1.1
D0803	15800.00	969.92	618.50	618.56	1.0
D0901	15700.00	881.36	593.52	593.70	1.1
D0902	15700.00	923.12	605.45	605.55	1.0
D0903	15700.00	968.81	618.50	618.61	1.0
D1001	15600.00	873.76	591.66	591.85	1.1
D1002	15600.00	920.55	605.03	605.16	1.1
D1003	15600.00	967.69	618.50	618.67	1.1
D1101	15500.00	866.16	589.81	589.95	1.1
D1102	15500.00	917.98	604.62	604.70	1.0
D1103	15500.00	966.57	618.50	618.50	1.0
D1201	15400.00	862.13	588.98	589.17	1.1
D1202	15400.00	915.41	604.20	604.28	1.0
D1203	15400.00	965.46	618.50	618.53	1.0
D1301	15300.00	858.10	588.15	588.33	1.1
D1302	15300.00	912.84	603.79	603.94	1.1
D1303	15300.00	964.34	618.50	618.62	1.1
D1401	15200.00	854.08	587.32	587.44	1.0
D1402	15200.00	910.27	603.37	603.53	1.1
D1403	15200.00	963.22	618.50	618.61	1.1
D1501	15100.00	850.05	586.49	586.59	1.0
D1502	15100.00	907.70	602.95	603.09	1.1
D1503	15100.00	962.11	618.50	618.58	1.1
D1601	15000.00	846.02	585.65	585.79	1.1
D1602	15000.00	905.12	602.54	602.69	1.1
D1603	15000.00	960.99	618.50	618.61	1.1
D1701	14900.00	842.00	584.82	585.04	1.0
D1702	14900.00	903.07	602.27	602.39	1.0
D1703	14900.00	959.88	618.50	618.70	1.2
D1801	14814.00	838.53	584.11	584.50	1.0
D1802	14782.32	869.87	593.16	593.36	1.1
D1803	14781.03	958.55	618.50	618.58	1.0
D1901	14814.00	838.53	584.11	584.54	1.0
D1902	14782.32	869.87	593.16	593.36	1.1
D1903	14693.63	870.07	618.50	618.62	1.1
D2001	14814.76	800.00	583.89	584.06	1.1
D2002	14752.37	800.00	601.71	601.84	1.1
D2003	14693.61	800.00	618.50	618.65	1.1
D2101	14816.75	700.00	583.31	583.61	1.1
D2102	14752.35	700.00	601.71	601.84	1.1
D2103	14693.59	700.00	618.50	618.65	1.2
D2201	14815.75	600.00	583.59	583.79	1.0
D2202	14752.33	600.00	601.71	601.85	1.1
D2203	14693.57	600.00	618.50	618.52	1.0
D2301	14814.30	500.00	584.00	584.18	1.0
D2302	14752.31	500.00	601.71	601.82	1.1
D2303	14693.55	500.00	618.50	618.68	1.1
D2401	14816.25	400.00	583.44	583.86	1.0
D2402	14752.29	400.00	601.71	601.85	1.1
D2403	14693.53	400.00	618.50	618.68	1.2
D2501	14816.13	300.00	583.46	583.64	1.0
D2502	14752.27	300.00	601.71	601.90	1.1
D2503	14693.51	300.00	618.50	618.67	1.0
D2601	14814.10	200.00	584.04	584.16	1.0
D2602	14751.84	200.00	601.83	601.97	1.1
D2603	14693.49	200.00	618.50	618.67	1.1
D2701	14813.23	156.69	584.29	584.61	1.1
D2702	14782.16	125.21	593.16	593.32	1.1
D2703	14693.47	125.04	618.50	618.68	1.1
D2801	14813.23	156.69	584.29	584.61	1.1
D2802	14782.16	125.21	593.16	593.32	1.1
D2803	14783.15	36.53	618.50	618.67	1.2
D2901	14900.00	155.37	584.99	585.36	1.1
D2902	14900.00	94.89	602.27	602.46	1.1
D2903	14900.00	38.08	618.50	618.63	1.1
D3001	15000.00	153.84	585.81	585.95	1.1
D3002	15000.00	95.01	602.62	602.78	1.1
D3003	15000.00	39.42	618.50	618.61	1.0
D3101	15100.00	152.32	586.63	586.81	1.1
D3102	15100.00	94.92	603.03	603.16	1.1
D3103	15100.00	40.75	618.50	618.68	1.2
D3201	15200.00	150.79	587.44	587.64	1.1
D3202	15200.00	94.82	603.43	603.55	1.1
D3203	15200.00	42.09	618.50	618.70	1.1
D3301	15300.00	149.26	588.26	588.52	1.0
D3302	15300.00	94.72	603.84	603.97	1.1
D3303	15300.00	43.42	618.50	618.63	1.1
D3401	15400.00	147.74	589.08	589.38	1.1
D3402	15400.00	94.63	604.25	604.38	1.1
D3403	15400.00	44.75	618.50	618.66	1.1
D3501	15500.00	146.21	589.89	590.06	1.1
D3502	15500.00	94.53	604.66	604.75	1.1
D3503	15500.00	46.09	618.50	618.61	1.1
D3601	15600.00	141.11	591.73	591.95	1.1
D3602	15600.00	94.44	605.07	605.18	1.1
D3603	15600.00	47.42	618.50	618.64	1.1
D3701	15700.00	136.02	593.57	593.77	1.1
D3702	15700.00	94.34	605.48	605.53	1.0
D3703	15700.00	48.75	618.50	618.60	1.1
D3801	15800.00	134.49	594.39	594.47	1.0
D3802	15800.00	94.24	605.88	605.98	1.0
D3803	15800.00	50.09	618.50	618.58	1.0
D3901	15900.00	132.96	595.20	595.94	1.2
D3902	15900.00	94.15	606.29	606.39	1.0
D3903	15900.00	51.42	618.50	618.54	1.0

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
D4001	16000.00	131.44	596.02	596.39	1.0
D4002	16000.00	94.05	606.70	606.83	1.0
D4003	16000.00	52.75	618.50	618.59	1.0
D4101	16084.54	130.16	596.71	597.11	1.0
D4102	16085.04	93.19	607.27	607.46	1.0
D4103	16085.56	53.89	618.50	618.69	1.0
D4201	16096.59	142.27	596.74	597.31	1.1
D4202	16133.47	142.26	607.27	607.50	1.0
D4203	16172.77	142.25	618.50	618.78	1.1
D4301	16095.39	200.00	596.39	596.84	1.1
D4302	16132.59	200.00	607.02	607.27	1.1
D4303	16172.79	200.00	618.50	618.67	1.1
D4401	16093.30	300.00	595.78	596.21	1.1
D4402	16131.56	300.00	606.71	606.93	1.1
D4403	16172.82	300.00	618.50	618.73	1.1
D4501	16093.23	400.00	595.75	596.06	1.1
D4502	16131.59	400.00	606.71	606.88	1.0
D4503	16172.85	400.00	618.50	618.72	1.1
D4601	16095.39	500.00	596.36	596.65	1.1
D4602	16131.62	500.00	606.71	606.93	1.0
D4603	16172.88	500.00	618.50	618.65	1.1
DB01	14900.00	352.42	583.83	583.91	1.1
DB02	15000.00	352.42	584.64	584.81	1.1
DB03	15100.00	352.42	585.45	585.60	1.1
DB04	15200.00	352.42	586.26	586.37	1.0
DB05	15300.00	352.42	587.06	587.23	1.2
DB06	15400.00	352.42	587.87	588.05	1.1
DB07	15500.00	352.42	588.68	588.84	1.1
DB08	15600.00	352.42	590.49	590.65	1.1
DB09	15700.00	352.42	592.30	592.32	1.0
DB10	15800.00	352.42	593.10	593.22	1.0
DB11	15900.00	352.42	593.91	594.11	1.1
DB12	16000.00	352.42	594.72	594.92	1.0
DB13	14900.00	513.35	584.78	584.95	1.1
DB14	15000.00	513.35	585.59	585.76	1.1
DB15	15100.00	513.35	586.40	586.60	1.2
DB16	15200.00	513.35	587.21	587.41	1.1
DB17	15300.00	513.35	588.01	588.20	1.2
DB18	15400.00	513.35	588.82	588.97	1.1
DB19	15500.00	513.35	589.63	589.79	1.1
DB20	15600.00	513.35	591.44	591.61	1.1
DB21	15700.00	513.35	593.24	593.40	1.1
DB22	15800.00	513.35	594.05	594.21	1.1
DB23	15900.00	513.35	594.86	594.99	1.1
DB24	16000.00	513.35	595.67	595.85	1.0
DB25	14900.00	674.29	583.83	584.03	1.1
DB26	15000.00	674.29	584.64	584.80	1.1
DB27	15100.00	674.29	585.45	585.58	1.1
DB28	15200.00	674.29	586.26	586.38	1.0
DB29	15300.00	674.29	587.07	587.24	1.1
DB30	15400.00	674.29	587.87	588.04	1.1
DB31	15500.00	674.29	588.68	588.85	1.1
DB32	15600.00	674.29	590.49	590.62	1.0
DB33	15700.00	674.29	592.30	592.36	1.0
DB34	15800.00	674.29	593.10	593.24	1.0
DB35	15900.00	674.29	593.91	594.00	1.1
DB36	16000.00	674.29	594.72	594.96	1.0
DG01	14900.00	200.00	584.73	584.87	1.0
DG02	15000.00	200.00	585.54	585.71	1.2
DG03	15100.00	200.00	586.35	586.53	1.1
DG04	15200.00	200.00	587.15	587.33	1.1
DG05	15300.00	200.00	587.96	588.14	1.1
DG06	15400.00	200.00	588.77	588.97	1.2
DG07	15500.00	200.00	589.58	589.78	1.1
DG08	15600.00	200.00	591.39	591.58	1.2
DG09	15700.00	200.00	593.19	593.28	1.0
DG10	15800.00	200.00	594.00	594.10	1.0
DG11	15900.00	200.00	594.81	595.05	1.0
DG12	16000.00	200.00	595.62	595.76	1.1
DG13	14900.00	300.00	584.14	584.23	1.0
DG14	15000.00	300.00	584.95	585.15	1.1
DG15	15100.00	300.00	585.76	585.94	1.2
DG16	15200.00	300.00	586.57	586.77	1.1
DG17	15300.00	300.00	587.37	587.56	1.1
DG18	15400.00	300.00	588.18	588.35	1.1
DG19	15500.00	300.00	588.99	589.17	1.1
DG20	15600.00	300.00	590.80	590.90	1.1
DG21	15700.00	300.00	592.60	592.80	1.1
DG22	15800.00	300.00	593.41	593.62	1.2
DG23	15900.00	300.00	594.22	594.44	1.0
DG24	16000.00	300.00	595.03	595.14	1.0
DG25	14900.00	400.00	584.11	584.27	1.0
DG26	15000.00	400.00	584.92	585.08	1.1
DG27	15100.00	400.00	585.73	585.87	1.1
DG28	15200.00	400.00	586.54	586.69	1.1
DG29	15300.00	400.00	587.34	587.46	1.1
DG30	15400.00	400.00	588.15	588.32	1.1
DG31	15500.00	400.00	588.96	589.12	1.1
DG32	15600.00	400.00	590.77	590.89	1.1
DG33	15700.00	400.00	592.58	592.71	1.1
DG34	15800.00	400.00	593.38	593.57	1.1
DG35	15900.00	400.00	594.19	594.38	1.1
DG36	16000.00	400.00	595.00	595.25	1.2
DG37	14900.00	500.00	584.70	584.87	1.1
DG38	15000.00	500.00	585.51	585.65	1.1
DG39	15100.00	500.00	586.32	586.43	1.1
DG40	15200.00	500.00	587.13	587.31	1.1
DG41	15300.00	500.00	587.93	588.11	1.2
DG42	15400.00	500.00	588.74	588.89	1.1
DG43	15500.00	500.00	589.55	589.73	1.1
DG44	15600.00	500.00	591.36	591.49	1.1
DG45	15700.00	500.00	593.17	593.34	1.1
DG46	15800.00	500.00	593.97	594.11	1.1
DG47	15900.00	500.00	594.78	594.94	1.2
DG48	16000.00	500.00	595.59	595.85	1.0
DG49	14900.00	600.00	584.27	584.45	1.1
DG50	15000.00	600.00	585.08	585.24	1.1
DG51	15100.00	600.00	585.89	586.06	1.1
DG52	15200.00	600.00	586.70	586.86	1.2
DG53	15300.00	600.00	587.50	587.67	1.2
DG54	15400.00	600.00	588.31	588.47	1.1
DG55	15500.00	600.00	589.12	589.30	1.1
DG56	15600.00	600.00	590.93	591.09	1.1
DG57	15700.00	600.00	592.73	592.90	1.1
DG58	15800.00	600.00	593.54	593.66	1.1
DG59	15900.00	600.00	594.35	594.45	1.0
DG60	16000.00	600.00	595.16	595.52	1.1

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
DG61	14900.00	700.00	583.99	584.10	1.1
DG62	15000.00	700.00	584.79	584.95	1.1
DG63	15100.00	700.00	585.60	585.77	1.1
DG64	15200.00	700.00	586.41	586.61	1.2
DG65	15300.00	700.00	587.22	587.41	1.2
DG66	15400.00	700.00	588.02	588.19	1.1
DG67	15500.00	700.00	588.83	589.00	1.1
DG68	15600.00	700.00	590.64	590.73	1.0
DG69	15700.00	700.00	592.45	592.57	1.1
DG70	15800.00	700.00	593.26	593.42	1.1
DG71	15900.00	700.00	594.06	594.22	1.1
DG72	16000.00	700.00	594.87	595.07	1.0
DG73	14900.00	800.00	584.57	584.70	1.1
DG74	15000.00	800.00	585.38	585.57	1.1
DG75	15100.00	800.00	586.19	586.39	1.2
DG76	15200.00	800.00	587.00	587.08	1.1
DG77	15300.00	800.00	587.81	587.98	1.2
DG78	15400.00	800.00	588.61	588.73	1.0
DG79	15500.00	800.00	589.42	589.59	1.1
DG80	15600.00	800.00	591.23	591.41	1.1
DG81	15700.00	800.00	593.04	593.17	1.0
DG82	15800.00	800.00	593.84	594.02	1.1
DG83	15900.00	800.00	594.65	594.84	1.1
DG84	16000.00	800.00	595.46	595.81	1.0

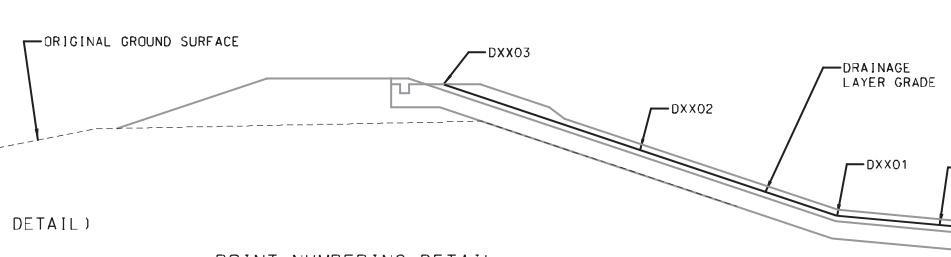
NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.

TYPICAL POINT NUMBER LOCATION

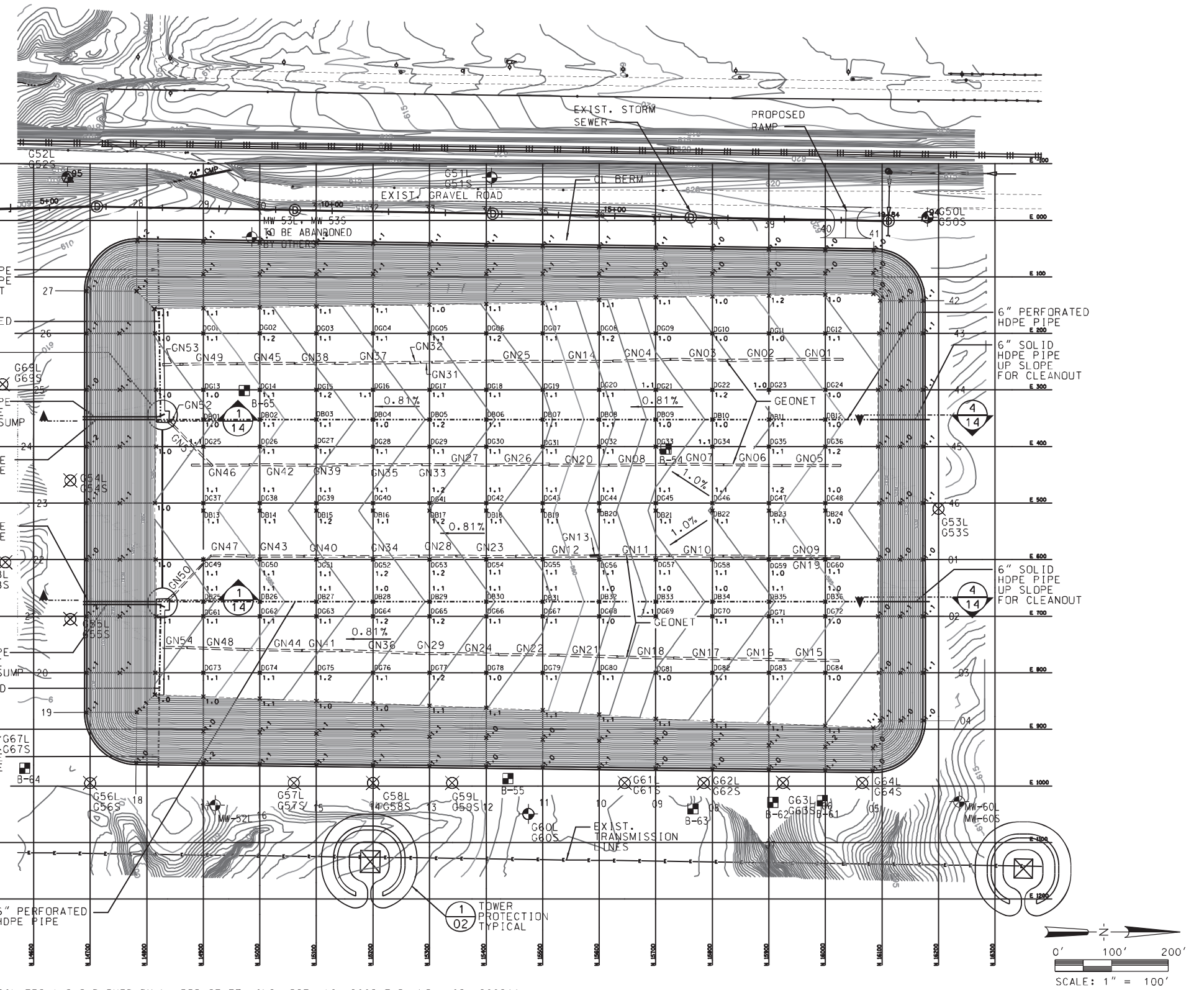
DB 00
- GRID POINT NUMBER
- DRAINAGE LAYER GRADE (BREAK POINT)

DG 00
- GRID POINT NUMBER
- DRAINAGE LAYER GRADE

D 00 00
- POINT NUMBER (SEE POINT NUMBERING DETAIL)
- CONTROL LINE NUMBER
- DRAINAGE LAYER GRADE



POINT NUMBERING DETAIL



GEONET COORDINATES (AS SURVEYED BY MAURER-STUTZ, INC. OCT. 16, 2008 THRU NOV. 09, 2008))

MSI Point #	Northing	Easting	Elevation
GN01 NE	16031.54	247.52	594.68
GN01 NW	16031.29	244.17	594.67
GN01 SE	15926.87	247.82	593.88
GN01 SW	15927.72	244.24	593.84
GN02 NE	15928.44	248.25	593.86
GN02 NW	15928.47	244.45	593.89
GN02 SE	15826.47	249.75	593.09
GN02 SW	15826.90	245.83	593.03
GN03 NE	15827.58	249.31	593.11
GN03 NW	15827.56	245.97	593.11
GN03 SE	15724.79	247.49	592.19
GN03 SW	15725.54	244.14	592.19
GN04 NE	15726.76	247.64	592.22
GN04 NW	15726.53	244.25	592.23
GN04 SE	15624.04	250.74	590.71
GN04 SW	15623.67	247.37	590.64
GN05 NE	16027.25	435.11	594.51
GN05 NW	16028.07	431.72	594.59
GN05 SE	15922.82	435.53	593.71
GN05 SW	15922.46	432.03	593.76
GN06 NE	15923.21	435.36	593.79
GN06 NW	15923.77	432.01	593.83
GN06 SE	15819.28	433.87	592.79
GN06 SW	15819.45	430.55	592.82
GN07 NE	15820.73	433.82	592.78
GN07 NW	15820.49	430.32	592.79
GN07 SE	15717.44	433.09	591.93
GN07 SW	15717.99	429.43	591.88
GN08 NE	15718.42	433.40	591.89
GN08 NW	15719.69	429.72	591.92
GN08 SE	15615.94	434.80	590.33
GN08 SW	15615.87	431.37	590.35
GN09 NE	16025.28	596.65	594.63
GN09 NW	16025.35	593.25	594.70
GN09 SE	15818.43	595.37	592.90
GN09 SW	15818.32	592.16	592.92
GN10 NE	15819.80	595.64	592.86

MSI Point #	Northing	Easting	Elevation
GN10 NW	15820.24	592.11	592.92
GN10 SE	15722.77	594.71	592.16
GN10 SW	15722.89	591.21	592.17
GN11 NE	15724.17	594.85	592.15
GN11 NW	15724.23	591.29	592.13
GN11 SE	15629.65	595.03	590.66
GN11 SW	15629.87	591.23	590.77
GN12 NE	15632.28	595.03	590.67
GN12 NW	15632.86	591.56	590.85
GN12 SE	15451.68	596.23	587.71
GN12 SW	15451.35	592.15	587.70
GN13 NE	15605.74	593.03	590.43
GN13 NW	15599.46	590.51	590.32
GN13 SE	15583.49	594.48	589.98
GN13 SW	15583.20	591.39	590.09
GN14 NE	15624.25	250.96	590.79
GN14 NW	15624.41	247.74	590.72
GN14 SE	15517.29	251.54	588.81
GN14 SW	15517.13	248.02	588.93
GN15 NE	16023.98	780.10	594.76
GN15 NW	16023.87	776.59	594.74
GN15 SE	15924.36	778.84	593.99
GN15 SW	15924.38	775.56	594.00
GN16 NE	15927.03	779.12	594.02
GN16 NW	15927.24	775.19	594.00
GN16 SE	15827.80	777.22	592.97
GN16 SW	15827.73	773.53	593.04
GN17 NE	15830.61	777.06	593.00
GN17 NW	15830.44	773.72	593.10
GN17 SE	15730.92	775.62	592.32
GN17 SW	15731.18	772.17	592.22
GN18 NE	15731.53	775.87	592.31
GN18 NW	15731.95	772.39	592.28
GN18 SE	15631.43	773.88	590.69
GN18 SW	15631.16	770.26	590.80
GN19 NE	16025.38	598.28	594.62
GN19 NW	16024.98	595.88	594.71

MSI Point #	Northing	Easting	Elevation
GN19 SE	15838.81	598.82	592.95
GN19 SW	15831.46	595.63	592.99
GN20 NE	15617.61	434.97	590.48
GN20 NW	15617.55	431.59	590.41
GN20 SE	15510.69	434.63	588.58
GN20 SW	15511.01	431.12	588.61
GN21 NE	15633.12	773.95	590.75
GN21 NW	15633.24	770.09	590.87
GN21 SE	15526.36	770.62	588.81
GN21 SW	15526.55	766.84	588.94
GN22 NE	15528.76	770.34	588.89
GN22 NW	15528.77	767.03	589.01
GN22 SE	15422.07	769.78	587.75
GN22 SW	15421.99	766.33	587.66
GN23 NW	15453.29	592.84	587.86
GN23 NE	15453.28	596.50	587.92
GN24 NW	15422.97	765.40	587.78
GN24 NE	15423.07	769.15	587.83
GN24 SE	15327.62	767.72	587.11
GN24 SW	15327.97	764.02	586.94
GN23 SE	15346.02	595.83	587.31
GN23 SW	15345.82	592.13	587.31
GN25 NW	15518.48	247.99	588.99
GN25 NE	15518.60	251.22	588.81
GN25 SW	15410.27	247.61	587.78
GN25 SE	15409.83	251.05	587.63
GN26 NW	15512.37	429.11	588.64
GN26 NE	15512.63	432.65	588.59
GN26 SE	15416.67	434.44	587.53
GN26 SW	15416.87	431.04	587.52
GN27 NE	15417.98	434.48	587.68
GN27 NW	15417.81	431.10	587.66
GN27 SE	15324.00	433.85	586.82
GN27 SW	15324.22	430.17	586.74
GN28 NE	15348.32	595.83	587.17
GN28 NW	15348.50	592.19	587.14
GN28 SE	15280.49	595.53	586.49

MSI Point #	Northing	Easting	Elevation
GN28 SW	15280.81	592.02	586.50
GN29 NE	15329.00	768.16	586.87
GN29 NW	15329.37	764.66	586.88
GN29 SE	15275.78	767.33	586.47
GN29 SW	15275.65	763.68	586.43
GN30 NE	15413.16	250.66	587.69
GN30 NW	15413.20	247.14	587.73
GN30 SE	15303.26	252.85	586.68
GN30 SW	15303.99	249.39	586.72
GN31 NE	15304.78	252.93	586.65
GN31 NW	15305.07	249.40	586.69
GN31 SE	15283.42	252.82	586.67
GN31 SW	15283.58	249.45	586.64
GN32 NE	15284.07	252.89	586.68
GN32 NW	15284.26	249.47	586.72
GN32 SE	15264.76	253.73	586.42
GN32 SW	15264.61	250.34	586.47
GN33 NE	15325.03	433.92	586.83
GN33 NW	15325.35	430.48	586.84
GN33 SE	15285.46	433.71	586.42
GN33 SW	15285.75	430.05	586.39
GN34 NE	15281.57	595.92	586.47
GN34 NW	15281.56	592.20	586.49
GN34 SE	15147.45	595.83	585.37
GN34 SW	15147.56	592.50	585.43
GN35 NE	15286.92	433.49	586.51
GN35 NW	15287.52	430.21	586.48
GN35 SE	15153.79	434.44	585.52
GN35 SW	15153.69	430.90	585.54
GN36 NE	15277.72	766.98	586.58
GN36 NW	15277.69	763.85	586.54
GN36 SE	15143.59	762.46	585.40
GN36 SW	15144.03	759.10	585.42
GN37 NE	15266.60	253.18	586.50
GN37 NW	15266.46	249.73	586.57
GN37 SE	15132.02	254.75	585.29
GN37 SW	15132.27	251.11	585.32

MSI Point #	Northing	Easting	Elevation
GN38 NE	15133.08	254.33	585.31
GN38 NW	15132.85	251.37	585.37
GN38 SE	15060.30	254.72	584.76
GN38 SW	15060.61	251.69	584.86
GN39 NE	15155.35	434.02	585.54
GN39 NW	15155.43	430.31	585.54
GN39 SE	15083.15	434.97	584.96
GN39 SW	15082.88	431.25	584.93
GN40 NE	15149.50	595.99	585.39
GN40 NW	15149.77	592.33	585.44
GN40 SE	15077.26	595.93	584.91
GN40 SW	15077.23	592.28	584.92
GN41 NE	15145.81	763.07	585.41
GN41 NW	15145.86	759.40	585.44
GN41 SE	15073.33	762.40	584.84
GN41 SW	15073.46	758.79	584.83
GN42 NE	15084.07	434.86	585.04
GN42 NW	15084.09	431.10	584.95
GN42 SE	14980.63	433.68	583.98
GN42 SW	14980.73	430.12	583.92
GN43 NE	15079.59	595.77	585.00
GN43 NW	15079.33	592.38	584.97
GN43 SE	14975.70	595.52	584.02
GN43 SW	14976.07	591.83	584.02
GN44 NE	15075.20	762.40	584.95
GN44 NW	15075.46	758.98	584.88
GN44 SE	14972.05	760.53	584.06
GN44 SW	14971.75	757.08	583.97
GN45 NE	15062.01	254.22	584.77
GN45 NW	15061.72	251.14	584.87
GN45 SE	14958.41	255.32	584.01
GN45 SW	14958.62	252.09	584.07
GN46 NE	14981.65	434.40	584.02
GN46 NW	14981.93	430.81	583.98
GN46 SE	14879.21	434.56	583.30
GN46 SW	14878.92	431.17	583.25
GN47 NE	14976.68	595.20	584.09

MSI Point #	Northing	Easting	Elevation
GN47 NW	14976.62	591.43	584.05
GN47 SE	14874.46	595.48	583.24
GN47 SW	14913.11	591.69	583.51
GN48 NE	14973.19	760.40	584.08
GN48 NW	14972.78	757.35	583.97
GN48 SE	14870.34	757.20	583.11
GN48 SW	14870.84	753.85	583.10
GN49 NE	14960.65	255.51	584.07
GN49 NW	14960.75	251.85	584.15
GN49 SE	14858.52	256.02	583.11
GN49 SW	14858.47	252.52	583.12
GN50 NE	14913.55	594.10	583.52
GN50 NW	14913.90	590.98	583.55
GN50 SE	14845.55	666.01	582.57
GN50 SW	14843.33	663.46	582.50
GN51 NE	14914.55	435.80	583.49
GN51 NW	14916.84	433.09	583.51
GN51 SE	14845.94	364.15	582.68
GN51 SW	14848.57	362.28	582.60
GN52 NE	14846.05	365.22	582.69
GN52 NW	14848.49	362.29	582.62
GN52 SE	14835.80	356.67	582.13
GN52 SW	14838.16	353.78	581.88
GN53 NE	14864.21	256.21	583.19
GN53 NW	14864.37	252.71	583.22
GN53 SE	14827.98	257.35	581.68
GN53 SW	14827.72	253.34	581.66
GN54 NE	14871.73	757.18	583.27
GN54 NW	14871.46	753.51	583.22
GN54 SE	14828.12	756.99	581.83
GN54 SW	14828.60	753.59	582.03
GN55 NE	14849.01	663.25	582.55
GN55 NW	14846.64	660.64	582.64
GN55 SE	14837.45	673.29	581.61
GN55 SW	14835.22	670.81	581.88

LEGEND

- $x_{1.1}$ DRAINAGE LAYER THICKNESS (IN FEET)
- GN54 GEONET

RECORD DRAWING

FILE NO. -C180-C102-10.dgn

Brans00939
09\4\2009
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AEG CAD GENERATED
DO NOT REVISE MANUALLY

LAYOUT	DBH	05-10-07
DRAWN	SKB	03-05-08
REVIEWED	SMB	10-10-08

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED POINT NO. DETAIL - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	10-10-08	TCJ	DBH	SMB	ADDITION OF GEOGRID AND SUMP MODIFICATIONS, REVISE GRADES DUE TO 2 FT. FOUNDATION RAISE
4	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

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SCALE -

DRAFTER -

DATE 03-26-09

DRAWING TITLE

GYPSUM STACK - LD/LCRS DRAINAGE LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS

DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER	REV.
C180-C102	4

SHEET NO. 10 OF 33

30x42

Electronic Filing: Received, Clerk's Office 06/20/2024

PAGE NO. - 11

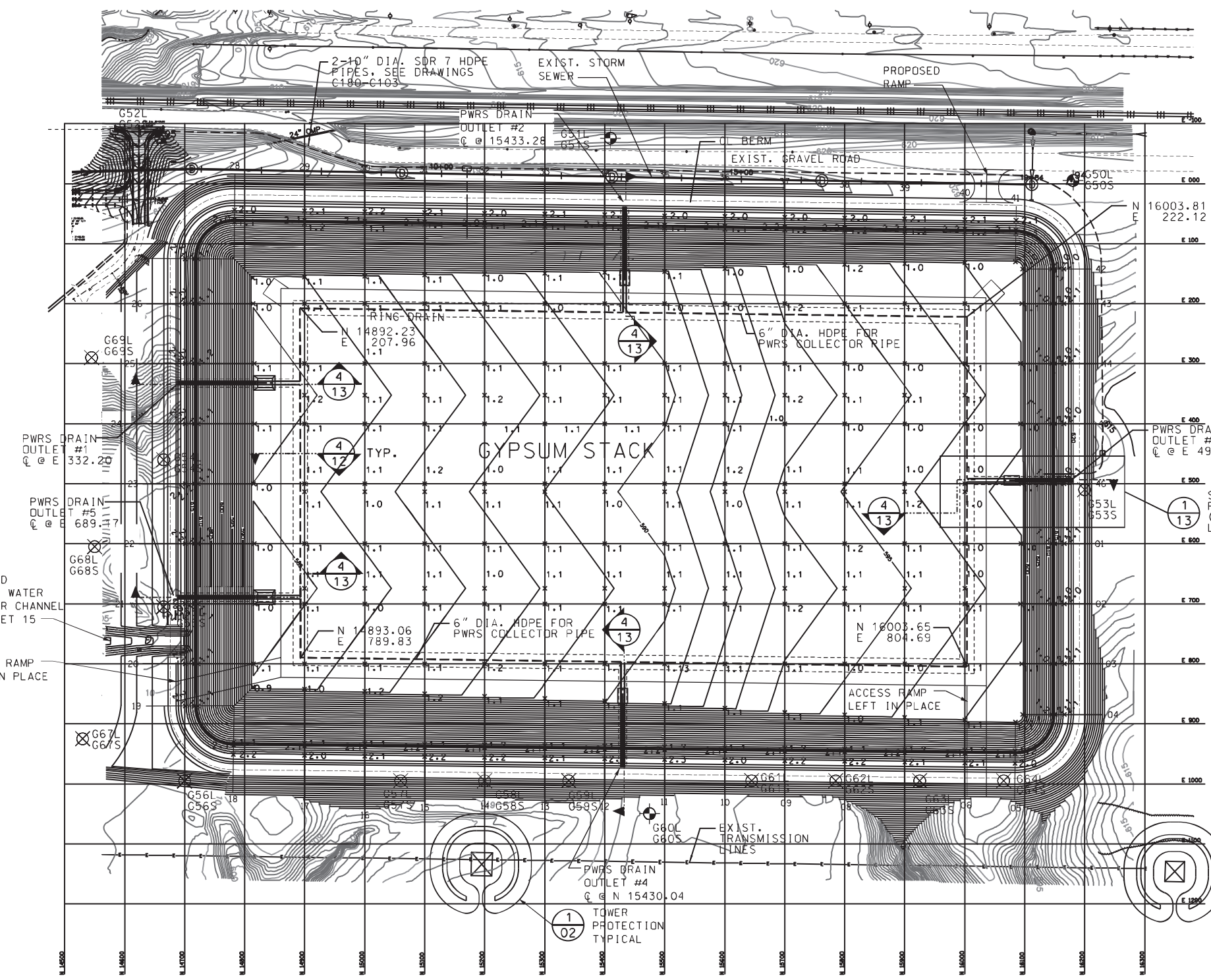
C180-C102

CONTROL POINT NUMBER	GRID COORDINATES		TOP OF CUSHION DIRT		CUSHION DIRT
	NORTHING	EASTING	DESIGN	RECORD	
C0101	16093.72	600.00	596.91	597.36	1.0
C0102	16144.88	600.00	611.53	611.82	1.1
C0103	16149.88	600.00	614.00	614.30	2.1
C0104	16165.63	600.00	618.50	618.74	2.1
C0201	16092.72	700.00	596.62	597.10	1.1
C0202	16144.91	700.00	611.53	611.82	1.1
C0203	16149.91	700.00	614.00	614.24	2.0
C0204	16165.66	700.00	618.50	618.74	2.0
C0301	16094.87	800.00	597.23	597.82	1.1
C0302	16144.94	800.00	611.53	611.75	1.0
C0303	16149.94	800.00	614.00	614.29	2.1
C0304	16165.69	800.00	618.50	618.78	2.1
C0401	16096.68	884.70	597.74	598.24	1.1
C0402	16144.96	884.71	611.53	611.79	1.2
C0403	16149.96	884.70	614.00	614.23	2.1
C0404	16165.72	884.69	618.50	618.74	2.1
C0501	16084.47	896.68	597.71	598.41	1.1
C0502	16083.93	945.11	611.56	611.85	1.2
C0503	16083.88	950.06	614.00	614.25	2.1
C0504	16083.70	965.81	618.50	618.69	2.0
C0601	16000.00	893.29	597.01	597.27	1.1
C0602	16000.00	944.12	611.53	611.82	1.2
C0603	16000.00	949.12	614.00	614.24	2.1
C0604	16000.00	964.87	618.50	618.72	2.1
C0701	15900.00	889.27	596.18	596.47	1.1
C0702	15900.00	943.00	611.53	611.82	1.2
C0703	15900.00	948.01	614.00	614.29	2.2
C0704	15900.00	963.76	618.50	618.70	2.1
C0801	15800.00	885.24	595.35	595.60	1.0
C0802	15800.00	941.89	611.53	611.80	1.1
C0803	15800.00	946.89	614.00	614.26	2.1
C0804	15800.00	962.64	618.50	618.78	2.2
C0901	15700.00	881.21	594.52	594.81	1.1
C0902	15700.00	940.77	611.53	611.82	1.2
C0903	15700.00	945.77	614.00	614.26	2.1
C0904	15700.00	961.53	618.50	618.80	2.2
C1001	15600.00	873.61	592.66	592.94	1.1
C1002	15600.00	939.66	611.53	611.76	1.1
C1003	15600.00	944.66	614.00	614.25	2.1
C1004	15600.00	960.41	618.50	618.73	2.0
C1101	15500.00	866.01	590.81	591.07	1.1
C1102	15500.00	938.54	611.53	611.82	1.2
C1103	15500.00	943.54	614.00	614.26	2.2
C1104	15500.00	959.29	618.50	618.78	2.3
C1201	15400.00	861.99	589.98	590.25	1.1
C1202	15400.00	937.42	611.53	611.82	1.2
C1203	15400.00	942.42	614.00	614.29	2.2
C1204	15400.00	958.18	618.50	618.73	2.2
C1301	15300.00	857.96	589.15	589.38	1.1
C1302	15300.00	936.31	611.53	611.79	1.1
C1303	15300.00	941.31	614.00	614.23	2.1
C1304	15300.00	957.06	618.50	618.75	2.1
C1401	15200.00	853.93	588.32	588.57	1.1
C1402	15200.00	935.19	611.53	611.82	1.2
C1403	15200.00	940.19	614.00	614.25	2.1
C1404	15200.00	955.94	618.50	618.76	2.2
C1501	15100.00	849.91	587.48	587.77	1.2
C1502	15100.00	934.07	611.53	611.81	1.1
C1503	15100.00	939.07	614.00	614.27	2.2
C1504	15100.00	954.83	618.50	618.78	2.2
C1601	15000.00	845.88	586.65	586.96	1.2
C1602	15000.00	932.96	611.53	611.81	1.1
C1603	15000.00	937.96	614.00	614.26	2.1
C1604	15000.00	953.71	618.50	618.72	2.1
C1701	14900.00	841.85	585.82	586.02	1.0
C1702	14900.00	931.84	611.53	611.82	1.1
C1703	14900.00	936.84	614.00	614.29	2.1
C1704	14900.00	952.60	618.50	618.71	2.0
C1801	14814.14	838.40	585.11	585.38	0.9
C1802	14781.51	930.52	611.53	611.79	1.1
C1803	14781.45	935.52	614.00	614.20	2.1
C1804	14781.24	951.27	618.50	618.77	2.2
C1901	14814.14	838.40	585.11	585.40	0.9
C1902	14721.66	870.00	611.53	611.75	1.1
C1903	14716.66	870.01	614.00	614.25	2.1
C1904	14700.91	870.05	618.50	618.76	2.1
C2001	14814.90	800.00	584.89	585.18	1.1
C2002	14721.64	800.00	611.53	611.82	1.1
C2003	14716.64	800.00	614.00	614.25	2.1
C2004	14700.89	800.00	618.50	618.71	2.1
C2101	14816.88	700.00	584.31	584.59	1.0
C2102	14721.62	700.00	611.53	611.80	1.1
C2103	14716.62	700.00	614.00	614.21	2.1
C2104	14700.87	700.00	618.50	618.72	2.0
C2201	14815.89	600.00	584.59	584.83	1.0
C2202	14721.60	600.00	611.53	611.81	1.2
C2203	14716.60	600.00	614.00	614.20	2.1
C2204	14700.85	600.00	618.50	618.70	2.2
C2301	14814.43	500.00	585.00	585.22	1.0
C2302	14721.58	500.00	611.53	611.81	1.1
C2303	14716.58	500.00	614.00	614.29	2.2
C2304	14700.83	500.00	618.50	618.76	2.1
C2401	14816.38	400.00	584.44	584.96	1.1
C2402	14721.56	400.00	611.53	611.77	1.1
C2403	14716.56	400.00	614.00	614.23	2.1
C2404	14700.81	400.00	618.50	618.71	2.1
C2501	14816.27	300.00	584.47	584.76	1.1
C2502	14721.54	300.00	611.53	611.78	1.2
C2503	14716.54	300.00	614.00	614.23	2.1
C2504	14700.79	300.00	618.50	618.74	2.2
C2601	14814.24	200.00	585.04	585.25	1.0
C2602	14721.52	200.00	611.53	611.78	1.1
C2603	14716.52	200.00	614.00	614.25	2.1
C2604	14700.77	200.00	618.50	618.72	2.1
C2701	14813.37	156.83	585.29	585.66	1.0
C2702	14721.50	125.09	611.53	611.75	1.1
C2703	14716.50	125.09	614.00	614.24	2.1
C2704	14700.75	125.05	618.50	618.70	2.1
C2801	14813.37	156.83	585.29	585.68	1.0
C2802	14782.84	64.56	611.53	611.79	1.1
C2803	14782.89	59.56	614.00	614.21	2.0
C2804	14783.07	43.81	618.50	618.68	2.0
C2901	14900.00	155.51	585.99	586.42	1.1
C2902	14900.00	66.12	611.53	611.82	1.2
C2903	14900.00	61.12	614.00	614.23	2.1
C2904	14900.00	45.37	618.50	618.74	2.1
C3001	15000.00	153.98	586.81	587.08	1.1

CONTROL POINT NUMBER	GRID COORDINATES		TOP OF CUSHION DIRT		CUSHION DIRT
	NORTHING	EASTING	DESIGN	RECORD	
C3002	15000.00	67.45	611.53	611.75	1.1
C3003	15000.00	62.45	614.00	614.23	2.1
C3004	15000.00	46.70	618.50	618.78	2.2
C3101	15100.00	152.46	587.63	587.91	1.1
C3102	15100.00	68.79	611.53	611.81	1.1
C3103	15100.00	63.79	614.00	614.25	2.1
C3104	15100.00	48.03	618.50	618.77	2.1
C3201	15200.00	150.93	588.44	588.66	1.0
C3202	15200.00	70.12	611.53	611.81	1.1
C3203	15200.00	65.12	614.00	614.23	2.0
C3204	15200.00	49.37	618.50	618.71	2.0
C3301	15300.00	149.41	589.26	589.61	1.1
C3302	15300.00	71.45	611.53	611.77	1.1
C3303	15300.00	66.45	614.00	614.25	2.1
C3304	15300.00	50.70	618.50	618.74	2.1
C3401	15400.00	147.88	590.08	590.46	1.1
C3402	15400.00	72.79	611.53	611.79	1.1
C3403	15400.00	67.79	614.00	614.22	2.1
C3404	15400.00	52.03	618.50	618.66	2.0
C3501	15500.00	146.36	590.89	591.14	1.1
C3502	15500.00	74.12	611.53	611.77	1.1
C3503	15500.00	69.12	614.00	614.24	2.1
C3504	15500.00	53.37	618.50	618.62	2.0
C3601	15600.00	141.26	592.73	592.98	1.0
C3602	15600.00	75.45	611.53	611.78	1.1
C3603	15600.00	70.45	614.00	614.25	2.1
C3604	15600.00	54.70	618.50	618.68	2.0
C3701	15700.00	136.16	594.57	594.81	1.0
C3702	15700.00	76.79	611.53	611.77	1.2
C3703	15700.00	71.79	614.00	614.27	2.2
C3704	15700.00	56.03	618.50	618.61	2.0
C3801	15800.00	134.63	595.39	595.65	1.2
C3802	15800.00	78.12	611.53	611.80	1.2
C3803	15800.00	73.12	614.00	614.26	2.2
C3804	15800.00	57.37	618.50	618.61	2.0
C3901	15900.00	133.11	596.20	596.94	1.0
C3902	15900.00	79.45	611.53	611.81	1.2
C3903	15900.00	74.45	614.00	614.25	2.2
C3904	15900.00	58.70	618.50	618.67	2.1
C4001	16000.00	131.58	597.02	597.43	1.0
C4002	16000.00	80.79	611.53	611.83	1.2
C4003	16000.00	75.79	614.00	614.30	2.2
C4004	16000.00	60.03	618.50	618.71	2.1
C4101	16084.54	130.31	597.71	598.14	1.0
C4102	16085.19	81.93	611.53	611.80	1.1
C4103	16085.25	76.93	614.00	614.24	2.1
C4104	16085.46	61.17	618.50	618.76	2.1
C4201	16096.44	142.27	597.74	598.33	1.0
C4202	16144.74	142.26	611.53	611.83	1.1
C4203	16149.74	142.26	614.00	614.26	2.0
C4204	16165.49	142.25	618.50	618.81	2.0
C4301	16095.25	200.00	597.39	597.91	1.1
C4302	16144.76	200.00	611.53	611.78	1.0
C4303	16149.76	200.00	614.00	614.26	2.0
C4304	16165.51	200.00	618.50	618.77	2.1
C4401	16093.16	300.00	596.78	597.28	1.1
C4402	16144.79	300.00	611.53	611.80	1.0
C4403	16149.79	300.00	614.00	614.21	2.0
C4404	16165.54	300.00	618.50	618.79	2.1
C4501	16093.09	400.00	596.75	597.07	1.0
C4502	16144.82	400.00	611.53	611.79	1.1
C4503	16149.82	400.00	614.00	614.25	2.0
C4504	16165.57	400.00	618.50	618.78	2.0
C4601	16095.24	500.00	597.36	597.71	1.1
C4602	16144.85	500.00	611.53	611.80	1.1
C4603	16149.85	500.00	614.00	614.22	2.0
C4604	16165.60	500.00	618.50	618.76	2.1
CB01	14900.00	352.42	584.83	585.07	1.2
CB02	15000.00	352.42	585.64	585.91	1.1
CB03	15100.00	352.42	586.45	586.72	1.1
CB04	15200.00	352.42	587.26	587.53	1.2
CB05	15300.00	352.42	588.06	588.29	1.1
CB06	15400.00	352.42	588.87	589.10	1.1
CB07	15500.00	352.42	589.68	589.97	1.1
CB08	15600.00	352.42	591.49	591.72	1.1
CB09	15700.00	352.42	593.30	593.51	1.2
CB10	15800.00	352.42	594.10	594.35	1.1
CB11	15900.00	352.42	594.91	595.17	1.1
CB12	16000.00	352.42	595.72	596.00	1.1
CB13	14900.00	513.35	585.78	586.01	1.1
CB14	15000.00	513.35	586.59	586.80	1.0
CB15	15100.00	513.35	587.40	587.68	1.1
CB16	15200.00	513.35	588.21	588.46	1.1
CB17	15300.00	513.35	589.01	589.30	1.1
CB18	15400.00	513.35	589.82	589.99	1.0
CB19	15500.00	513.35	590.63	590.92	1.1
CB20	15600.00	513.35	592.44	592.65	1.0
CB21	15700.00	513.35	594.24	594.54	1.1
CB22	15800.00	513.35	595.05	595.28	1.1
CB23	15900.00	513.35	595.86	596.16	1.2
CB24	16000.00	513.35	596.67	596.84	1.0
CB25	14900.00	674.29	584.83	585.12	1.1
CB26	15000.00	674.29	585.64	585.88	1.1
CB27	15100.00	674.29	586.45	586.73	1.1
CB28	15200.00	674.29	587.26	587.43	1.0
CB29	15300.00	674.29	588.07	588.35	1.1
CB30	15400.00	674.29	588.87	589.18	1.1
CB31	15500.00	674.29	589.68	589.93	1.1
CB32	15600.00	674.29	591.49	591.74	1.1
CB33	15700.00	674.29	593.30	593.51	1.1
CB34	15800.00	674.29	594.10	594.32	1.1
CB35	15900.00	674.29	594.91	595.15	1.1
CB36	16000.00	674.29	595.72	596.01	1.0
CG01	14900.00	200.00	585.73	585.97	1.1
CG02	15000.00	200.00	586.54	586.80	1.1
CG03	15100.00	200.00	587.35	587.59	1.1
CG04	15200.00	200.00	588.15	588.45	1.1
CG05	15300.00	200.00	588.96	589.15	1.0
CG06	15400.00	200.00	589.77	590.03	1.1
CG07	15500.00	200.00	590.58	590.79	1.0
CG08	15600.00	200.00	592.39	592.62	1.0
CG09	15700.00	200.00	594.19	594.49	1.2
CG10	15800.00	200.00	595.00	595.25	1.1
CG11	15900.00	200.00	595.81	596.13	1.1
CG12	16000.00	200.00	596.62	596.82	1.1
CG13	14900.00	300.00	585.14	585.35	1.1
CG14	15000.00	300.00	585.95	586.21	1.1

CONTROL POINT NUMBER	GRID COORDINATES		TOP OF CUSHION DIRT E		CUSHION DIRT
	NORTHING	EASTING	DESIGN	RECORD	
CG15	15100.00	300.00	586.76	587.03	1.1
CG16	15200.00	300.00	587.57	587.86	1.1
CG17	15300.00	300.00	588.37	588.67	1.1
CG18	15400.00	300.00	589.18	589.41	1.1
CG19	15500.00	300.00	589.99	590.25	1.1
CG20	15600.00	300.00	591.80	592.04	1.1
CG21	15700.00	300.00	593.60	593.86	1.1
CG22	15800.00	300.00	594.41	594.67	1.0
CG23	15900.00	300.00	595.22	595.45	1.0
CG24	16000.00	300.00	596.03	596.27	1.1
CG25	14900.00	400.00	585.11	585.36	1.1
CG26	15000.00	400.00	585.92	586.15	1.1
CG27	15100.00	400.00	586.73	587.01	1.1
CG28	15200.00	400.00	587.54	587.78	1.1
CG29	15300.00	400.00	588.34	588.58	1.1
CG30	15400.00	400.00	589.15	589.40	1.1
CG31	15500.00	400.00	589.96	590.20	1.1
CG32	15600.00	400.00	591.77	592.03	1.1
CG33	15700.00	400.00	593.58	593.74	1.0
CG34	15800.00	400.00	594.38	594.62	1.0
CG35	15900.00	400.00	595.19	595.41	1.0
CG36	16000.00	400.00	596.00	596.27	1.0
CG37	14900.00	500.00	585.70	586.00	1.1
CG38	15000.00	500.00	586.51	586.75	1.1
CG39	15100.00	500.00	587.32	587.59	1.2
CG40	15200.00	500.00	588.13	588.34	1.0
CG41	15300.00	500.00	588.93	589.21	1.1
CG42	15400.00	500.00	589.74	590.01	1.1
CG43	15500.00	500.00	590.55	590.81	1.1
CG44	15600.00	500.00	592.36	592.65	1.2.
CG45	15700.00	500.00	594.17	594.43	1.1
CG46	15800.00	500.00	594.97	595.22	1.1
CG47	15900.00	500.00	595.78	595.97	1.0
CG48	16000.00	500.00	596.59	596.89	1.0
CG49	14900.00	600.00	585.27	585.53	1.1
CG50	15000.00	600.00	586.08	586.34	1.1
CG51	15100.00	600.00	586.89	587.16	1.1
CG52	15200.00	600.00	587.70	587.97	1.1
CG53	15300.00	600.00	588.50	588.78	1.1
CG54	15400.00	600.00	589.31	589.59	1.1
CG55	15500.00	600.00	590.12	590.35	1.0
CG56	15600.00	600.00	591.93	592.23	1.0
CG57	15700.00	600.00	593.73	593.98	1.1
CG58	15800.00	600.00	594.54	594.82	1.2
CG59	15900.00	600.00	595.35	595.59	1.1
CG60	16000.00	600.00	596.16	596.52	1.0
CG61	14900.00	700.00	584.99	585.21	1.1
CG62	15000.00	700.00	585.79	585.98	1.0
CG63	15100.00	700.00	586.60	586.86	1.1
CG64	15200.00	700.00	587.41	587.68	1.1
CG65	15300.00	700.00	588.22	588.48	1.1
CG66	15400.00	700.00	589.02	589.30	1.1
CG67	15500.00	700.00	589.83	590.12	1.1
CG68	15600.00	700.00	591.64	591.85	1.1
CG69	15700.00	700.00	593.45	593.72	1.1
CG70	15800.00	700.00	594.26	594.52	1.1
CG71	15900.00	700.00	595.06	595.32	1.1
CG72	16000.00	700.00	595.87	596.17	1.1
CG73	14900.00	800.00	585.57	585.81	1.1
CG74	15000.00	800.00	586.38	586.66	1.1
CG75	15100.00	800.00	587.19	587.44	1.1
CG76	15200.00	800.00	588.00	588.27	1.2
CG77	15300.00	800.00	588.81	589.10	1.1
CG78	15400.00	800.00	589.61	589.80	1.1
CG79	15500.00	800.00	590.42	590.72	1.1
CG80	15600.00	800.00	592.23	592.52	1.1
CG81	15700.00	800.00	594.04	594.31	1.1
CG82	15800.00	800.00	594.84	595.06	1.0
CG83	15900.00	800.00	595.65	595.88	1.0
CG84	16000.00	800.00	596.46	596.87	1.1

NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.



STANDARD LEGEND
(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- 1.1 CUSHION DIRT LAYER THICKNESS (IN FEET)
- RING DRAIN SAND LIMITS
- CONSTRUCTION ROAD LIMITS

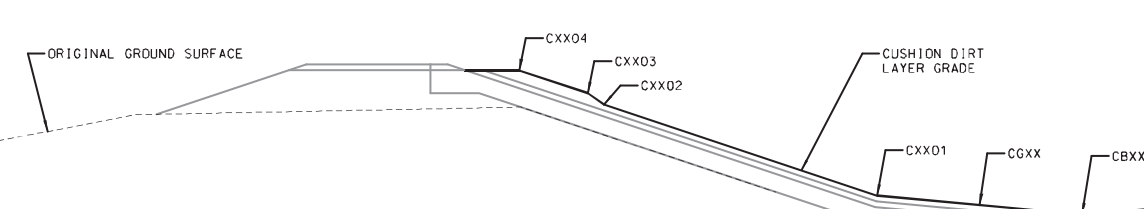
0' 100' 200'
SCALE: 1" = 100'

TYPICAL POINT NUMBER LOCATION

CB 00
- GRID POINT NUMBER
- CUSHION LAYER GRADE (BREAK POINT)

CG 00
- GRID POINT NUMBER
- CUSHION LAYER GRADE

C 00 00
- POINT NUMBER (SEE POINT NUMBERING DETAIL)
- CONTROL LINE NUMBER
- CUSHION LAYER GRADE



POINT NUMBERING DETAIL

Brans00939
09\14\2009
I:\03 Jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-II.dgn

AEG CAD GENERATED
DO NOT REVISE MANUALLY

LAYOUT	KNK	05/10/07
DRAWN	SKB	03-05-08
REVIEWED		

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED CONTOURS / TABLE - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	10-14-08	TJL	DBH	SMB	REVISED GRADING TABLE AND CONTOURS FOR 2 FT. FOUNDATION GRADE RAISE FOR THE NORTH 400' OF THE GYPSUM STACK FLOOR
4	11-17-08	DBH	DBH	SMB	ADDED CENTERLINE COORDINATES FOR PWRS DRAIN LOCATIONS
5	02-09-09	DBH	SKB	SMB	RELOCATE SOUTH RING DRAIN ALIGNMENT 30' NORTH
6	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	

RECORD DRAWING

FILE NO. -C180-C102-II.dgn

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

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SCALE -

DRAFTER -

DATE 03-26-09

DRAWING TITLE

PWRS-RING DRAIN SYSTEM CUSHION DIRT LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 6

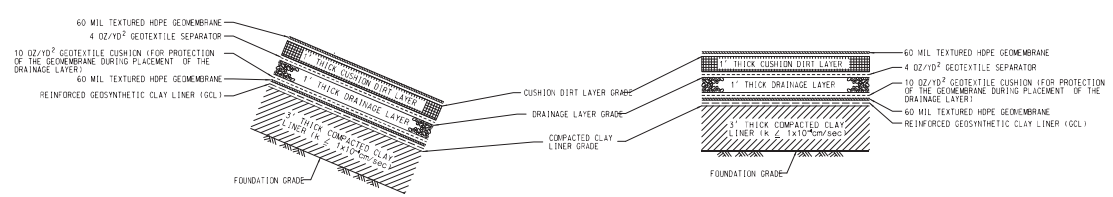
SHEET NO. 11 OF 33

30x42

Electronic Filing: Received, Clerk's Office 06/20/2024

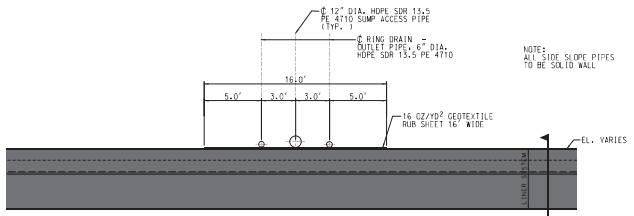
PAGE NO. - 12

C180-C102

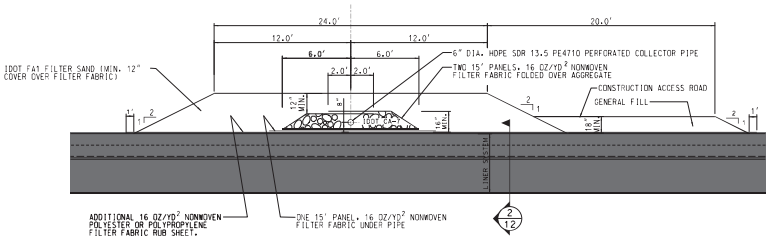


1/12 SIDE SLOPE LINER SYSTEM
NTS
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

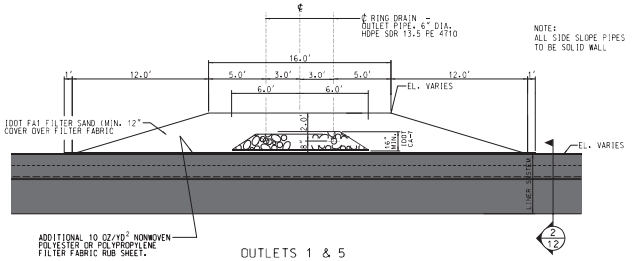
2/12 BOTTOM LINER SYSTEM
NTS
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

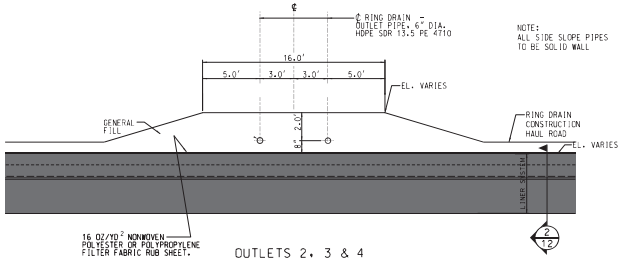


3/12 RING DRAIN RISER CROSS SECTION (3-PIPES) FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

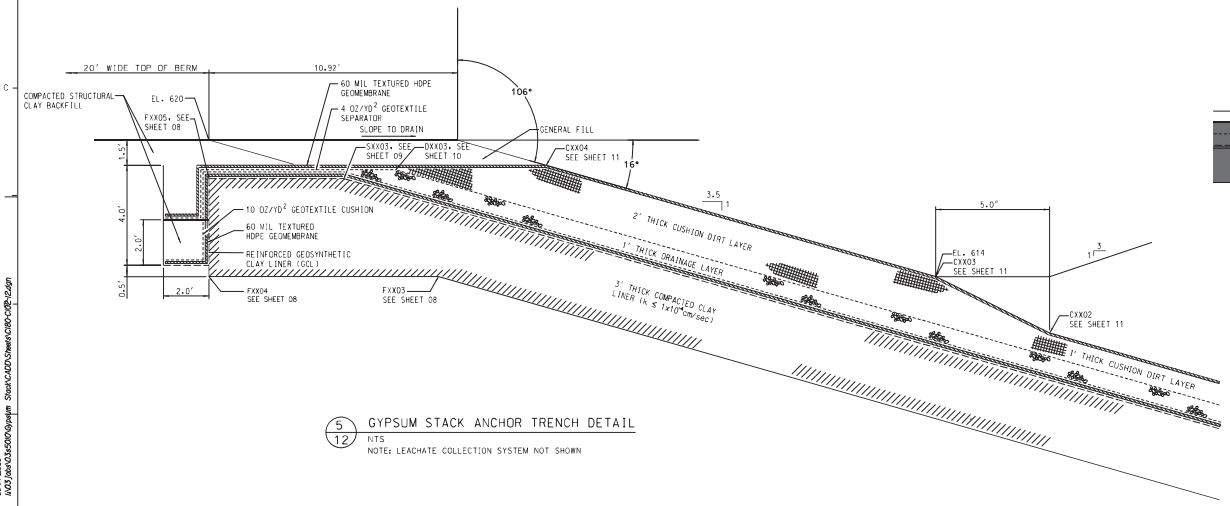


4/12 RING DRAIN COLLECTOR CROSS SECTION FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN





6/12 PIPES BETWEEN RING DRAIN AND RISERS FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN



5/12 GYPSUM STACK ANCHOR TRENCH DETAIL
NTS
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

RECORD DRAWING

FILE NO. -C180-C102-12.dgn

HANSON
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1525 South Sixth Street
Springfield, Illinois 62703-2886
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Illinois Licensed Professional Service
Corporation #184.001352
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DRAWING TITLE
PWRS - RING DRAIN DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 5
SHEET NO. 12 OF 33

SCALE -
DRAFTER -
DATE 03-26-09

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED DETAIL 5 - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	9-19-08	TCJ	RWH	RWH	ADDED LEACHATE COLLECTION NOTE TO ALL DETAILS
4	02-12-09	SKB	SMB	SMB	REVISED DETAIL 6
5	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

ISSUE	INK	05/30/07
LAST	SKB	03-05-09
REVIEWED		

30x42

Brandt0039
05/30/2007
\\03jaix03s500\Projects\Duck Creek\CADD\Sheets\C180-C02R-12.dgn

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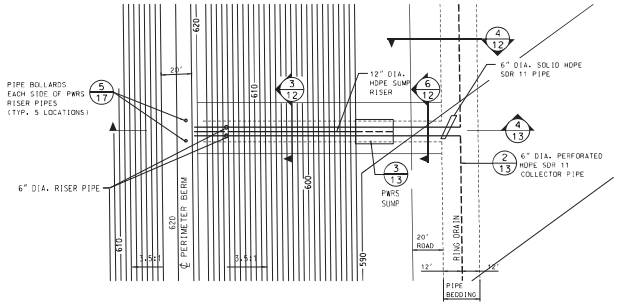
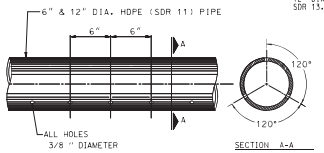
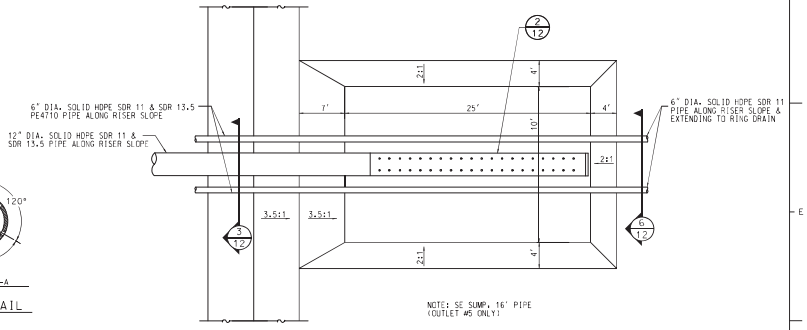
PERFORATED PIPE
SOLID PIPE



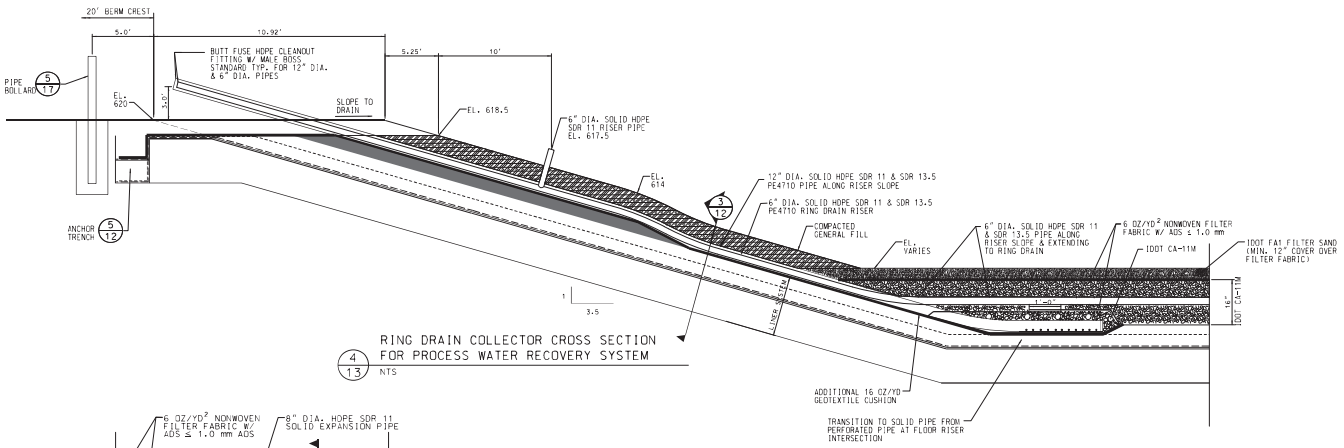
1 13 PROCESS WATER RECOVERY SYSTEM - PARTIAL PLAN (TYP. 5 LOCATIONS)
SCALE: 1"=30'



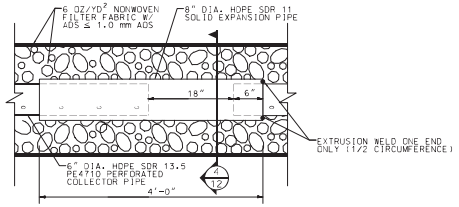
2 13 RING DRAIN COLLECTOR PIPE DETAIL
NTS



3 13 PWRS SUMP PLAN
NTS



4 13 RING DRAIN COLLECTOR CROSS SECTION FOR PROCESS WATER RECOVERY SYSTEM
NTS



5 13 RING DRAIN COLLECTOR PIPE EXPANSION UNION
NTS

NOTE:
INSTALL EXPANSION UNION EVERY 100 FT OF 6" DIA. PERFORATED COLLECTOR PIPE

NOTE:
RING DRAIN COLLECTOR PIPES ARE PERFORATED.
RING DRAIN RISER PIPES ARE NOT PERFORATED.

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD											
REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION	REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION	–	–	–	–	–	
1	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION						
2	–	SKB	JDM	–	ISSUED FOR RECORD DRAWING						

ISSUE	INK	05-25-07
DATE	JDM	04-25-08
REVIEWED		

RECORD DRAWING

FILE NO. C180-C102-13.dgn

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DRAWING TITLE
PWRS - RING DRAIN DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. –

SCALE –
DRAFTER
DATE 03-26-09

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 2
SHEET NO. 13 OF 33

30x42

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2008/04/25
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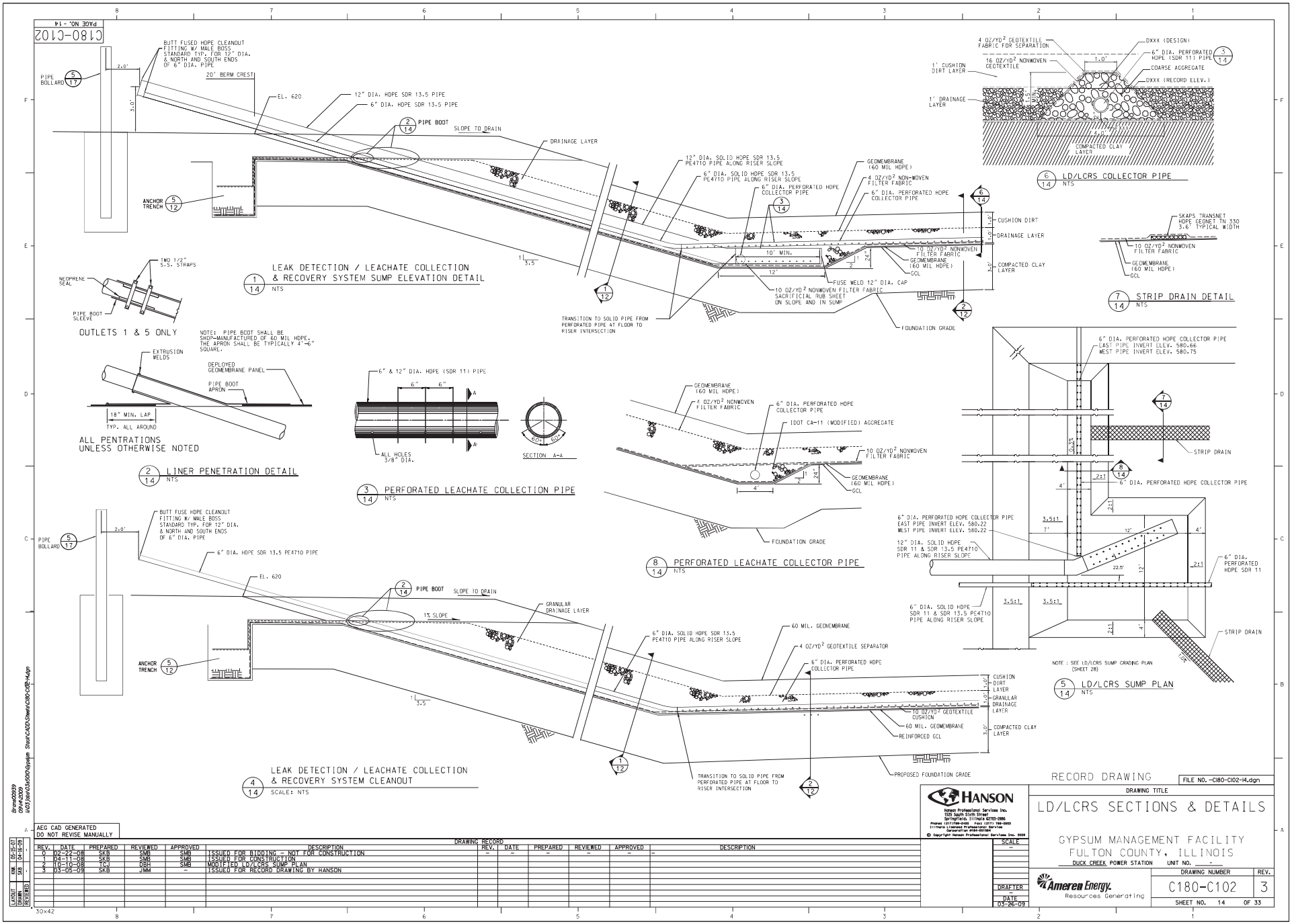
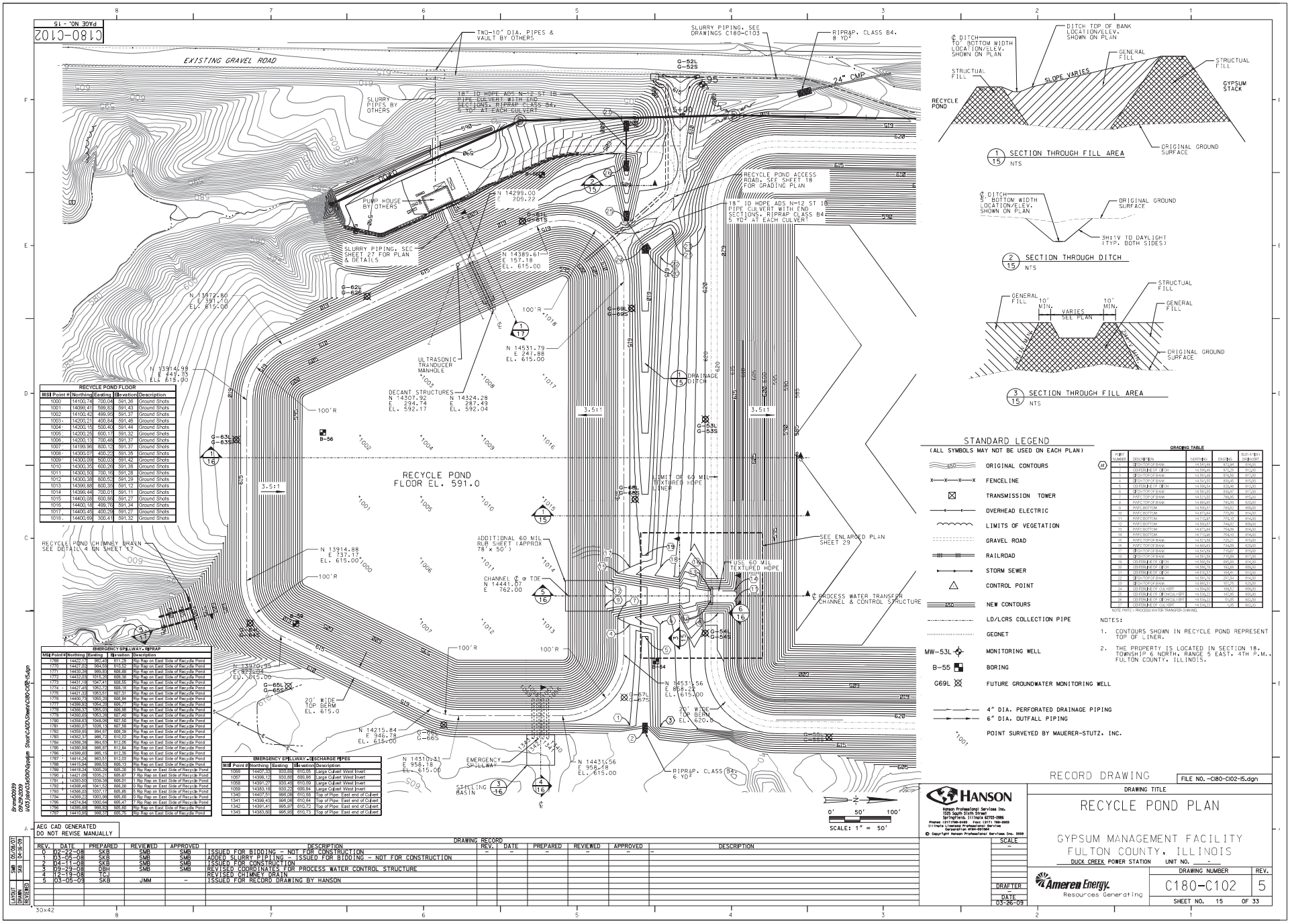


Electronic Filing: Received, Clerk's Office 06/20/2024



RECYCLE POND FLOOR

MSI Point #	Northing	Easting	Elevation	Description
1000	14100.74	700.04	591.36	Ground Shots
1001	14090.41	599.83	591.43	Ground Shots
1002	14100.42	499.95	591.37	Ground Shots
1003	14200.21	400.84	591.48	Ground Shots
1004	14200.15	500.40	591.44	Ground Shots
1005	14200.25	600.17	591.32	Ground Shots
1006	14200.13	700.48	591.37	Ground Shots
1007	14199.96	800.12	591.37	Ground Shots
1008	14300.07	400.23	591.35	Ground Shots
1009	14300.09	500.03	591.42	Ground Shots
1010	14300.35	600.28	591.38	Ground Shots
1011	14300.50	700.18	591.28	Ground Shots
1012	14300.38	800.52	591.29	Ground Shots
1013	14399.88	800.32	591.12	Ground Shots
1014	14399.44	700.01	591.11	Ground Shots
1015	14400.08	600.86	591.27	Ground Shots
1016	14400.18	499.76	591.34	Ground Shots
1017	14400.45	400.25	591.27	Ground Shots
1018	14400.69	300.41	591.32	Ground Shots

EMERGENCY SPILLWAY RIPRAP

MSI Point #	Northing	Easting	Elevation	Description
1769	14402.17	982.46	611.28	Rip Rap on East Side of Recycle Pond
1770	14402.82	984.59	610.52	Rip Rap on East Side of Recycle Pond
1771	14403.38	986.83	608.88	Rip Rap on East Side of Recycle Pond
1772	14403.03	1016.26	609.38	Rip Rap on East Side of Recycle Pond
1773	14403.18	1047.41	608.55	Rip Rap on East Side of Recycle Pond
1774	14402.45	1062.73	608.18	Rip Rap on East Side of Recycle Pond
1775	14401.32	1063.51	607.31	Rip Rap on East Side of Recycle Pond
1776	14400.73	1065.26	606.84	Rip Rap on East Side of Recycle Pond
1777	14398.82	1064.26	606.77	Rip Rap on East Side of Recycle Pond
1778	14398.31	1065.03	606.98	Rip Rap on East Side of Recycle Pond
1779	14399.85	1063.28	607.40	Rip Rap on East Side of Recycle Pond
1780	14398.83	1048.06	607.50	Rip Rap on East Side of Recycle Pond
1781	14399.27	1028.13	607.58	Rip Rap on East Side of Recycle Pond
1782	14399.83	994.93	609.39	Rip Rap on East Side of Recycle Pond
1783	14392.27	986.73	610.52	Rip Rap on East Side of Recycle Pond
1784	14399.39	984.63	612.06	Rip Rap on East Side of Recycle Pond
1785	14399.99	998.87	612.84	Rip Rap on East Side of Recycle Pond
1786	14399.60	995.19	612.36	Rip Rap on East Side of Recycle Pond
1787	14414.24	983.51	612.05	Rip Rap on East Side of Recycle Pond
1788	14416.84	988.53	609.13	Rip Rap on East Side of Recycle Pond
1789	14418.24	1005.29	605.26	Rip Rap on East Side of Recycle Pond
1790	14421.66	1005.21	606.67	Rip Rap on East Side of Recycle Pond
1791	14393.60	1039.36	606.01	Rip Rap on East Side of Recycle Pond
1792	14399.48	1041.52	606.00	Rip Rap on East Side of Recycle Pond
1793	14396.03	1037.17	605.85	Rip Rap on East Side of Recycle Pond
1794	14399.22	1001.88	605.60	Rip Rap on East Side of Recycle Pond
1795	14374.84	1000.84	605.47	Rip Rap on East Side of Recycle Pond
1796	14386.68	998.82	605.60	Rip Rap on East Side of Recycle Pond
1797	14410.86	998.37	605.75	Rip Rap on East Side of Recycle Pond

EMERGENCY SPILLWAY DISCHARGE PIPES

MSI Point #	Northing	Easting	Elevation	Description
1056	14407.30	920.89	610.05	Large Culvert West Invert
1057	14396.12	920.80	609.86	Large Culvert West Invert
1058	14391.29	920.48	610.09	Large Culvert West Invert
1059	14383.18	920.22	609.84	Large Culvert West Invert
1340	14407.51	995.06	610.68	Top of Pipe: East end of Culvert
1341	14396.43	995.08	610.64	Top of Pipe: East end of Culvert
1342	14391.41	995.07	610.72	Top of Pipe: East end of Culvert
1343	14383.06	995.36	610.73	Top of Pipe: East end of Culvert

GRADING TABLE

POINT NUMBER	DESCRIPTION	NORTHING	EASTING	ELEVATION
1	TOP OF BANK	14,541.48	817.24	615.00
2	CENTERLINE OF DITCH	14,519.44	875.25	611.00
3	TOP OF BANK	14,519.28	875.74	617.00
4	TOP OF BANK	14,514.55	936.41	615.00
5	CENTERLINE OF DITCH	14,509.42	936.41	611.00
6	TOP OF BANK	14,509.25	936.91	617.00
7	PVI TOP OF BANK	14,512.33	1396.93	615.00
8	PVI TOP OF BANK	14,499.85	1397.25	620.00
9	PVI TOP OF BANK	14,499.67	1398.22	600.00
10	PVI TOP OF BANK	14,417.24	1777.29	614.00
11	PVI TOP OF BANK	14,417.24	1778.29	614.00
12	PVI TOP OF BANK	14,417.24	1779.29	614.00
13	PVI TOP OF BANK	14,417.24	1780.29	614.00
14	PVI TOP OF BANK	14,417.24	1781.29	614.00
15	PVI TOP OF BANK	14,417.24	1782.29	614.00
16	PVI TOP OF BANK	14,417.24	1783.29	614.00
17	PVI TOP OF BANK	14,417.24	1784.29	614.00
18	PVI TOP OF BANK	14,417.24	1785.29	614.00
19	PVI TOP OF BANK	14,417.24	1786.29	614.00
20	PVI TOP OF BANK	14,417.24	1787.29	614.00
21	TOP OF BANK	14,417.24	1788.29	614.00
22	CENTERLINE OF DITCH	14,417.24	1789.29	614.00
23	CENTERLINE OF DITCH	14,399.73	1789.29	610.00
24	CENTERLINE OF DITCH	14,399.73	1789.29	610.00
25	TOP OF BANK	14,399.73	1789.29	614.00
26	TOP OF BANK	14,399.73	1789.29	614.00
27	CENTERLINE OF DITCH	14,399.73	1789.29	610.00
28	CENTERLINE OF CULVERT	14,399.73	1789.29	610.00
29	CENTERLINE OF CULVERT	14,399.73	1789.29	610.00
30	CENTERLINE OF CULVERT	14,399.73	1789.29	610.00
31	CENTERLINE OF CULVERT	14,399.73	1789.29	610.00
32	CENTERLINE OF CULVERT	14,399.73	1789.29	610.00

NOTE PWTC = PROCESS WATER TRANSFER CHANNEL

STANDARD LEGEND
(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- 650 ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- 650 NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- 1001 POINT SURVEYED BY MAUERER-STUTZ, INC.

NOTES:
1. CONTOURS SHOWN IN RECYCLE POND REPRESENT TOP OF LINER.
2. THE PROPERTY IS LOCATED IN SECTION 18, TOWNSHIP 6 NORTH, RANGE 5 EAST, 4TH P.M., FULTON COUNTY, ILLINOIS.

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	ADDED SLURRY PIPING - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	09-29-08	DBH	SMB	SMB	REVISED COORDINATES FOR PROCESS WATER CONTROL STRUCTURE
4	12-19-08	TCJ			REVISED CHIMNEY DRAIN
5	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

RECORD DRAWING

FILE NO. -C180-C102-15.dgn

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service
Corporation No. 184.001352
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DRAWING TITLE
RECYCLE POND PLAN
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

SCALE -
DRAFTER
DATE 03-26-09

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 5
SHEET NO. 15 OF 33

30x42

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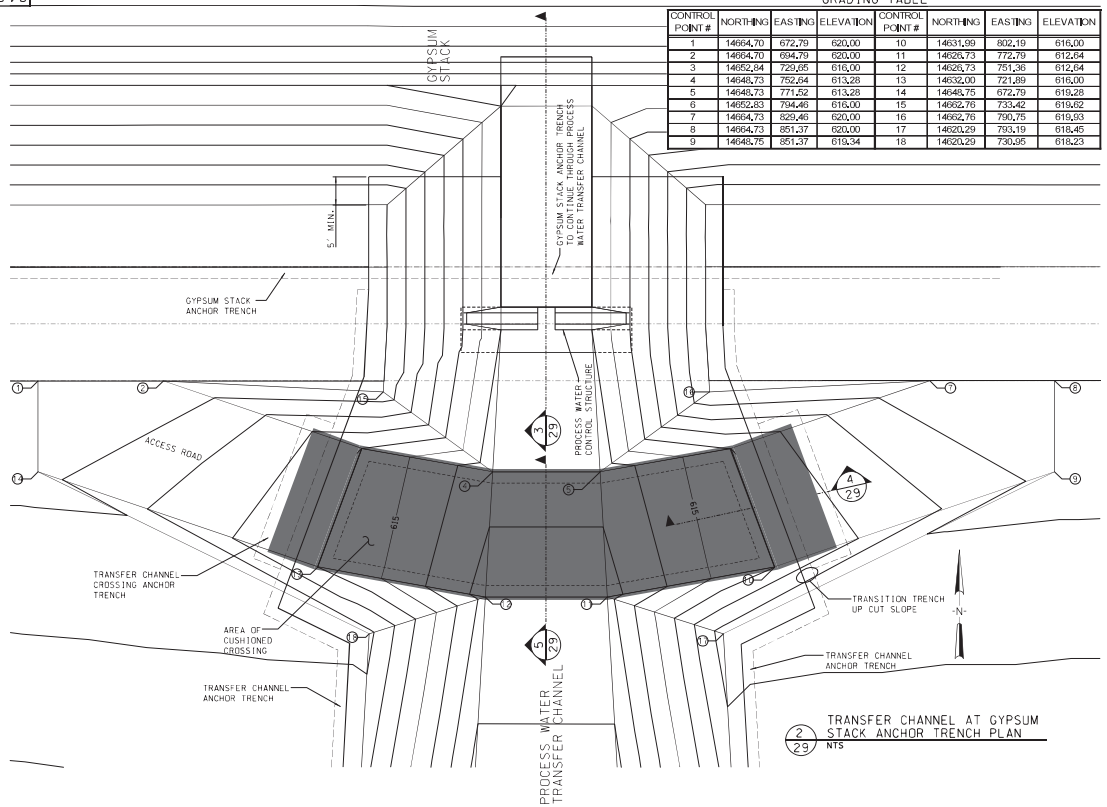
C180-C102

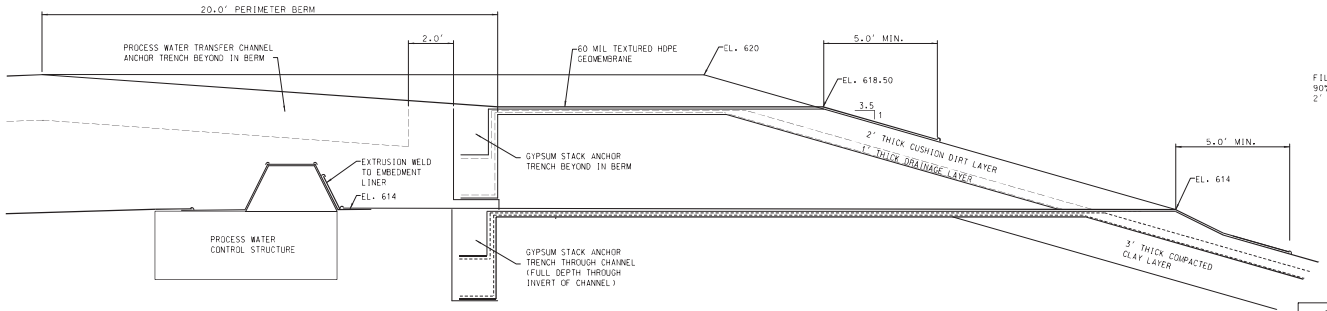
PAGE NO. - 29

GRADING TABLE

CONTROL POINT #	NORTHING	EASTING	ELEVATION	CONTROL POINT #	NORTHING	EASTING	ELEVATION
1	14664,70	672,79	620,00	10	14631,99	802,19	616,00
2	14664,70	694,79	620,00	11	14626,73	772,79	612,64
3	14652,84	729,65	616,00	12	14626,73	751,36	612,64
4	14648,73	752,64	613,28	13	14632,00	721,89	616,00
5	14648,73	771,52	613,28	14	14648,75	672,79	619,28
6	14652,83	794,46	616,00	15	14662,76	733,42	619,62
7	14664,73	829,46	620,00	16	14662,76	790,75	619,93
8	14664,73	851,37	620,00	17	14620,29	793,19	618,45
9	14648,75	851,37	619,34	18	14620,29	730,95	618,23



2 29 TRANSFER CHANNEL AT GYPSUM STACK ANCHOR TRENCH PLAN
NTS

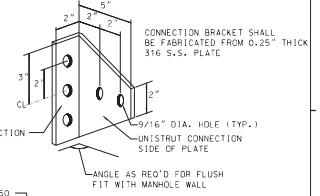


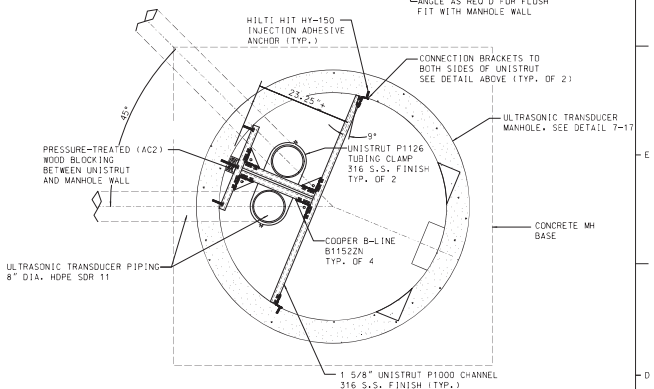
3 29 TRANSFER CHANNEL AT GYPSUM STACK ANCHOR TRENCH SECTION
NTS

NOTE:

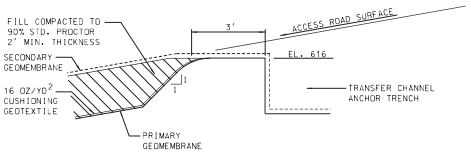
ALL ANCHORS IN MANHOLE WALLS SHALL BE HILTI HIT HY-150 MAX INJECTION ADHESIVE ANCHORS SET TO A DEPTH OF 3".

ALL FASTENER HARDWARE AND UNISTRUT CHANNEL NUTS (PART P1010) SHALL BE 316 S.S. WITH 1/2"x13 BOLT SIZE

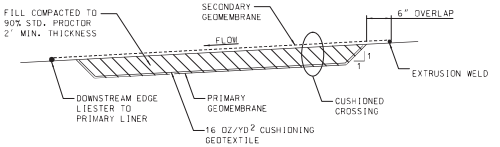




1 29 ULTRASONIC TRANSDUCER PIPE SUPPORT DETAIL
1"=1'



4 29 ACCESS ROAD AT TRANSFER CHANNEL TRENCH
NTS



5 29 ACCESS ROAD THRU PROCESS WATER TRANSFER CHANNEL TRENCH
NTS

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-07-08	TCJ	DBH	SMB	ISSUED FOR CONSTRUCTION
1	01-08-09	TCJ	DBH	DBH	ADDED ACCESS ROAD CROSSING AND DETAILS
2	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION

ENGR	SKB	10-28-08
DRAFTER	SKB	10-28-08
APPR		- / - / -
REVIEWED		-

AWING

FILE NO. -C180-C102-29.dgn

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
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DRAWING TITLE

MISCELLANEOUS DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

SCALE -

DRAFTER

DATE 03-26-09

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 2

SHEET NO. 29 OF 33

30x42

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06/20/2024
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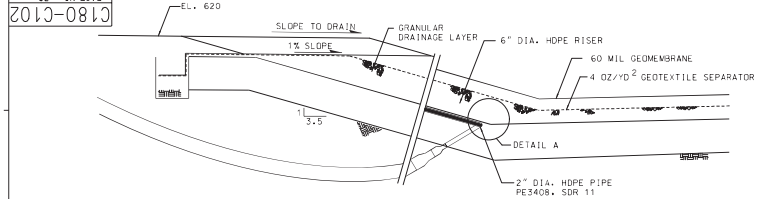
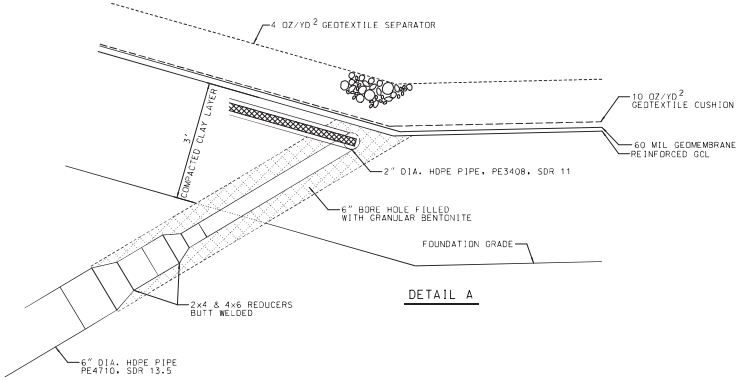
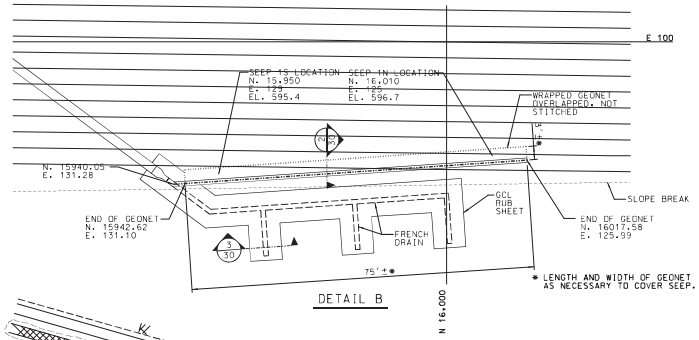


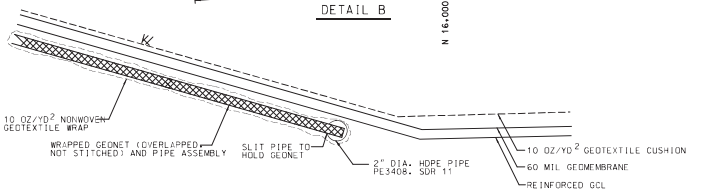
1/30 RISER DETAIL
SCALE: NTS



DETAIL A



DETAIL B



2/30 GEONET DETAIL
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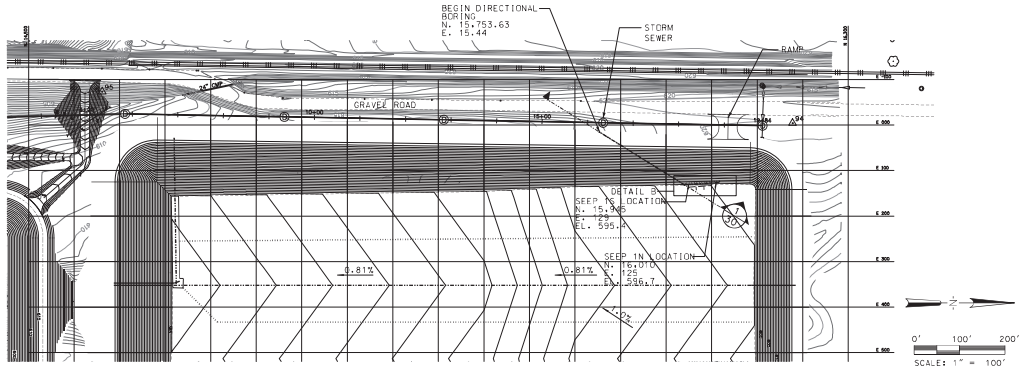
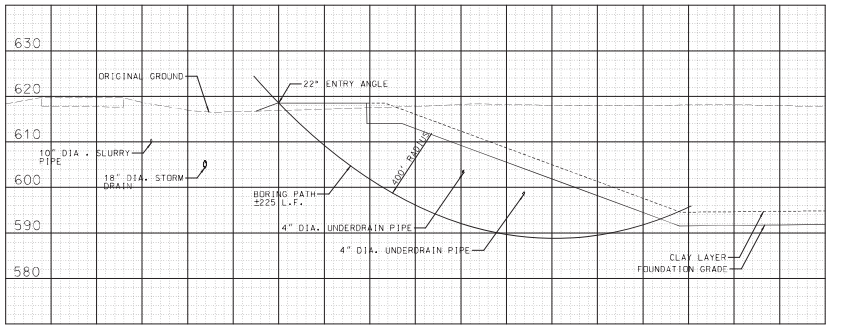
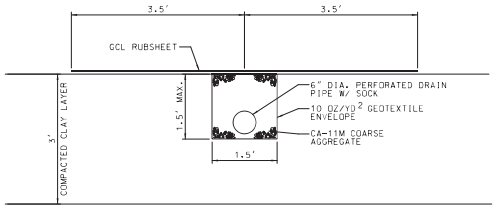




BORING PROFILE

STATION	CLAY LAYER ELEVATION	BORING PATH ELEVATION
0+00	618.50	618.50
0+10	618.50	614.57
0+20	618.50	610.94
0+30	618.50	607.62
0+40	618.50	604.58
0+50	618.50	601.82
0+60	618.26	599.34
0+70	616.79	597.14
0+80	615.31	595.19
0+90	613.84	593.51
1+00	612.36	592.09
1+10	610.89	590.93
1+20	609.41	590.02
1+30	607.94	589.36
1+40	606.46	588.95
1+50	604.98	588.80
1+60	603.51	588.89
1+70	602.03	589.23
1+80	600.56	589.83
1+90	599.08	590.67
2+00	597.61	591.77
2+10	596.13	593.13
2+20	594.66	594.74



3/30 FRENCH DRAIN DETAIL
SCALE: NTS

NOTE:
SEE OTHER PLAN SHEETS FOR STANDARD LEGEND.

RECORD DRAWING

FILE NO. -C180-C102-30_SEEP1.dgn

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DRAWING TITLE

LD/LCRS UNDERDRAIN DEWATERING SYSTEM-SEEP 1

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS

DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 2

SHEET NO. 30 OF 33

SCALE

DRAFTER

DATE 03-26-09

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-07-08	TCJ	RWH	DBH	ISSUED FOR CONSTRUCTION
1	11-14-08	TCJ			REVISED BORING PATH AND ENTRY POINT - ISSUED FOR CONSTRUCTION
2	03-05-09	SKB	JMM		ISSUED FOR RECORD DRAWING BY HANSON

REVISED	TCJ	11-25-08
CHECKED	SKB	12-09-08
DRAWN	DBH	11-26-08

30x42

Brandt09939
09/03/2009
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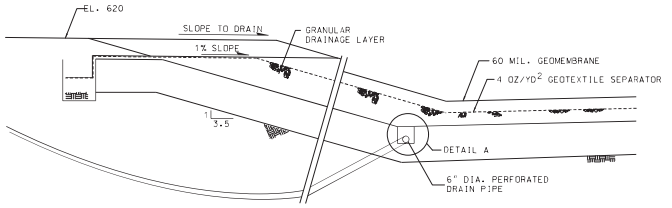
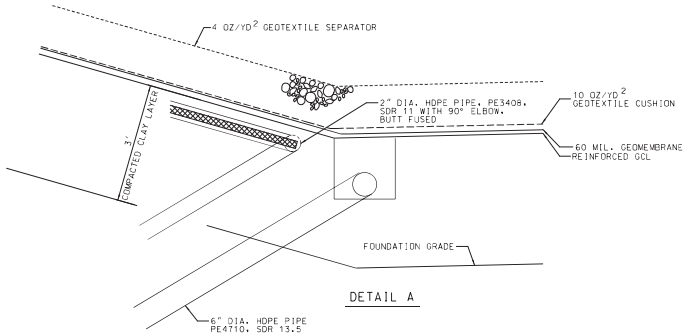
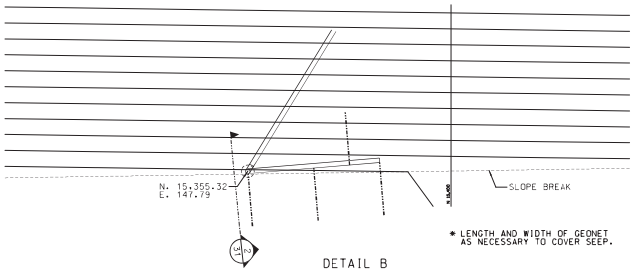


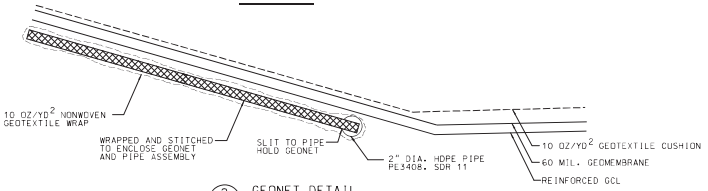
1/31 RISER DETAIL
SCALE: NTS



DETAIL A



DETAIL B



2/31 GEONET DETAIL
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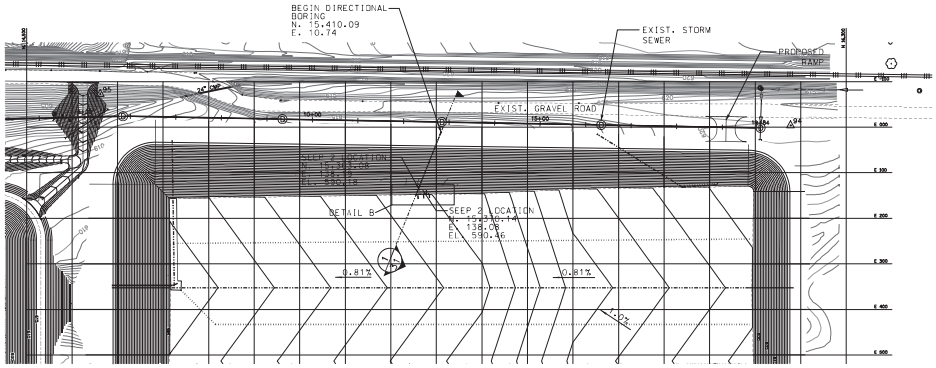

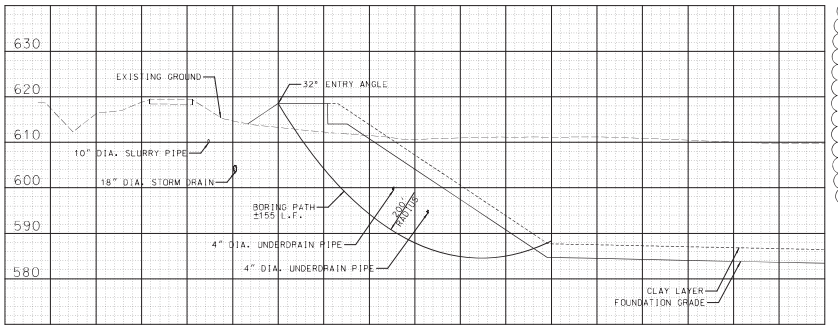

BORING PROFILE

STATION	CLAY LAYER ELEVATION	BORING PATH ELEVATION
0+00	618.50	618.50
0+10	618.50	612.21
0+20	618.50	606.70
0+30	618.50	601.90
0+40	616.55	597.77
0+50	613.88	594.24
0+60	611.21	591.30
0+70	608.55	588.91
0+80	605.88	587.05
0+90	603.21	585.72
1+00	600.54	584.89
1+10	597.88	584.57
1+20	595.21	584.75
1+30	592.54	585.43
1+40	589.88	586.61

①

STANDARD LEGEND

(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- 650 ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- 650 NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING

N

0' 100' 200'
SCALE: 1" = 100'

RECORD DRAWING

FILE NO. -C180-C102-31_SEEP2.dgn

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
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DRAWING TITLE

LD/LCRS UNDERDRAIN DEWATERING SYSTEM-SEEP 2

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy. Resources Generating

DRAWING NUMBER C180-C102 REV. 2

SHEET NO. 31 OF 33

SCALE -
DRAFTER -
DATE 03-26-09

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-19-08	TCJ	—	—	ISSUED FOR CONSTRUCTION
1	11-24-08	TCJ	RWH	DBH	ISSUED FOR CONSTRUCTION REVISED PENETRATION LOCATION
2	03-05-09	TCJ	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

LAYOUT TCJ 11-25-08
DRAWN TCJ 11-25-08
REVIEWED DBH 11-25-08

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AECOM

Appendix C: Duck Creek Power Station Boring and Piezometer Locations

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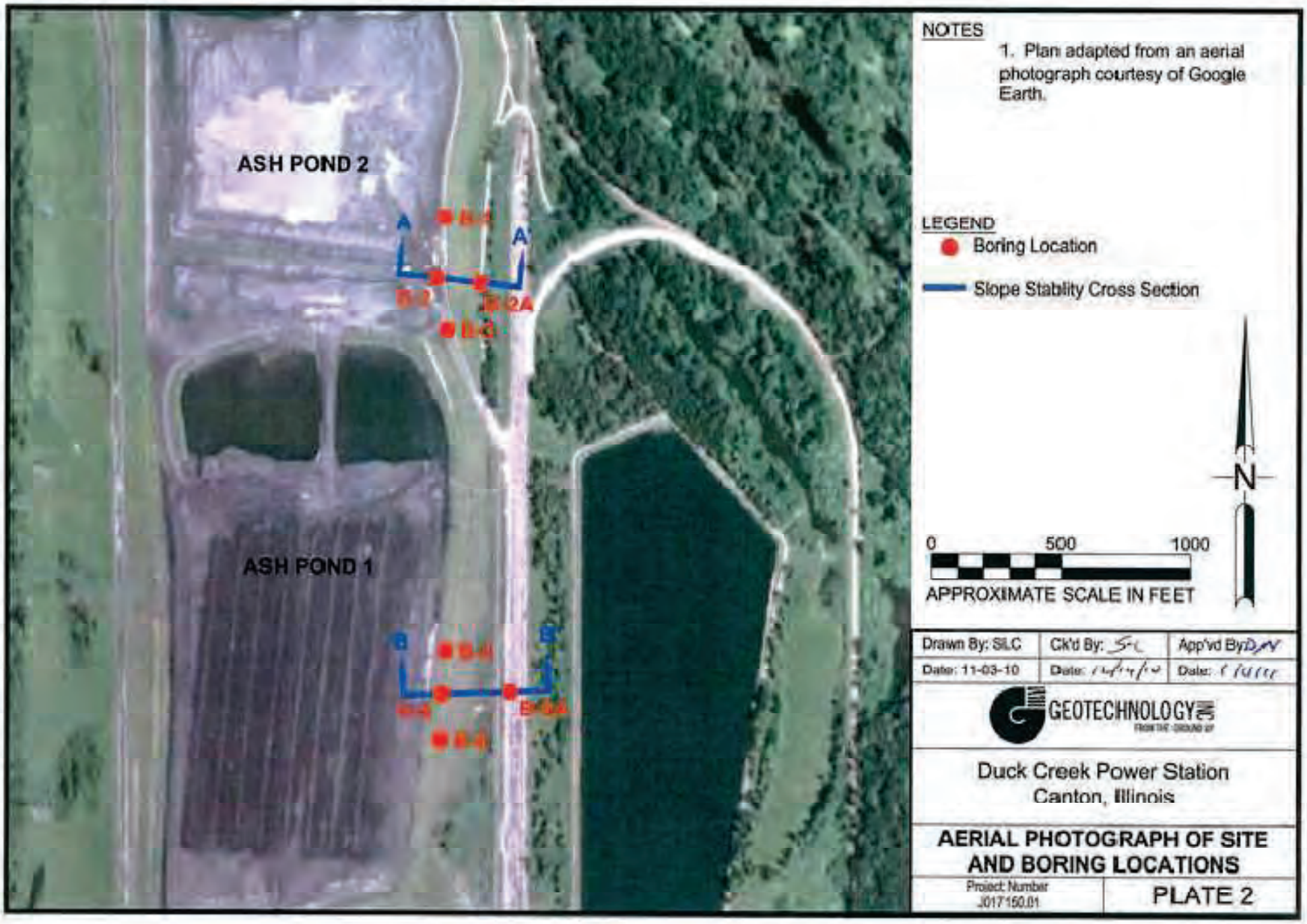

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AECOM



Figure C.1. Piezometer locations for Ash Pond No. 1 and Ash Pond No. 2.

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AECOM

Appendix D: Project Manual; Specification No's.: C180-C102 (excerpt)

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PROJECT MANUAL
GYPSUM STACK AND RECYCLE POND AND CCB LANDFILL CONSTRUCTION
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

SPECIFICATION NO'S.: C180-C102

Prepared For:

AMEREN ENERGY RESOURCES GENERATING COMPANY

Prepared By:

HANSON PROFESSIONAL SERVICES INC.
1525 South Sixth Street
Springfield, Illinois 62703

Specifications for Construction

April 11, 2008

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BIDDING CLARIFICATIONS FOR AMEREN CONTRACT DOCUMENTS
AMEREN ENERGY RESOURCES GENERATING COMPANY
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
PROJECT SPECIFICATIONS NO. C180-C102
ADDENDUM #2

Prepared March 24, 2008
By Hanson Professional Services, Inc.
Preparer: DBH

Hanson Professional Services is please to provide the following clarifications to outstanding questions regarding the contract documents:

1) *Please clarify again Bid Form page BF-A-5 the 146,740 cy is the amount excavated and stockpiled. In addition in that price we include 146,740 cy going back in place?*

   Answer: The Estimated Quantity of 146,740 C.Y. shown on Bid Forms A and B is our estimated TOTAL excavation needed for the Over-excavation of Soil and Sand from NE & SW Corners of Gypsum Stack Area. The excavation shall be backfilled with suitable structural backfill after the unsuitable sand lens material has been removed and stockpiled. Our estimate for unsuitable sand material is the 17,600 C.Y. shown in the same section of the Bid Forms.

2) *What is the status of design on slurry piping plan and details? Currently sheet C102-27 does not provide sufficient information.*

   Answer: An updated sheet will be issued with Addendum #2.

3) *Per sheet C102-05, "All under drain pipes installed under the excavation contract C180-C101 shall remain in place. Subsurface drainage piping shall be sealed with bentonite slurry in accordance with project specifications upon completion of the liner system". Please provide specifications.*

   Answer: Sealing of the subsurface drainage system is specified in Section 02141 - Surface Water Management, paragraph 3.06.

4) *Is dwg. format available with Landfill, Gypsum and Recycle Pond area merged to one drawing. We specifically need existing and proposed contours for both projects consolidated as one design and existing layer. The tins provided are for the Gypsum Pond only, would appreciate fill for Landfill if drawings can not be merged. Will Hanson be able to provide design contours for cushion dirt layer? Currently available drawings provide points only from sheet C102-11.*

   Answer: We will be issuing updated tin & dwg files for the Gypsum Stack Recycle Pond that reflects the work completed under Contract C180-C101 with Addendum #2. Tin & DWG files for the CCB Landfill will be issued later in the week, as it is currently being surveyed and verified.

5) *The granular materials for the drainage layer and seperation berm shall provide a minimum hydraulic conductivity (ASTM D2434) of 1 X 10-3. Is there a specific material anticipated for the completion of this work?*

   Answer: The granular materials required for the drainage layer and separation berm are adequately specified in the Project Specifications. The Contractor shall be responsible for determining availability and sourcing for these materials.

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6) *Is a construction joint allowed in the Process Water Control Structure.*

Answer: A Bonded Construction Joint will be allowed for this structure, provided that it is constructed in accordance with article 503.09 of the Illinois Department of Transportation "Standard Specifications for Road and Bridge Construction" Adopted January 1. 2007.

7) *What if anything is required on the low water crossing on sheet 16 of the CCB Landfill?*

Answer: No special materials are required in this area, the invert of the existing spillway channel shall be maintained and crossed by the proposed haul road.

8) *Is the Coarse Aggregate for the Leachate collection pipe also the IDOT CA-7 Per Article 1004.1 of IDOT Specs.*

Answer: The Coarse Aggregate for the Leachate Collection Pipe shall be a gradation as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec. We will issue a correction to the specifications with Addendum #2.

9) *Detail 7/17 for the Ultrasonic Transducer from your web site is different than your handout at the pre-bid meeting is the web site detail the one we are to provide?*

Answer: The latest detail on the web site is the latest one, however a revision to that detail will be issued with Addendum #2.

10) *Bid Form page A-3 Riprap Class B4, the unit of measure is LF, should that be TONS or S.Y.?*

Answer: The correct unit should be S.Y.

11) *In an effort to utilize local aggregate sources, can we use "Special Provision Rock" as specified by IDOT for Contracts 68206 & 68205 for the aggregate base and surface course?*

Answer: All aggregates shall be supplied as specified in Section 02315 Granular Materials.

12) *Can we substitute a butt fusion reducer in lieu of the 50% welded extrusion joints" as shown in detail 5/13?*

Answer: A butt fusion reducer would be acceptable in that location (Detail 5/13 - Plans C180-C102)

13) *Page 27, slurry piping- Is this the sluice piping from section 2640? There is no size listed on the plans. The plan shows dashed and solid lines, what do they represent. Section 2640 calls for valves in the sluice piping, are these the valves shown on sheet 27?*

Answer: A revised sheet C180-102-27 and a new sheet C180-102-28 are included in Addendum #2.

14) *The specs say all underdrain within lined areas of cell is to be grouted. Is the recycle pond lined?*

Answer: The subdrainage outfall piping beneath the recycle pond is to be grouted.

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15) *We are trying to figure out what gradation of rock is required for detail 6/14 on the gypsum stack and also for detail 1/12 and 2/12 on the CCB Landfill. Section 2315 Part 2 does not have the gradation language we are used to looking at for the CCB Landfill Course Aggregate.*

Answer: The Coarse Aggregate material called out in these details is the same as is specified in Section 02315 - Part 2.01-B-2 for CCB Landfill Coarse Aggregate. A revised specification will be included in this Addendum.

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BIDDING CLARIFICATIONS FOR AMEREN CONTRACT DOCUMENTS
AMEREN ENERGY RESOURCES GENERATING COMPANY
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
PROJECT SPECIFICATIONS NO. C180-C102

ADDENDUM #3

Prepared March 27, 2008
By Hanson Professional Services, Inc.
Preparer: DBH

Hanson Professional Services is pleased to provide the following clarifications to outstanding questions regarding the contract documents:

Question: One GCL manufacturer produces a double nonwoven, needlepunch reinforced geosynthetic clay liner that will meet or exceed the project requirements and the GRI-GCL-3 specification, with only two clarifications:

Footnote #2 in Table 1 of the GRI-GCL-3 specification states that for nonwoven reinforced GCLs, one of the Geotextiles must contain a scrim component of mass > 2.9 oz/yd2 for dimensional stability. An exception to the scrim reinforcement requirement has been requested.

Table 1 of the GRI-GCL-3 specification states that nonwoven reinforced GCLs should be manufactured with minimum 5.9 and 5.8 oz/yd2 Geotextiles. Our product is manufactured with minimum 6.0 and 2.7 oz/yd2 nonwoven Geotextiles and it will still meet the peel and tensile strength requirements in the specifications. Accordingly, an exception to the minimum geotextile weights has been requested.

Answer: *We will allow these exceptions, provided that all of the other requirements of the specifications are met by the GCL being submitted for bid.*

Question: Aggregate suppliers cannot perform the testing required to qualify that their materials will meet the project specifications in the time allotted for bidding. What can the aggregate suppliers do to provide a reasonable quote for the aggregate materials within the Gypsum Stack and CCB Landfill footprints.

Answer: Adequate bidding time was allotted for relatively quick permeability and gradation testing, and these test results should be available. However, based on the time allotted for bidding and the turn-around time needed to complete the longer tests necessary to certify project specification compliance, we will allow aggregate suppliers to certify a unit price for these materials based on the contingency that they will meet the following required specifications:

ASTM D3042-03 Standard Test Method for Insoluble Residue in Carbonate Aggregates (15% loss Max.)

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Na_2SO_4 Soundness 5 Cycle, Illinois Modified AASHTO T 104 (15% Loss Max.)
ASTM C 1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) (Less than 0.10% internal expansions at 16 days after casting)

Additional question related to the overexcavation and replacement of materials in the NE and SW corners of the gypsum stack area:
Please clarify "The excavation shall be backfilled with suitable structural backfill". How and where will that backfill be paid for?

Answer: Please note that the bid form section for additional items to be paid on a unit cost or time and material basis provides estimated quantities only. The bid form allows for separate pricing for unsuitable sand soils that will need to be excavated from the NE and SW corners of the gypsum stack areas and transported to stockpiles (estimated at 17,600 cy) and for excavation and recompaction of soil material suitable for reuse (estimated at 146,740 cy). Based on these ESTIMATED volumes, the total ESTIMATED volume to be over-excavated from the NE and SW corners of the gypsum stack excavation is 164,340 cy (17,600 cy of which is estimated to be unsuitable sand that needs to be transported out of the excavation and stockpiled). Note again that we will be removing an unknown amount of sand from the excavation. Shrinkage as a result of the compaction process may also be a factor. Any shortage of suitable backfill shall be obtained from the subsoil stockpiles. Backfilling the excavation with Structural Fill to be obtained from stockpiles will be paid for at Time and Material or by the unit cost included on the bid form for "Backfill w/Structural Fill from Stockpile."

Question: Can the test pad for the clay liner be constructed outside the footprint of the cell?

Answer: The test soil liner must be constructed within the footprint of the cell.

What end treatment is to be applied to the upstream ends of the 6" and 12" perforated laterals shown on Sheet C180-C110-09 and detailed on sheet C180-C110-12 for the CCB Landfill?

Answer: Cleanouts with threaded caps shall be installed at the termination points for the 6" and 12" perforated laterals. Revised drawing #C180-C110-09 is attached indicating this detail.

Question: The new details for vaults on the slurry lines show 8" RFP being bolted into 8" Valves, then a 10" HDPE pipes. The bolt patterns on the 10" pipe and 8" valve are not compatible. Please clarify.

Answer: An FRP spindle needs to be provided to go from the 8" valve to the 10" HDPE pipe. Revised drawing #C180-C102-28 is attached to show this configuration.

FINAL NOTE: THE BIDS ARE DUE MONDAY, 3/31/08. NO MORE QUESTIONS WILL BE ACCEPTED PRIOR TO BIDDING. PLEASE INCLUDE ANY ADDITIONAL ASSUMPTIONS AND CLARIFICATIONS WITH YOUR BIDS.

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GYPSUM STACK AND RECYCLE POND AND CCB LANDFILL CONSTRUCTION
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

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Appendix 1 – Field Change Order Process

Appendix 2 – Construction Quality Assurance (CQA) Plan

Appendix 3 – Geotechnical Data

~~Appendix 4 – Construction Field Office~~

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DIVISION 1 - GENERAL REQUIREMENTS
Section 01010 - Summary of Work
ADDENDUM #1

PART 1. GENERAL

1.0 INTRODUCTION

A. Gypsum Management Facility

The intent of this contract is to provide the services of a General Contractor to construct Gypsum Management Facility, consisting of a lined Gypsum Stack and Recycle Pond for the disposal of gypsum at Ameren Energy Resources Generating Company (AERG) Duck Creek Power Station's Gypsum Management Facility located near Canton, Illinois.

Excavation to approximately 5.4 ft. above foundation grade, partial construction of Recycle Pond perimeter berm, installation of a temporary stormwater outlet ditch, a temporary subsurface drainage system and the Recycle Pond pump station pad with access road were completed under a prior contract as outlined in the plans. Excavated material was stockpiled north and east of the excavation for use in this contract.

B. CCB Landfill

The intent of this contract is to provide the services of a General Contractor to construct a CCB Landfill, consisting a base 3 ft. thick Compacted Clay Liner, Geosynthetic Clay Liner (GCL), High Density Polyethylene (HDPE) Geomembrane, Geotextile Cushion Fabric and Leachate Collection System for the permanent disposal of coal combustion by-products (CCB) at the Ameren Energy Resources Generating Company (AERG) Duck Creek Power Station CCB Landfill located near Canton, Illinois.

Excavation to approximately 6 in. above foundation grade, construction of perimeter berm, installation of a permanent berm ditch outlet structure and a temporary subsurface drainage system were completed under prior contract. Excavated material was visually segregated during excavation and stockpiled east of the excavation for use in this contract.

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2.0 DESCRIPTION OF WORK

2.01 Gypsum Management Facility

The scope of work shall consist of furnishing all materials, equipment, tools, labor, and incidentals necessary to perform the work as described below:

A. Gypsum Stack - Foundation Preparation

1. Excavate areas indicated on the plans to remove areas of underground sand seams and backfill with structural soil backfill.
2. Locally excavate to the foundation grade as indicated on the plans and finish grade the portion of the cell to be covered by Compacted Clay Liner.
3. Proof roll to identify unsuitable foundation soil materials.
4. As directed by the Owner's Representative, Excavate and replace unsuitable foundation materials consisting of unknown pockets of peat, sand, muck or other unsuitable materials with suitable structural backfill. Installation of geotextile fabric for ground stabilization, as deemed necessary by the owner's Representative, will be installed on a time and materials basis.

B. Gypsum Stack - Compacted Clay Liner

1. Construct Test Soil Liner, as outlined Section 5.0 of the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, to demonstrate construction procedures and equipment that will produce the specified permeability.
2. Obtain Foundation Grade Verification by Amerens Field Surveyor prior to constructing areas requiring Compacted Clay Liner, as outlined in Section 6.2.1a of the project Construction Quality Assurance Plan.
3. Install Compacted Clay Liner in accordance with the project specifications using the compactive means demonstrated by the Test Soil Liner.

C. Gypsum Stack - Excavation and Backfill of Anchor Trench

1. Excavate anchor trench.
2. Place initial trench backfill after installation of Geosynthetic Clay Liner (GCL) and High Density Polyethylene (HDPE) Geomembrane by geosynthetic liner Contractor.
3. Complete trench backfill after installation of separation geotextile.

D. Gypsum Stack - Geosynthetic Clay Liner (GCL)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Compacted Clay Liner with the Owner's Representative

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before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Compacted Clay Liner during GCL placement and submit a Certificate of Acceptance in the daily report that no GCL was placed over visibly defective Compacted Clay Liner.

2. Furnish and install GCL on accepted Compacted Clay Liner. Provide reinforced GCL on the sideslopes and bottom of Gypsum Stack. Protect GCL per the Manufacturer's recommendations until it is covered by HDPE Geomembrane

E. Gypsum Stack High Density Polyethylene (HDPE) Geomembrane (Lower Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the GCL with the Owner's Representative: continuously observe the condition of the GCL during HDPE Geomembrane placement; and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective GCL.
2. Furnish and install HDPE geomemebrane on accepted GCL. Provide textured HDPE liner on the side slopes and bottom of the Gypsum Stack. Protect HDPE liner until it is covered by geotextile cushion fabric.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

F. Gypsum Stack - Geotextile Cushion Fabric

1. The Geosynthetics Installer's Representative shall jointly inspect the HDPE Geomembrane with the Owner's Representative: continuously observe the condition of the HDPE Geomembrane during placement of the geotextile cushion fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective HDPE Geomembrane.
2. Furnish and install geotextile cushion on accepted Geomembrane.
3. Furnish and install drainage layer material for ballast.

G. Gypsum Stack - HDPE Leachate Collection Piping

1. Furnish and install geotextile fabric for coarse aggregate envelope.
2. Furnish and install initial lift of coarse agregate.
3. Furnish and install leachate collection piping as shown on the plans.
4. Furnish and install coarse aggregate along the pipe to provide lateral stability.
5. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design

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requirements before placing remainder of coarse aggregate and geotextile envelope.

H. Gypsum Stack - Drainage Layer

1. Furnish and install granular material for drainage layer in accordance with the project plans and specifications.
2. Obtain verification by the Owner's Field Surveyor that the minimum required Drainage Layer thickness has been achieved.

I. Gypsum Stack - Separation Fabric

1. The Geosynthetics Installer's Representative shall jointly inspect the Drainage Layer with the Owner's Representative; continuously observing the condition of the surface of the Drainage Layer during placement of the Geotextile Separation Fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective Drainage Layer surface.
2. Furnish and install geotextile fabric on accepted Drainage Layer and anchor geotextile fabric in anchor trench.

J. Gypsum Stack - Cushion Dirt

1. Place Cushion Dirt to facilitate installation of the second HDPE Geomembrane. The Contractor shall protect the underlaying Separation Fabric per the project specifications.
2. Obtain verification by the Owner's Field Surveyor that the minimum required Cushion Dirt thickness has been achieved.

K. Gypsum Stack High Density Polyethylene (HDPE) Geomembrane (Upper Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Cushion Dirt with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Cushion Dirt during HDPE Geomembrane placement and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective Cushion Dirt.
2. Furnish and install HDPE Geomembrane on approved Cushion Dirt. Provide textured HDPE Geomembrane on cell side slopes and bottom of cell. Protect HDPE Geomembrane until it is initially covered by gypsum waste material.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

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L. Gypsum Stack - HDPE Process Water Recovery System

1. Furnish and install HDPE Process Water Collection System, as shown on the plans.
2. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design requirements before covering the piping with aggregate and filter fabric as shown on the plan.

M. Gypsum Stack - Miscellaneous Earthwork

1. Provide access ramp to perimeter berm of cell.

N. Gypsum Sluice Piping

1. Connect to existing piping and install new Gypsum Sluice Piping, fittings and valves for the Gypsum Stack.

O. Gypsum Stack - Subdrainage System

1. Abandon existing subdrainage system, and remove vent pipes, vertical drains and inlet structures as specified in Section 02140 – Surface Water Management.

P. Gypsum Stack - Erosion Control

2. Maintain previously installed temporary erosion control systems during the life of the contract.
3. Seed and mulch all exposed soil surfaces.

Q. Recycle Pond - Earthwork

1. Strip topsoil from areas of the proposed excavation and proposed compacted berms.
2. Excavate the recycle pond to the lines and grades shown on the plans.
3. Proof roll stripped/excavated areas to expose unsuitable materials.
4. Remove and replace unsuitable foundation material and/or install geotextile fabric for ground stabilization as directed by the Owner's Representative. Work required to correct unsuitable foundation material will be paid by the Owner on a Time and Materials Basis.
5. Construct Recycle Pond Embankments, Process Water Transfer Channel and Emergency Spillway to the line and grades shown on the plans.

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R. Recycle Pond – Toe Drain

1. Furnish and install aggregate materials and filter fabric at the outside toe of the recycle pond dam as shown on the plans.

S. Recycle Pond - Excavation and Backfill of Anchor Trench

1. Excavate anchor trench.
2. Backfill trench after installation of High Density Polyethylene (HDPE) Geomembrane by Geosynthetics Installer.

T. Recycle Pond - HDPE Geomembrane

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the recycle pond foundation soils with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the foundation soils during HDPE Geomembrance placement and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective foundation soil.
2. Furnish and install HDPE Geomembrane on approved foundation soil. Provide textured HDPE Geomembrane on recycle pond side slopes and bottom. Anchor in the excavated anchor trench and backfill in accordance with the project specifications.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

U. Recycle Pond - Water Transfer Structures

1. Furnish, fabricate, and install all materials and aggregate necessary to construct the Process Water Control Structure, Process Water Transfer Channel, Recycle Pond Emergency Spillway/Riprap Stilling Basin, and Side Slope Decant Pipe/Riprap Basin as shown on the plans.

~~V. Construction Field Office~~

~~The Contractor shall furnish and install a Construction Field Office for the Owner's use in accordance with the Specifications of Appendix 4 of these Specifications.~~

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2.02 CCB Landfill

A. Foundation Preparation:

1. Remove top 6" of soil from the existing excavation and stockpile in an area designated on the Plans.
2. Finish grade the portion of the cell to be covered by Compacted Clay Liner.
3. Proof roll to expose any unsuitable foundation materials..
4. Remove and replace unsuitable foundation material and/or install geotextile fabric for ground stabilization as directed by the Owner's Representative.

B. Compacted Clay Liner

1. Construct Test Soil Liner, as outlined Section 5.0 of the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, to demonstrate construction procedures and equipment that will produce the specified permeability.
2. Obtain Foundation Grade Verification by Amerens Field Surveyor prior to constructing areas requiring Compacted Clay Liner, as outlined in Section 6.2.1a of the project Construction Quality Assurance Plan.
3. Install Compacted Clay Liner in accordance with the project specifications using the compactive means demonstrated by the Test Soil Liner.

C. Excavation and Backfill of Anchor Trench:

1. Excavate anchor trench.
2. Place initial trench backfill after installation of GCL and HDPE geomembrane by geosynthetic liner contractor.
3. Complete trench backfill after installation of separation geotextile.

D. Geosynthetic Clay Liner (GCL)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Compacted Clay Liner with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Compacted Clay Liner during GCL placement and submit a Certificate of Acceptance in the daily report that no GCL was placed over visibly defective Compacted Clay Liner.
2. Furnish and install GCL on accepted Compacted Clay Liner. Provide re-inforced GCL on the sideslopes and bottom of the cell. Protect GCL per the Manufacturer's recommendations until it is covered by HDPE Geomembrane

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E. High Density Polyethylene (HDPE) Geomembrane (Lower Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the GCL with the Owner's Representative; continuously observe the condition of the GCL during HDPE Geomembrane placement; and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective GCL.
2. Furnish and install HDPE Geomemebrane on accepted GCL. Provide textured HDPE Geomembrane on cell side slopes and smooth HDPE Geomembrane on bottom of the cell. Protect HDPE liner until it is covered by geotextile cushion fabric.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

F. Geotextile Cushion Fabric:

1. The Geosynthetics Installer's Representative shall jointly inspect the HDPE Geomembrane with the Owner's Representative; continuously observe the condition of the HDPE Geomembrane during placement of the geotextile cushion fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective HDPE Geomembrane.
2. Install geotextile cushion on accepted Geomembrane.
3. Install drainage layer material for ballast.

G. HDPE Leachate Collection Piping:

1. Place geotextile fabric for coarse aggregate envelope.
2. Place initial lift of Coarse Aggregate Bedding.
3. Furnish and install HDPE Leachate Collection Piping on Coarse Aggregate bedding.
4. Place coarse aggregate along the pipe to provide lateral stability.
5. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design requirements before covering the piping with remainder of coarse aggregate and geotextile envelope as shown on the plans.

H. Drainage Layer and Separation Berm:

1. Place granular material for separation berm and drainage layer.

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I. Separation Fabric:

1. Install geotextile fabric on accepted drainage layer and anchor geotextile fabric in anchor trench.

J. Haul Road

s

1. Funish materials and construct Haul Road to the top of the CCB Landfill.

K. Miscellaneous Earthwork:

1. Provide construction access ramp to bottom of cell.
2. Place general fill to form in-board side of berm ditch.

L. Construct and maintain temporary erosion control systems during the life of the contract. Remove and dispose of temporary erosion control items when no longer required. Seed and mulch all remaining disturbed soil surfaces.

3.0 OWNER AND MANUFACTURER'S DRAWINGS

3.1 Provided By Ameren Energy Resources Generating

A. Hard-Copy Drawings

The following drawings are intended to indicate the scope of the work to be done and details necessary for the installation of items set forth in this specification, and are part of this specification. These drawings in general are to scale, but dimensions shall always be followed and drawings are not to be scaled. In case of errors or discrepancies, the Owner's Representative shall be consulted for the adjustment of all complications arising therefrom. The Owner's Representative's decisions shall be final.

AERG DRAWING NO.	SHEET TITLE
C180-C102-01	Title & Index
C180-C102-02	General Notes
C180-C102-03	Site Plan
C180-C102-04	Existing Site Conditions
C180-C102-04A	Existing Subsurface Drainage Profiles
C180-C102-05	Existing Subsurface & Vertical Drain Details
C180-C102-06	Existing Subsurface Drainage Details
C180-C102-07	Existing Grading Plan
C180-C102-08	Gypsum Stack-Foundation Grade
C180-C102-09	Gypsum Stack-Top of Clay Layer
C180-C102-10	Gypsum Stack- Leak Detection/Leachate Collection

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AERG DRAWING NO.	SHEET TITLE
	Recovery System (LD/LCRS) Drainage Layer Grade
C180-C102-11	Process Water Recovery System (PWRS) - Ring Drain System Cushion Dirt Layer Grade
C180-C102-12	PWRS-Ring Drain Details
C180-C102-13	PWRS-Ring Drain Details
C180-C102-14	LD/LCRS Sections & Details
C180-C102-15	Recycle Pond Plan
C180-C102-16	Recycle Pond Details
C180-C102-17	Recycle Pond Details
C180-C102-18	Access Road and Pump Station Site Plan
C180-C102-19	Access Road Vertical Alignments
C180-C102-20	Erosion Control Plan
C180-C102-21	Erosion Control Details
C180-C102-22	Groundwater Monitoring & Boring Plan
C180-C102-23	Geological Cross Sections
C180-C102-24	Geological Cross Sections
C180-C102-25	Geological Cross Sections
C180-C102-26	Geological Cross Sections

AERG DRAWING NO.	SHEET TITLE
C180-C110-01	Title and Index
C180-C110-02	General Notes
C180-C110-03	Site Plan
C180-C110-04	Foundation Grade Plan
C180-C110-05	Foundation Grade Control Data
C180-C110-06	Base Grade Plan
C180-C110-07	Base Grade Control Data
C180-C110-08	Geomembrane Panel Layout
C180-C110-09	Drainage Layer Grade Plan & Leachate Collection Piping
C180-C110-10	Drainage Grade Control Data
C180-C110-11	Typical Sections and Details
C180-C110-12	Leachate Collection Details
C180-C110-13	Typical Cross Sections
C180-C110-14	Separation Berm Details
C180-C110-15	Exist. Sub-Drain Plan & Details
C180-C110-16	~~Haul Road / Construction Water Access Road Plan~~ ***Landfill Haul Road***
~~C180-C110-17~~	~~Construction Water Access Road~~
C180-C110-17	Boring Well and Section Locations

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AERG DRAWING NO.	SHEET TITLE
C180-C110-18	Geologic Cross Sections A and B
C180-C110-19	Geologic Cross Sections C, D, and E
C180-C110-20	Geologic Cross Sections F to K

B. Electronic Files

The following electronic files are provided solely for the convenience of the bidder and/or Contractor and are subject to the terms and conditions stipulated in the Disclaimer text included with the electronic files.

1. Drawings listed above in PDF format.
2. TIN files of the existing and proposed ground surfaces.
3. Bid Forms.
4. Disclaimer text.

In the event of a conflict between the hard-copy documents and the electronic files, the hard-copy documents shall govern.

3.2 Provided by the Contractor

The Contractor shall submit to the Owner's Representative, with such promptness as to cause no delay in the performance of the work, four copies of shop drawings, product data sheets, etc., as required by these specifications. No purchasing, fabrication, erection, processing, or shipping of the aforementioned materials may begin until the required documentation has been reviewed by the Owner.

Three copies of data required to be submitted to the Owner's Representative shall be forwarded to each of the following:

Ameren Energy Resources Generating
Dave Boyce
Duck Creek Power Station
17751 North CILCO Road
Canton, Illinois 61520

Hanson Professional Services Inc.
Steven Bishoff
1525 South Sixth Street
Springfield, Illinois 62703-2886

Data sheets and shop drawings shall be reviewed and returned to the Contractor within ten (10) working days after receipt. Approval is for general design features only and will not relieve the Contractor of responsibility for proper quantities, adequacy of details, and

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coordination with other trades. Deviation from Contract Documents are not approved unless specifically requested in writing by the Contractor and approved in writing by the Owner.

Should field changes be required, such changes shall be promptly documented by the Contractor and submitted to the Owner in the form of as-built drawings. The field change order process is included in Appendix 1.

4.0 MATERIALS AND EQUIPMENT SUPPLIED BY THE OWNER

The materials and equipment that are to be furnished by the Owner are listed in the schedule below:

ITEM	SHIPPING DATE	LOCATION
~~Drainage Layer Material (Gypsum Stack & CCB Landfill)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Coarse Aggregate Encasement for Ring Drain Piping (IDOT CA-7) (Gypsum Stack)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Filter Sand for Protection of Ring Drain Piping (IDOT FA-1) (Gypsum Stack)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Coarse Aggregate Coarse Encasement For Leachate Collection Piping (CCB Landfill)~~	~~Prior to Start of Construction~~	~~Stockpile~~

Note: Per Addendum #1, none of the above listed aggregates will be supplied by the owner

5.0 MATERIALS AND EQUIPMENT FURNISHED BY THE CONTRACTOR

All materials, equipment, tools, and any incidental items necessary to complete each portion of the work described herein and/or shown on the drawings shall be furnished by the Contractor.

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6.0 UTILITIES, FACILITIES, AND MISCELLANEOUS

The following utilities, facilities, etc., shall be provided as indicated.

	Item	Provided By
A.	Telephone Service for Use of Construction Forces	Contractor
B.	Sanitary Facilities	Contractor
C.	Drinking Water	Contractor
D.	Construction Water	Contractor
E.	Electric Service for Contractor's Use	Contractor
F.	Construction Office and Storage Facilities for Contractor's Use	Contractor
G.	Construction of Gravel Haul Roads and Parking Area for Construction Forces	Contractor

Submit with the bid documents a general layout of temporary facilities required for the Contractor's operations, such as haul roads, parking areas, temporary drainage facilities, Contractor's construction field office and storage facilities, electric service, telephone service, staging and laydown areas, etc.

7.0 SCHEDULE

The Contractor shall be required to furnish the Owner's Representative with a complete schedule of the Work to be performed under this contract broken down by major activity.

The schedule shall include the Contractor's estimate of man-days required for each activity, and shall show precedent relationships between activities. The schedule shall be included as part of the bid package presented by the Contractor. The schedule shall comply with the dates and guidelines listed below:

A. The required start date of this contract is upon receipt of Purchase Order. The Purchase Order is expected to be issued within two (2) weeks of the bid due date.

B. The required finish date of this for the Gypsum Management Facility Contract is September 30, 2008. The required finish date for the CCB Landfill Contract is December 31, 2008 for the Scope of Work incuded in Bid Forms A & C.

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C. The level of detail in each schedule shall be sufficient to permit the Owner to monitor the Contractor's performance relative to the specified guidelines. The required level of detail will be discussed at the pre-bid meeting.

D. The Contractor shall submit a daily construction report and shall furnish schedule status reports at weekly progress meetings until the work is completed. The schedule status reports shall indicate by activity the scheduled percent of completion as shown on the original schedule, the actual percent completion as of the date of the report, and the number of man-days expended on the project to date.

If at any time during this Contract, when the Contractor's actual progress, in the opinion of the Owner, is such that the completion dates of the work will not be met, the Contractor shall participate in a re-evaluation of the remaining work.

If, as a result of this re-evaluation of the remaining work, it is determined by the Owner that the completion date will not be met, the Owner retains the right to direct the Contractor to accelerate the construction program. It shall be the responsibility of the Contractor to initiate and comply with such corrective action as required or directed.

At the time of the award of this contract, scheduling requirements will be discussed in detail by all interested parties.

8.0 CONSTRUCTION QUALITY CONTROL ASSURANCE

A. Construction Quality Assurance Plan

A Construction Quality Assurance (CQA) Plan has been developed for this project to ensure compliance with the all applicable permit requirements. A copy of this plan is included in Appendix 2. The testing requirements and frequency of this plan will govern in instances which there may be discrepancies between the CQA Plan and these specifications.

B. Testing and Inspections:

1. The Contractor is responsible for construction quality control testing, sampling, and inspections to ensure that the materials and workmanship comply with the plans and specifications. The Contractor shall submit results of construction quality control testing. The Contractor shall visually inspect underlying surfaces on a continuous basis immediately ahead of placement of geosynthetics and geotextile and shall certify in the daily report that no material was placed over visibly defective substrate.
2. The Contractor is responsible for non-destructive testing of all Geomembrane seams and for providing samples for prequalification material testing and destructive seam testing as directed by the Owner's

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Representative. The minimum sampling frequencies are specified in Appendix 2.

3. Except as specified above, Construction Quality Assurance (CQA) testing, sampling, and inspections to verify compliance with the plans and specifications are the responsibility of the Owner. The CQA sampling and testing requirements are summarized in Appendix 2. The Contractor shall coordinate and cooperate with the Owner's materials testing consultant to provide samples and accommodate testing activities at no additional cost to the Owner.

C. Construction Surveying

Construction surveying for layout and grading control shall be the responsibility of the Contractor. Finished grades will be surveyed by the Owner's surveyor to verify that the finished grade is within 0.1 ft. of plan grade.

D. CQA Surveys to certify material thickness, leachate piping and ditch grades are the responsibility of the Owner. CQA Surveying requirements are summarized in Appendix 2.

9.0 COORDINATION WITH OTHERS

This Contractor will work in close harmony with other Contractors or AERG personnel who may be employed at this site. In the event of differences of opinion regarding scheduling of work, the decision of the Owner will be final and binding.

The following construction activities are anticipated within the landfill facility boundary during this contract:

A. Loading and Hauling of coal combustion by-product to the site by AERG personnel or Contractor.

B. Loading and Hauling of water for dust contol operations on AERG property.

C. Loading and hauling stockpiled excavated material from the stockpile south of East McKinley Road by Fulton County Highway Department Contractor and by Ameren personnel or contractor.

D. Monitoring, removing, and disposing of leachate by Ameren's CCB disposal facility operator.

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10.0 SAFETY AND SITE SECURITY

The Contractor will comply with safety and security requirements stipulated in the General Conditions and Supplemental General Conditions.

A. Although the Ameren Energy Resources Generating property is generally fenced and patrolled by Ameren Energy Resources Generating security, the site should not be considered secure.

1. A Security Check-In Station will be provided by AERG for the duration of the construction project at the entrance on McKinley Road.

B. Contractor personnel will be required to attend a 2-hour site-specific safety orientation conducted by the Owner.

C. Contractor personnel will be required to submit to a ten (10) panel drug test to be performed and provided by AERG.

D. A copy of the Contractor's Field Construction Safety Program shall be submitted with the Contractor's bid package.

E. The Contractor shall have a designated Safety Supervisor on site whenever construction work is being performed.

11.0 DUST CONTROL

The Contractor shall be responsible for controlling dust and air-borne dirt generated by construction activities. Dust shall be controlled by applying water to exposed surfaces, particularly surfaces on which construction vehicles travel. Water from the Duck Creek Reservoir is unsuitable. A pond north and east of the proposed CCB Landfill is designated at the only water source available for use by the Contractor.

No chemical dust suppressants shall be permitted unless approved in writing by the Owner's Representative. Dust control measures shall be readily available for implementation whenever the Contractor or the Owner's Representative deems that that dust control is needed. The cost of dust control shall be included in the contract lump sum price.

PART 2. PRODUCTS

No products used.

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PART 3. EXECUTION

1.0 The Contractor shall be responsible for inspecting the site to note any and all conditions that may affect the work under the contract. The Contractor shall satisfy himself as to the nature, extent and location of the work; the configuration of the ground; the equipment and facilities needed for construction; the general and local conditions of the area; and all other factors and conditions which can, in any way, affect the work under the contract. Any failure by the Contractor to do so will not relieve him from responsibility for successfully performing the work without additional expense to the Owner.

2.0 The Contractor is specifically advised of the presence of overhead power lines that traverse the project work area.

END OF SECTION 01010

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DIVISION 1–GENERAL REQUIREMENTS
Section 01356 – Storm Water Pollution Prevention Measures

PART 1. GENERAL

1.01 DESCRIPTION

A. This section pertains to the construction and maintenance of existing and proposed temporary erosion control systems to control erosion and sediment damage to adjacent properties and water resources.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

02936 - Topsoil, Seeding, and Mulching.

1.03 REFERENCES

The following reference, or cited portions thereof, governs the work:

Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SUBMITTALS

A. Submittals shall follow the provisions of Section 01010.

B. Preconstruction Submittals: A storm water best management practices (BMP) plan shall be submitted that includes the following items:

1. Inspection and record-keeping procedures; and
2. Maintenance procedures for erosion controls.

PART 2. PRODUCTS

2.01 EROSION CONTROL SYSTEMS

Materials for erosion control systems shall be in accordance with Article 280.02 of the IDOT Standard Specifications.

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PART 3. EXECUTION

3.01 EXAMINATION

The site shall be examined to determine the condition existing temporary erosion controls systems installed under a prior contract and the extent of new work required.

3.02 PRECONSTRUCTION JOBSITE INSPECTION

A. The person who shall be at the jobsite during construction and who shall be responsible for insuring that erosion control work is completed in a timely manner shall be identified at the preconstruction meeting.

B. A jobsite inspection shall be conducted with the Owner's Representative to review and designate the locations and types of erosion protection to be placed. The inspection shall be scheduled at the preconstruction conference and carried out on the job site before beginning any work that will disturb existing drainage or potentially create erodible conditions.

3.03 CONSTRUCTION

A. Temporary erosion control systems shall be constructed in accordance with IDOT Standard 280001 and Article 280.04 of the Standard Specifications and as directed by the Owner's Representative. Erosion control devices shall be in place and approved by the Owner's Representative prior to beginning other work.

B. Incorporate permanent erosion control features into the project at the earliest practicable time to minimize the need for temporary erosion controls.

3.04 MAINTENANCE

A. Temporary erosion control systems shall be maintained in accordance with Article 280.05 of the Standard Specifications, except that measurement and payment provisions shall not apply.

B. Temporary erosion control systems for unprotected disturbed areas shall be cleaned of trapped sediment and repaired immediately prior to project close out.

C. Temporary seeding shall be applied to all disturbed areas except the gypsum stack excavation and the future fill and topsoil stockpiles.

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3.05 REMOVAL AND DISPOSAL

All temporary erosion control system shall be left in place by the Contractor for future construction operations at both facilities.

END OF SECTION 01356

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DIVISION 2 - SITE WORK
Section 02010 - Subsurface Investigation

PART 1. GENERAL

1.01 DESCRIPTION

Logs of borings and laboratory soil test data.

PART 2. PRODUCTS

No products used.

PART 3. EXECUTION

3.01 TEST BORINGS

A. Test borings were taken at the locations shown on the drawings. Copies of boring logs, along with soil test data on soil samples recovered from the borings are included in Appendix 3.

B. Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. Data are made available for the convenience of the Contractor.

C. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner, provided such operations are approved by the Owner's Representative.

3.02 SITE OBSERVATIONS

B. Gypsum Management Facility (Gypsum Stack & Recycle Pond)

1. The Gypsum Stack has been excavated to foundation grade on the sideslopes, and to within approximately 5.4 of foundation grade at the bottom of the cell. The remaining 5.4 feet of material will be utilized to construct the 3 foot thick clay layer. A drainage channel was cut from the southwest floor of the excavation to allow adequate surface water drainage. During the pre-bid meeting, Contractors will be given opportunity to view the excavation and resulting stockpiles, and to observe the in-situ conditions at the time of the meeting.

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2. The earthwork for the recycle pond pump station pad and access road, as well as sections of the recycle pond perimeter berm have been constructed to finish grade. During the pre-bid meeting, Contractors will be given the opportunity to view the in-situ conditions at the time of the meeting.

A. CCB Landfill

1. The CCB Landfill has been excavated to within 6 in. of foundation grade. During the pre-bid meeting, Contractors will be given opportunity to view the excavation and observe the in-situ conditions near foundation grade at the time of the meeting.

END OF SECTION 02010

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DIVISION 2 - SITEWORK
Section 02100 - Site Preparation
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to stripping of topsoil and vegetation from areas of the site that are to be excavated.

1.02 RELATED SECTIONS

No related sections.

PART 2. PRODUCTS

No products used.

PART 3. EXECUTION

3.01 EXAMINATION

The Contractor shall examine the site to determine the extent of work required, as well as the extent of previously stripped topsoil completed under a previous contract.

3.02 SITE PREPARATION - STRIPPING

A. The Gypsum Stack and portions of the Recycle Pond grading limits have been previously stripped under a separate contract as shown on the plans. Any remaining vegetation and topsoil encountered within the Gypsum Stack and Recycle Pond grading limits required to complete the work in this contract shall be stripped. ~~Topsoil shall be kept clean and free of all foreign material, and stored in separate stockpiles from vegetation and common excavations. Stockpiles shall be located as indicated on the drawings or as directed by the Owner's Representative.~~ ***Topsoil removed by stripping shall not be stockpiled, and shall be deposited completely as described in section 3.02-C of this specification.***

B. The top 6" of the existing excavation area of the CCB Landfill-Cell 1 within the CCB Landfill shall be removed and stockpiled per Specification Section 02200 Earthwork.

C. Stripped Topsoil shall be used to fill depressions east of the Gypsum Management Facility as shown in the Plans.

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3.03 DISPOSAL

A. All materials resulting from site preparation operations shall be stockpiled in the designated spoil area. Contractor shall obey all laws and regulations when disposing of the materials.

END OF SECTION 02100

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PART 1. GENERAL

1.01 DESCRIPTION OF WORK

Control of surface water caused by precipitation and abandonment of existing subsurface drainage facilities within the construction limits of the Gypsum Management CCB Landfill shall be considered as part of the work under this specification.

A. The work to be completed by the Contractor includes, but is not necessarily limited to, the following:

1. Maintenance of existing Erosion and Sedimentation Control Measures according to Section 01356; and
2. Dewatering excavations from water caused by precipitation.
3. Abandonment of the existing subdrainage systems.

B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control and abandonment of the existing subsurface dewatering systems at the end of the Contract.

1.02 EXISTING FACILITIES

A. Gypsum Management Facility

1. An existing ditch at the south end of the existing excavation provides gravity outlet for the excavation to 5.4 feet above the foundation grade.

2. An existing subdrainage system provides limited control of groundwater migration into the excavation. The subdrainage system outlets by gravity flow to an existing ditch approximately 0.3 mile south of the existing excavation.

B. CCB Landfill Facility

1. An existing ditch at the southeast corner of the existing excavation provides gravity outlet for the excavation to foundation grade.

2. An existing subdrainage system provides limited control of groundwater migration into the excavation. The subdrainage system outlets by gravity flow to an existing channel approximately 0.2 mile east of the existing excavation.

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1.03 REQUIREMENTS

B. The General Contractor shall employ standard surface water management practices to prevent the ponding of stormwater runoff and/or erosion of existing and proposed earth surfaces, as required to complete the work.

1.04 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 01356 – Storm Water Pollution Prevention Measures
2. 02010 - Subsurface Investigation
3. 02200 - Earthwork

PART 2. PRODUCTS

2.01 MATERIALS

A. Materials and equipment for surface water management shall be reviewed by the Owner's Representative for compatibility with future construction and operation of the facility.

PART 3. EXECUTION

3.01 SURFACE WATER MANAGEMENT

A. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water caused by precipitation from all construction work areas and excavations.

B. Drainage features shall have sufficient capacity to avoid flooding of work areas.

C. Drainage features shall be so arranged and altered, as required to avoid degradation of the final excavated surface(s).

D. The Contractor shall utilize all necessary erosion and sediment control measures according to Section 01356 to avoid construction-related sedimentation of existing and proposed facilities.

3.02 WATER DISPOSAL

A. Dispose of water removed from the excavations in such a manner as:

1. Will not endanger portions of work under construction or completed.
2. Will cause no inconvenience to Owner or to others working near site.
3. Will comply with the stipulations of Section 01356.

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4. Will control runoff. The Contractor shall be responsible for control of runoff in all work areas, including, but not limited to: excavations, access roads, parking areas, stockpile, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with Section 01356.

B. Existing site drainage features or proposed subdrainage system may be used for water disposal.

3.03 DAMAGES

A. Immediately repair damages to adjacent facilities caused by the surface water management facilities, as constructed by the Contractor.

3.04 REMOVAL OF STORMWATER MANAGEMENT SYSTEMS INSTALLED BY CONTRACTOR

A. Remove and backfill temporary sumps, ditches, trenches, etc. according to Section 02300, as required by the Owner.

3.05 CORRECTIVE ACTION

Work shall be performed as necessary for reinstatement of foundation soil and damaged structure resulting from such inadequacy or failure by Contractor to control surface water, at no additional cost to Owner.

3.06 ABANDONMENT OF EXISTING SUBDRAINAGE SYSTEMS

Concurrence shall be obtained from Owner before discontinuing operation of subdrainage system.

The General Contractor shall maintain the existing subdrainage systems during construction of the Gypsum Management and CCB Landfill Facilities.

Prior to construction of the Compacted Clay Liner at the Gypsum Management Facility, all vertical drains consisting of a geotextile fabric encased pea gravel envelope shall be removed. The pea gravel shall be stockpiled and the geotextile fabric shall be removed and disposed of in a legal manner. Subdrainage piping damaged during removal of the vertical drains shall be repaired with equal material incidental to the work. An existing drainage structure consisting of 24" diameter reinforced concrete pipes with a ditch grate shall be removed. The concrete pipes shall be disposed of in a legal manner and the ditch grate shall be salvaged per the direction of Owner's Representative

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Upon completion of the construction of either facility, that facility's existing subdrainage system within the lined portion of the cell shall be abandoned as follows:

1. At each subdrainage vent pipe riser location, a mixture of high solids bentonite grout shall be pumped into the subdrainage piping to completely seal the system. The high solids bentonite grout shall be CETCO Volclay Grout or an approved equal that is NSF/ANSI Standard 60 certified. The grout shall be mixed *according to* the manufacturer's specifications for this application to provide a low permeability seal less than $1x10^{-7}$ cm/sec.
2. Cut the vent pipe risers 36 inches below with the ground surface. Fill the remaining vent piping with concrete as shown on the plans.
3. Remove completely the existing concrete inlet at the southeast quadrant of the gypsum stack excavation and dispose of in a legal manner. The grate will be salvaged and stored at the direction of the owner.
4. Remove completely the vent pipe protective bollards and dispose of in a legal manner.

END OF SECTION 02140

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DIVISION 2 – SITEWORK
Section 02200 – Earthwork
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to excavation, fill, and backfill required for foundation preparation, construction of Compacted Clay Liners, anchor trench construction, miscellaneous site grading, berm construction.

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 01356 – Storm Water Pollution Prevention Measures
2. 02100 - Site Preparation
3. 02140 – Surface Water Management
4. 02373 – Geotextiles
5. 02936 - Topsoil, Seeding, and Mulching

1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007
2. Department of Sustainable Natural Resources, Soil Survey Standard Test Method, Unified Soil Classification System: Field Method (USCS).

1.04 MEASUREMENT AND PAYMENT

A. The Contractor shall be responsible for estimating the extent of excavation and fill required to complete the work, including, but not limited to, excavation to required elevations; loading, transporting, placing, and compacting the Compacted Clay Liners; excavation and backfill of anchor trench; and miscellaneous site grading, including berm construction. The Contractor shall include the dollar amount associated with all earthwork in his Lump Sum Bid amount.

B. Removal and replacement of unsuitable foundation material (including underground sand channel materials) and subgrade stabilization measures directed by the Owner's Representative will be paid for on a time and material basis. Payment quantities will be based volume of excavation, determined from field surveys by the Owner's Field Surveyor.

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1.05 EARTHWORK COMPLETED UNDER PRIOR CONTRACT

A. Gypsum Management Facility

1. The gypsum stack has been excavated to approximately 5.4 ft. above foundation grade across the bottom of the cell.

2. Excavated subsoil material was stockpiled north and east into short term and long term subsoil stockpiles as shown on the plans. Stripped Topsoil was stockpiled separately.

3. The ~~75,000 yard~~ subsoil stockpile east of the Gypsum Stack shall be completely depleted under this contract. Schedule and timing shall be determined by the Contractor.

B. CCB Landfill

1. The cell has been excavated to approximately 6 in. above foundation grade and the perimeter berm has been completed, except for an existing construction access ramp on the east side of the cell near Sta. 205+00.

2. Excavated material was stockpiled in locations east of the excavation. The intended use and location for each stockpile is shown on the plans

1.06 COORDINATION

Existing utilities or other plant facilities shall not be interrupted, except when permitted in writing by the Owner's Representative and then only after acceptable temporary services have been provided. A minimum 48-hour notice shall be provided prior to proceeding with an approved temporary interruption.

1.07 SURFACE WATER MANAGEMENT

Control of surface water caused by precipitation necessary for completion of the work under this contract according to Section 02140 is the responsibility of the Contractor and shall be included in the contract lump sum price.

1.08 SUBMITTALS

A. Materials Handling Plan.

A materials handling plan shall be submitted for construction and protection of the Compacted Clay Liner. The plan shall describe the following:

1. Processing and placement of the Compacted Clay Liner: type, model number, weight, and critical dimensions of equipment to be used for soil processing, compaction, scarification, and smooth rolling;

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2. Method of protecting the Compacted Clay Liner from changes in moisture content and freezing after placement.

PART 2. PRODUCTS

2.01 MATERIALS

A. Earth Fill Material

Earth Fill Material shall consist of a mixture of clay, silt, sand, and gravel-sized particles obtained from previously constructed subsoil stockpiles. These materials can be used separately or mixed as required for best results. These materials shall be free of ice, snow, organic matter, rubbish, and debris. Coarse-grained particles shall be well dispersed to prevent the development of segregated pockets or zones with insufficient fine material to fill the interstices.

B. Compacted Clay Liners

1. Gypsum Management Facility

The Compacted Clay Liner for the Gypsum Management Facility shall be soil materials obtained from the approximately 5.4 ft. of material remaining above the foundation grade that was left in-place under the previous excavation contract. The material shall be free of ice, snow, organic matter, rubbish, and debris, and shall have a maximum clod size no greater than the length of the compactor foot for the compaction equipment proposed by the Contractor. When compacted, the material shall have a vertical hydraulic conductivity of less than 1×10^{-4} cm/sec.

2. CCB Landfill

The Compacted Clay Liner for the CCB Landfill shall be soil materials obtained from on-site excavations and materials stockpiled east of the cell. The material shall be free of ice, snow, organic matter, rubbish, and debris, and shall have a maximum clod size no greater than the length of the compactor foot for the compaction equipment proposed by the Contractor. When compacted, the material shall have a vertical hydraulic conductivity of less than 1×10^{-6} cm/sec.

C. Soil Stabilizers and Moisture Conditioning Agents

Additives to accelerate drying or to improve stability and workability of soil shall not be permitted unless approved in writing by the Owner's Representative.

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2.02 EQUIPMENT

A. Compaction Equipment

1. Tamping foot rollers

Compaction equipment shall consist of tamping foot rollers which have a minimum weight of 40,000 pounds. At least one tamping foot shall be provided for each 110 square in. of drum surface. The length of each tamping foot, measured from the outside surface of the drum, shall be at least 1 in. longer than the loose lift thickness.

2. Steel-Wheeled Rollers

Equipment used to produce a smooth compacted surface shall be a smooth, non-vibratory steel wheeled roller weighing not less than 1,000 lb. per lineal ft.

B. Scarification Equipment

Discs, rotor tillers, or other equipment used to scarify the surface shall be capable of uniformly disturbing at least the upper 6 in. of surface to provide good bonding between lifts.

C. Mixing and Spreading Equipment

Discs, harrows, and motor graders or other similar equipment shall be available at the site for use in spreading, mixing, and drying Compacted Subsoil Stockpile Material.

PART 3. EXECUTION

3.01 PREPARATION

A. Control of Work

Benchmarks, monuments, and other reference points shall be maintained throughout the work area.

B. Utility Location

Before starting excavation, the location and extent of underground utilities in the work area shall be established.

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3.02 EXCAVATION

A. General

Excavation consists of removal and redistribution of material encountered when establishing required grade and subgrade elevations. The Contractor shall be responsible for dewatering, protection, shoring, and disposal of excavated materials as necessary to complete the excavation.

B. Procedures

Excavation may be accomplished by any method and by use of any equipment that is suitable to the work, except that blasting will not be permitted. Based on previous construction experience at the site, it is recommended that excavation to the foundation grade be completed as far in advance of the Compacted Clay Liner placement as possible to allow the foundation surface to dry and form a "crust" capable of sustaining compactive effort.

C. Overexcavation

Overexcavation shall be performed to the lines and grades indicated on the plans. Additional overexcavation required to remove unsuitable materials as requested by the Owner's Representative shall be paid for by the Owner for at the Unit Price for Excavation. Any overexcavation or excess excavation not requested by the Owner's Representative shall be at the expense of the Contractor.

D. Disposal of Excavated Materials

Contractor shall stockpile excess excavated subsoil or topsoil materials in their corresponding stockpile for future use.

3.03 SUBGRADE PREPARATION

A. Areas to receive fill shall be proof rolled under the observation of the Owner's Representative. Soft, loose, weak, or wet materials shall be removed and replaced with compacted fill or stabilized with geotechnical fabric or geogrid as directed by the Owner's Representative and paid on a time and materials basis. Joints, fractures, and moisture seeps shall be repaired, and local sand deposits, if present at foundation grade, shall be removed and backfilled with compacted fill material as directed by the Owner's Representative.

B. The Owner's Representative may recommend additional drying time for soft, wet subgrade that has not been exposed long enough to permit "crust" formation. If approved by the Owner's Representative, the Contractor may install, at his own expense, geotechnical fabric to stabilize the wet subgrade and expedite construction.

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C. Following the excavation for the Compacted Clay Liner, the CQA Officer shall direct the Owner's Field Surveyor to verify that actual depths and grades of the foundation are in accordance with the plans and specifications. Elevations shall be surveyed on a 100 ft. grid pattern for the bottom of the cell. The points surveyed for side slopes will be at the top, midpoint, and toe. In addition, all breaks in grade will be surveyed. Foundation excavation grading shall meet a control tolerance requirement of 0 ft to -0.4 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor agency. The CQA Officer shall review the survey data for conformance to requirements and, if found in agreement with requirements, provide certification for the work in accordance with CQA Plan Procedures.

C. The Contractor shall not place fill until the subgrade has been examined jointly with the Owner's Representative and a certificate of approval for the subgrade has been submitted to the Owner's Representative.

3.04 STRUCTURAL FILL

A. Placement

1. Unless otherwise indicated on the plans, all Fill shall be composed of Earth Fill Material.
2. Fill materials used in embankment construction shall normally be placed in lanes parallel to the embankment axis and shall be placed in conformance with the lines, grades, and slopes as indicated on the plans. Placement of fill materials in lanes which are not parallel to the embankment will be allowed only where working room is too restricted for normal placement as determined by the Owner's Representative.
3. Fill shall be spread in approximately flat layers in such a manner as to obtain lifts of relatively uniform thickness without spaces between successively deposited loads. Segregation shall be prevented during placing and spreading. Hauling equipment shall be routed across the fill in such a way as to promote uniform compaction and to prevent the formation of ruts.
4. The maximum compacted thickness of each lift shall not exceed 8 in. where heavy compaction equipment will be used. The maximum compacted thickness shall not exceed 3 in. where power tampers or similar smaller equipment will be used. It may be necessary to reduce the thickness of lifts in order to obtain the required minimum density.
5. Where compacted Fill is to be placed against existing slopes, each lift shall be keyed into existing slope by removing existing slope material in steps as each new lift is placed.
6. The surface of the fill shall be kept reasonably smooth. The fill surface shall be sloped transverse to the axis of the embankments to allow drainage. If the compacted surface is, in the opinion of the Owner's Representative, too smooth or too dry to bond properly with the succeeding lift, it shall be roughened by scarifying, light discing, or other acceptable means, and it shall be sprinkled with water before the

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succeeding lift is placed thereon. If the surface becomes rutted or uneven subsequent to compaction, it shall be flattened and leveled before placing the next lift. This extra work shall be at the Contractor's expense.

7. Fill operations shall be suspended during periods of extended wet weather. Upon resuming operations, all fill materials that are excessively wet or soft shall be reprocessed in place or removed and stockpiled for reprocessing. The removal of soft material shall be carried to such depth as is necessary to expose firm materials. Fill shall not be placed on frozen surfaces.
8. When filling operations at any section will be suspended for any period in excess of 12 hours or in wet weather, the surface of the fill shall be rolled smooth to seal it against excessive absorption of moisture and to facilitate runoff. Prior to resuming fill placement and compaction, the fill surface shall be scarified and/or disced and moisture conditioned as required.
9. The Contractor will receive no additional compensation for any removal, reprocessing, stockpiling, recompaction, wasting, or similar operation related to suspensions or conditions due to weather or other causes unless caused by the Owner.
10. Earth fill access ramps shall not be constructed within the limits of the compacted embankments without the approval of the Owner's Representative. When such ramps are approved, they shall be constructed of Compacted Clay Liner material (in-board of the perimeter berm) or compacted Fill (out-board of the perimeter berm).

B. Compaction -

1. Fill materials shall be compacted to a dry density equal to or greater than the following:

   a. The Gypsum Management Facility: 95 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.
   b. The CCB Landfill: 90 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.

   In order to insure uniform coverage and to facilitate construction inspection and control, the compaction of each layer shall proceed in a systematic, orderly, and continuous manner. Rolling shall be parallel to the embankment axis, except where there is insufficient working room for such operations.

2. The moisture content of all earth fill materials shall be as uniform as practicable throughout each lift. Fill shall be compacted at a moisture content that is no more than 2 percent below and no more than 2 percent above optimum moisture content.
3. Moisture conditioning of fill materials shall be performed by discing, harrowing, plowing, blading, or other suitable means prior to excavation. Moisture conditioning where the fill is placed shall be limited to minor adjustments prior to compaction. Addition of moisture shall be by using a

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pressure spray bar mounted in front of or to one side of a water tanker so that water will not collect in the tracks of the truck.

4. Any materials that are placed but not compacted prior to drying out or becoming too wet shall be removed and replaced or reprocessed at the Contractor's expense.
5. No admixtures as drying agents or to improve the workability of the soil will be allowed.

3.05 GENERAL FILL

General Fill materials shall be placed to the specifications for Structural Fill, except it shall be compacted to a dry density equal to or greater than 92 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698

3.06 COMPACTED CLAY LINERS

A. Sources

The Compacted Clay Liners for both the Gypsum Management Facility and the CCB Landfill shall be constructed from Compacted Clay Liner material as described in paragraph 2.01(B) above.

B. Test Soil Liner

A Test Soil Liner of the actual full scale liner shall be constructed in accordance with the following requirements:

1. Test liner will be constructed from the same soil material sources, to the same design specifications, and with similar equipment and procedures as are proposed for the full scale liner.
2. Test liner will be at least four times the width of the widest piece of equipment to be used.
3. Test liner will be no less than 100 ft long to allow equipment to reach normal operating speed before reaching a central 40-ft test area.
4. Test liner will be constructed with maximum 8-in. compacted lifts for a total liner thickness of 3 *ft*.
5. Test liner will be tested by the Owner's Testing Firm in accordance with the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, summarized below for each of the following physical properties:

    a. Multiple two-stage Boutwell permeameter tests will be used on the test liner to determine the hydraulic conductivity. The two-stage field hydraulic conductivity test is a falling head infiltration test conducted in a cased borehole, typically 4 in. in diameter. The test is cited in the U.S. EPA Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, September 1993 (EPA/600/R-93/182).

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b. Undisturbed samples (Shelby tubes) will be tested in the laboratory for hydraulic conductivity to determine if there is a statistical correlation to the field testing results.

c. Other engineering parameters including, but not limited to, particle size analysis, liquid limits, plasticity, water content, and in-place density that are needed to evaluate the full scale liner will be determined.

6. Additional test fills will be constructed for each new soil type or for each change in equipment or procedures.

C. Full Scale Liner Construction:

1. Full scale liner construction shall not be commenced until the results of the in-place compaction testing and Boutwell permeameter tests on the test liner confirm that the construction procedures and specified compaction requirements produce in-situ hydraulic conductivities as specified in Section 2.01(B) above.

2. The liner shall be constructed according to the placement and compaction requirements for general fill, except the material shall be compacted to a density of no less than 95 percent of maximum dry density as determined by the Standard Proctor Test (ASTM D 698) at the following moisture contents:

   a. Gypsum Stack Compacted Clay Liner shall be compacted at a moisture content between 100 percent and 105 percent of optimum.

   b. CCB Landfill Compacted Clay Liner shall be compacted at a moisture content determined by the "acceptable zone" criteria as outlined in the project CQA Plan.

   The same compaction procedures, such as number of passes, speed, and compaction equipment used on construction of the test liner shall be used. Grade stakes shall not be driven into the clay liner.

3. Moisture/density, hydraulic conductivity, and strength testing of the Compacted Clay Liner shall be conducted by the soil testing agency under the requirements and frequencies specified in the project CQA Plan to verify that ongoing liner placement meets the criteria developed by the Test Soil Liner.

4. The completed liner shall be smooth rolled to limit moisture loss and promote run-off of surface water. Moisture content shall be maintained within the specified range and erosion or other damage that occurs in the soil liner shall be repaired as directed by the Owner's Representative until the geosynthetic liner is placed.

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5. Voids created in the Compacted Clay Liner during construction (including, but not limited to, penetrations for test samples, and other penetrations necessary for construction) shall be repaired by removing material that does not meet the requirements for Compacted Clay Liner material, backfill with Compacted Clay Liner material, granular or pelletized bentonite, or a mixture of bentonite and Compacted Clay Liner material in lifts no thicker than 2 in. and tamping each lift with a steel rod. Each lift shall be tamped a minimum of 25 times altering the location of the rod within the void for each blow. Other ruts and depressions in the surface of the lifts shall be scarified, filled, and then compacted to grade.

3.07 CUSHION DIRT (Gypsum Management Facility Only)

Cushion Dirt to be placed beneath the upper High Density Polyethylene (HDPE) Geomembrane is to be placed to the specifications for General Fill in Section 3.04 above, except fill materials for Cushion Dirt shall be compacted to a dry density equal to or greater than 90 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.

3.08 ANCHOR TRENCH CONSTRUCTION

A. Gypsum Management Facility – Gypsum Stack

1. The anchor trench shall be excavated to the depth and width shown on the anchor trench details. The front edge of the trench shall be rounded to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Loose soil shall be removed or compacted into the floor of the trench.

2. Subsequent to Geosynthetic Clay Liner (GCL), Bottom HDPE Geomembrane and Geotextile Cushion installation, the liners shall be placed in the trench to fully cover the entire trench floor, but do not extend up the back of the trench wall. After the liner installation, the trench shall be backfilled with 1 ft. of Compacted Clay Liner material. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the GCL and liner materials.

3. Subsequent to installation of separation geotextile on top of drainage layer, it shall be verified that the fabric extends across the top of the initial 1 ft layer of trench backfill, but does not extend up the back of the trench wall. After the separation geotextile has been installed in, the trench shall be backfilled with 2 ft of Compacted Clay Liner material. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the separation geotextile.

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4. Subsequent to installation of the upper HDPE Geomembrane, the liner shall be installed into the trench and extend across the top of the initial 1 ft layer of trench backfill, but not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the HDPE Geomembrane.

B. Gypsum Management Facility – Recycle Pond

1. The anchor trench shall be excavated to the depth and width shown on the anchor trench details. The front edge of the trench shall be rounded to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Loose soil shall be removed or compacted into the floor of the trench.

2. Subsequent to HDPE Geomembrane installation, it shall be verified that the liner covers the entire trench floor, but does not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Recycle Pond berm. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the liner material.

C. CCB Landfill

1. Excavate a ledge at bottom of anchor trench elevation and place and compact Compacted Clay Liner material on the ledge as shown on the anchor trench details in the plans.

2. Excavate the anchor trench to the depth and width shown on the anchor trench details. Round the front edge of the trench to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Remove loose soil or compact it into the floor of the trench.

3. Subsequent to GCL and HDPE geomembrane installation by the geosynthetic liner contractor, verify that the liners cover the entire trench floor, but do not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was

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installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the GCL and HDPE geomembrane.

4. Subsequent to installation of separation geotextile on top of drainage layer, verify that the fabric extends across the top of the initial 1 ft layer of trench backfill, but does not extend up the back of the trench wall. After the fabric installation in the trench has been inspected and approved by the Owner's Representative, backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the geotextile fabric.

3.09 TESTING

A. Construction Quality Assurance (CQA) compaction and permeability tests will be made by the Owner's Testing Consultant during the progress of the work as indicated in the Construction Quality Assurance Plan, included in Appendix 2. The Contractor shall cooperate with the Testing Consultant and allow such tests to be performed.

B. If tests indicate that an area of fill or Compacted Clay Liner does not meet the specified requirements, additional tests shall be performed to determine the extent of non-compliance. The Contractor shall moisture condition and recompact that area until a passing test result is obtained.

C. Moisture/density testing by nuclear methods will be conducted by the Owner's Testing Firm at a minimum frequency as outlined in the Construction Quality Assurance (CQA) Plan. The range of moisture content will be determined in accordance with the "acceptable zone" method which is also outlined in the Project CQA Manual. A moisture test will be considered failed if the result indicates that the moisture content does not lie within the "acceptable zone." Material that fails will be dried or wetted until satisfactory moisture content is achieved. A density test will be considered failed if the result indicates a dry density outside the "acceptable zone." The material will be compacted until a passing test is achieved.

To ensure accuracy and reproducibility of testing of the soil liner for compaction and moisture content, all density gauges shall be certified by annual calibration.

3.10 FINISH GRADING

All excavated and filled areas shall be fine graded and leveled to provide a smooth finish free of debris, foreign matter, objectionable stones, clods, lumps, pockets, or high spots, properly drained and true to indicated elevations. Finish grading shall be only near completion of work or when requested. Any portions

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of the berm damaged by construction shall be restored. The berm ditch shall be finished to design grade, and the ditch side slopes shaped and trimmed to provide a uniform ditch cross section.

3.11 CONSTRUCTION TOLERANCES

A. Elevations will be surveyed at breaks in slopes and on a 100 ft. grid pattern on the base before and after liner construction to verify liner thickness and to verify that proper drainage slopes to leachate collection piping are maintained. To verify material thickness, all horizontal survey coordinates will be the same for the bottom and the top of the material that is placed. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points. A test will be considered failed if it does not meet the minimum design requirements. To obtain the specified design thickness, additional soil material will be placed and compacted in failing areas where the as-built thickness is less than the design thickness. Surveying required for verification of final construction tolerances will be performed by the Owner's Land Surveyor.

B. The minimum specified design thickness of all Compacted Clay Liners shall be 3.00 ft.

END OF SECTION 02200

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DIVISION 2 - SITE WORK
Section 02275 - Riprap

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to the placement of riprap for erosion control.

1.02 RELATED SECTIONS

The following section contains items which are related to the work in this section:

02200 - Earthwork

1.03 REFERENCES

Specified references or cited portions thereof, current at date of bidding documents unless otherwise specified, govern the work.

A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SUBMITTALS

Product Data: Provide quarry name and material type prior to delivery.

PART 2. PRODUCTS

2.01 MATERIALS

A. Stone Riprap and Bedding materials according to Article 1005.01 of the Illinois Standard Specifications for Road and Bridge Construction.

B. Filter Fabric material, where required by IDOT specifications for Stone Riprap, shall furnished according to Article 1080.03, with an AOS (Apparent Opening Size) as indicated on the plans.

C. Riprap Source shall be listed on the current IDOT Approved Aggregate Source List.

D. Gradation as indicated in the drawings. Quality shall be Class A.

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PART 3. EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

A. Stone Riprap and Bedding shall be installed in accordance with Section 281 of the Illinois Standard Specifications for Road and Bridge Construction for the placement of Stone Riprap. Measurement and payment provisions of Section 281 shall not apply.

B. Filter Fabric for Stone Riprap shall be installed in accordance with Section 282 of the Illinois Standard Specifications for Road and Bridge Construction.

C. The Owner's Representative shall be allowed to visually inspect Riprap for compliance with specifications prior to placement.

END OF SECTION 02275

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DIVISION 2 – SITEWORK
Section 02315 – Granular Materials
ADDENDUM #2

PART 1. GENERAL

1.01 DESCRIPTION

A. Gypsum Management Facility

This section pertains to the following:

1. Furnishing and placing granular drainage materials for the drainage layer and Leachate Collection System piping.
2. Furnishing and placing coarse aggregate for encasement of the Process Water Recovery System piping.
3. Furnishing and installing Filter Sand for the protection of the Process Water Recovery System piping.
4. Furnishing and installing materials for roadbed construction related to the Gypsum Management Facility access roads.
5. Recycle Pond Drain.
6. Furnishing and installing materials for roadbed construction related to maintaining McKinley Road on AERG property.
7. ***Furnishing and installing materials for roadbed construction related to the Landfill Haul Road.***

B. CCB Landfill

This section pertains to the following:

1. Placing granular material for Drainage Layer.
2. Placing granular material for Separation Berm.
3. Placing Coarse Aggregate for encasement of leachate collection piping.
4. Furnishing and installing materials for roadbed construction related to the landfill access road.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 02300 - Earthwork
2. 02373 - Geotextiles
3. 02640 - Leachate Collection Piping

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1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.
2. American Society for Testing and Materials (ASTM):
   a. ASTM D 75 (2003) Practice for Sampling Aggregates.
   b. ASTM D 422 (1963; R 2002) Test Method for Particle-Size Analysis of Soils.
   c. ASTM D 2434 (1968, R 2000) Test Method for Permeability of Granular Soils (Constant Head).
   d. ASTM D 3042 (2003) Test Method for Insoluble Residue in Carbonate Aggregates.
   e. ASTM C 1260 (2005) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
3. American Geological Institute (AGI). Geoscience Handbook AGI Data Sheets, 4th Edition.

1.04 MEASUREMENT AND PAYMENT

The Contractor shall be responsible for estimating the extent of granular materials required to complete the work including, but not limited to, construction of drainage layer, encasement of leachate collection piping, and road-bed construction. The Contractor shall include the dollar amount associated with furnishing and placing all granular materials in his Lump Sum Bid amount.

1.05 COORDINATION

A. The geosynthetic liner shall be covered with granular materials as soon as practicable after a section of liner has been approved by the Owner's Representative.

1.06 SUBMITTALS

A. Product Data:

1. Aggregate source list: Submit a list of proposed aggregate sources.

2. Shipping Tickets: Submit shipping tickets for the granular materials delivered to the site. Shipping tickets shall be according to paragraph 1004.01f of the IDOT Standard Specifications.

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B. Test Reports.

1. Submit results of grain size analysis (ASTM D422) and hydraulic conductivity testing (ASTM D2434) for gradations established by the Contractor that provide the specified hydraulic conductivity. Test results are required for each proposed source and gradation. Submit test results for each source demonstrating compliance with reactivity, soundness, and abrasion requirements specified herein.

C. Samples:

1. Submit one sample per source for each gradation proposed for use on the project. Samples shall be at least one pound and shall be obtained and shipped according to ASTM D75. Submit samples at least 15 days prior to starting construction of the drainage layer and coarse aggregate encasement for leachate piping.

1.07 STORAGE AND HANDLING

A. Storage and handling of granular materials shall be according to paragraph 1004.01e of the IDOT Standard Specifications.

PART 2. PRODUCTS

2.01 MATERIALS

A. General

1. Coarse Granular materials shall be meet the Description of Gravel, as described in Section 1004.01(a)(1) of the IDOT Standard Specifications, and shall be spherical to sub-discoidal, sub-rounded to well rounded particles as defined by AGI Data Sheet, 4th Edition, Sheet 8.4 – Comparison Charts for Estimating Roundness and Sphericity.
2. Granular materials shall experience no more than 15 percent carbonate loss per ASTM D3042.
3. Granular materials shall be free of deleterious material, and shall meet the Na_2SO_4 soundness and Los Angeles Abrasion Specifications for Class B quality aggregate per paragraph 1004.01 of the IDOT Standard Specifications.
4. All material shall pass the 2 in. sieve, and no greater than 5 percent shall be retained on the No. 200 sieve.
5. Granular materials shall be innocuous to alkali-silica reactivity, and shall exhibit internal expansions of less than 0.10 percent at 16 days after casting as determined by ASTM C 1260.

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B. Gypsum Management Facility Granular Materials

1. Granular Materials for Drainage Layer

Gradation for granular material for Drainage Layer shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec.

2. Coarse Aggregate around Ring Drain Collection Piping

Coarse Aggregate used to encase the ring drain collection piping shall be IDOT Gradation CA 7 material as outlined in Article 1004.01 of the IDOT Standard Specifications for Road and Bridge Construction.

3. Filter Sand

Filter Sand used for protective cover over the ring drain collection system shall be IDOT Gradation FA 1, Class B or better according to Article 1003 of the IDOT Standard Specifications for Road and Bridge Construction.

4. Aggregate Base Course, Type B

Aggregate Base Course, Type B used for base material for all new access roads and ***the Landfill Haul Road*** shall be IDOT Gradation CA 2, in accordance with Section 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction. The requirements from Section 2.01A of this specification shall not apply.

5. Aggregate Surface Course, Type B

Aggregate Surface Course, Type B used for surface material for all new access roads and the ***Landfill Haul Road*** ~~McKinley Road relocation~~ shall be IDOT Gradation CA 6, in accordance with Section 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction. The material shall originate from an IDOT approved source. The requirements from Section 2.01A of this specification shall not apply.

6. Coarse Aggregate for Leachate Collection/Leachate Detection Piping

Gradation for coarse aggregate encasement around Leachate Collection/Leachate Detection Laterals shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-1} cm/sec.

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B. CCB Landfill Granular Materials

1. Granular Materials for Drainage Layer and Separation Berm.

Gradation for granular material for drainage layer and separation berm shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec.

2. Coarse Aggregate.

Gradation for coarse aggregate shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-1} cm/sec.

2.02 EQUIPMENT

Equipment for spreading and compacting granular materials shall be low ground pressure equipment to prevent damage to the underlying geosynthetic liners.

PART 3. EXECUTION

3.01 PROTECTION OF GEOSYNTHETICS

A. Protection of the geosynthetic liners is critically important. Approved geosynthetic liner shall be covered by granular material as soon as practicable. Granular material shall be placed to a minimum thickness of 1 ft before any heavy equipment or loaded trucks are allowed on the lined area.

B. No vehicular traffic shall travel directly on the geosynthetic liner other than an approved low ground pressure All Terrain Vehicle or equivalent.

C. Any damage to the geosynthetic liner system shall be repaired, as directed by the Owner's Representative, at the expense of the Contractor.

3.02 DRAINAGE LAYER (GYPSUM STACK)

A. Placement on Cell Floor

1. The granular material shall be back-dumped on the geotextile cushion fabric in a sequence of operations beginning at the perimeter of the liner on the cell floor.
2. Placement of material on the fabric shall be accomplished by spreading dumped material off of previously placed material with a bulldozer blade or endloader, in such a manner as to prevent tearing or shoving of the cloth. Dumping of material directly on the fabric will only be permitted to establish an initial working platform. No vehicles or construction

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equipment shall be allowed on the fabric prior to placement of the granular blanket to a minimum thickness of 1 ft.

B. Placement on Cell Side Slopes

1. Placement of granular material on cell side slopes shall be accomplished using methods and equipment similar to that specified for placement of material on cell floor.
2. The Contractor may place earth fill material underlain with separation geotextile fabric to buttress the granular material on the slope:

   a. The Construction Quality Assurance (CQA) survey to certify thickness of drainage material shall be completed within the footprint of the gypsum stack before it is covered with separation geotextile fabric.
   b. Separation geotextile fabric shall extend beyond the toe of gypsum buttress a sufficient distance to prevent contamination of the granular drainage layer. See Sections 02373 and 02320 for construction of separation geotextile fabric.

3.03 DRAINAGE LAYER (CCB LANDFILL)

A. Placement on Cell Floor.

1. The granular material shall be back-dumped on the geotextile cushion fabric in a sequence of operations beginning at the perimeter of the liner on the cell floor.
2. Placement of material on the fabric shall be accomplished by spreading dumped material off of previously placed material with a bulldozer blade or endloader, in such a manner as to prevent tearing or shoving of the cloth. Dumping of material directly on the fabric will only be permitted to establish an initial working platform. No vehicles or construction equipment shall be allowed on the fabric prior to placement of the granular blanket to a minimum thickness of 1 ft.

B. Placement on Cell Side Slopes.

1. Placement of granular material on cell side slopes shall be accomplished using methods and equipment similar to that specified for placement of material on cell floor.
2. The Contractor may place CCB underlain with separation geotextile fabric to buttress the granular material on the slope:

   a. The Construction Quality Assurance (CQA) survey to certify thickness if drainage material shall be completed within the footprint of the CCB before CCB placement.

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b. Separation geotextile fabric shall extend beyond the toe of CCB buttress a sufficient distance to prevent contamination of the granular drainage layer. See Sections 02373 and 02320 for construction of separation geotextile fabric and CCB, respectively.

C. Placement in Separation Berm.

1. Granular material for the separation berm shall be placed and spread in uniform lifts not to exceed 1 ft. The initial lift shall be placed according to paragraph A. The separation berm shall be constructed across the floor of the cell to at least the level of the top of drainage layer before any CCB is placed within the cell, and the top of berm shall be maintained at or above the level of adjacent CCB as CCB placement progresses.

3.04 COARSE AGGREGATE FOR ENCASEMENT OF RING DRAIN COLLECTION PIPING (GYPSUM MANAGEMENT FACILITY)

A. The geotextile filter fabric for encasement of leachate collection piping shall be placed on the approved cushion geotextile fabric according to Section 02373 – Geotextiles.

B. The coarse aggregate shall be placed and consolidated with a vibratory plate compactor on the encasement fabric to the width shown on the plans to the level of the bottom of the ring drain collection piping.

C. Course aggregate shall be placed and consolidated with a vibratory plate compactor along the pipe during pipe installation. The coarse aggregate shall be placed longitudinally along the pipe in lifts not to exceed 8 in. thick to a height of at least the center of the pipe. The aggregate shall be maintained at equal elevation on each side of the pipe, and the first lift of material shall be mechanically tamped to ensure that the space under the pipe is completely filled. The top of pipe shall not be covered until the CQA survey certifies leachate piping grade has been completed.

D. After the CQA survey has been completed, coarse aggregate material shall continue to be placed in lifts not to exceed 8 in. thick, as specified in the previous paragraph until the minimum cover height shown in the plans is attained.

E. The running of trucks or heavy equipment over leachate piping shall be avoided until there is at least a 12 in. cover of Filter Sand over the completed geotextile envelope.

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3.05 COARSE AGGREGATE FOR ENCASEMENT OF LEACHATE COLLECTION PIPING (CCB LANDFILL)

A. Place geotextile fabric for encasement of leachate collection piping on the approved cushion geotextile fabric according to Section 02373 – Geotextiles.

B. Place and consolidate coarse aggregate with a vibratory plate compactor on the encasement fabric to the width shown on the plans to the level of the bottom of the leachate piping.

C. Place and consolidate course aggregate along the pipe during pipe installation. Place coarse aggregate longitudinally along the pipe in lifts not to exceed 8 in. thick to a height of at least the center of the pipe. Maintain the aggregate at equal elevation on each side of the pipe, and mechanically tamp the first lift of material to ensure that the space under the pipe is completely filled. Do not cover the top of pipe until the CQA survey to certify leachate piping grade has been completed.

C. After the CQA survey has been completed, continue placing coarse aggregate material in lifts not to exceed 8 in. thick, as specified in the previous paragraph until the minimum cover height shown in the plans is attained.

D. Avoid running trucks or heavy equipment over leachate piping until there is at least 12 in. cover over the completed geotextile envelope. Provide temporary ramps no steeper than 10H:1V transverse to the piping for temporary equipment crossings until the first lift of CCB is placed.

3.06 ROADWAY CONSTRUCTION

A. Prepare the roadway subgrade as shown on the plans, in accordance with Section 02200 – Earthwork.

B. Furnish Geotechnical Fabric for Ground Stabilization in accordance with Section 02373 – Geotextiles.

C. Furnish Aggregate Base Course, Type B in accordance with Article 351 of the IDOT Standard Specifications for Road and Bridge Construction.

D. Furnish Aggregate Surface Course, Type B in accordance with Article 402 of the IDOT Standard Specifications for Road and Bridge Construction.

3.07 TESTING

A. Independent gradation and permeability tests will be made by the Owner's Testing Lab during the progress of the work at frequencies as required in the project Construction Quality Assurance (CQA) Plan, included in Appendix 2.

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The Contractor shall cooperate with the Testing Lab and allow such tests to be performed.

B. If tests indicate that an area of granular material or coarse aggregate does not meet the specified requirements of the project CQA Plan, then the Contractor shall remove the material and replace it with suitable material.

3.05 FINISH GRADING

The granular drainage layer shall be fine graded, but not compacted, to provide a smooth finish before a CQA survey of the completed portion of the drainage layer is requested. The CQA Officer shall direct the survey agency to determine elevations at the top of the final constructed surface of the Drainage Layer using a 100 ft. grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify thickness, all horizontal survey coordinates shall be the same for the top of the cushion, and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points. In no instance shall the field determined thickness be less than 1.0 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the survey agency. Ruts or erosion damage shall be repaired before placement of the separation geotextile fabric.

END OF SECTION 02315

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PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to furnishing and installing geotextile fabrics on prepared surfaces.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 02300 - Earthwork
2. 02315 - Granular Materials
3. 02800 – HDPE Geomembrane

1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.
2. American Society for Testing and Materials (ASTM):
    a. ASTM 3776 (1996; R 2002) Standard Test Method for Mass per Unit Area (Weight) of Fabric;
    b. ASTM D 3786 (2001) Test Method for Hydraulic Bursting Strength of Textile Fabrics -- Diaphragm Bursting Strength Tester Method;
    c. ASTM D 4533 (2004) Test Method for Trapezoid Tearing Strength of Geotextiles;
    d. ASTM D 4632 (1991; R 2003) Test Method for Grab Breaking Load and Elongation of Geotextiles;
    e. ASTM D 4751 (2004) Test Method for Determining Apparent Opening Size of Geotextile;
    f. ASTM D 4833 (2000) Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products;
    g. ASTM D 4873 (2002) Guide for Identification, Storage, and Handling of Geosynthetic Rolls;
    h. ASTM D 4884 (1996; R 2003) Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles;
    i. ASTM D5261-92(2003) Standard Test Method for Measuring Mass per Unit Area of Geotextiles

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j. ASTM D6241-04 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.04 MEASUREMENT AND PAYMENT

A. The Contractor shall be responsible for estimating the extent of geotextile fabric required to complete the work including fabric for laps, anchorage, repairs, and samples for Construction Quality Assurance (CQA) testing. The Contractor shall include the dollar amount associated with all geotextile construction in his Lump Sum Bid amount, except as specified in paragraph B.

B. Geotextile Fabric for Ground Stabilization, when directed by the Owner's Representative for stabilization of foundation soils, will be paid for on a time and materials basis.

C. No additional payment will be made for geotextile fabric for ground stabilization installed at the Contractor's discretion.

1.05 SUBMITTALS

A. Product Data

1. The manufacturer's list of guaranteed properties for each geotextile fabric proposed for use on the project shall be submitted.
2. The manufacturer's installation guidelines shall be submitted.

B. Samples

Samples of geotextile fabrics shall be submitted for CQA prequalification testing. Sample size and sampling frequency are specified in Appendix 2.

C. Inventory

A copy of the roll inventory that identifies, as a minimum, manufacturer or supplier, product or style number, roll number, width, and length of roll as identified on the roll label shall be submitted.

1.06 STORAGE AND HANDLING

Geotextiles shall be stored and handled according to ASTM D4873.

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PART 2. PRODUCTS

2.01 MATERIALS

A. Geotextile Fabric for Liner System

Geotextile fabrics for use in the cell liner system shall consist of non-woven filaments of polypropylene, polyester, or polyethylene. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Non-woven fabric may be needle-punched, heat-bonded, or a combination thereof. The filaments shall be dimensionally stable (i.e., filaments shall maintain their relative position with respect to each other) and resistant to delamination. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile. The filaments shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

Fabric shall have the following physical properties:

Physical Properties[1]	4 oz. (Separation)	6 oz. (PWRS)	16 oz. (CA Envelope & Rub Sheet)
Mass/Unit Area (oz./yd^2) ASTM D5261	4.0	6.0	16.0
Grab Tensile Strength (lb.) ASTM D4632	115	160	380
Grab Elongation (%) ASTM D4632	50	50	50
Puncture Strength (lb.) ASTM D4833	65	85	240
Puncture (CBR) Strength (lb.) ASTM D6241	310	410	1025
Mullen Burst Strength (psi) ASTM D3786	210	280	750
Trapezoidal Tear Strength (lb.) ASTM D4533	50	60	150
Width (ft.)	15	15	15
Apparent Opening Size (AOS) Max. US Std. Sieve No. ASTM D4751	70	70	100
UV Resistance[2] (%) ASTM D4355	70	70	70
Roll Width (ft.)	15	15	15

Notes

(1) All Values listed are Minimum Average Roll Values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations.

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(2) UV Resistance is a minimum value and not a MARV. Evaluation to be on 2.0 inch strip tensile specimens after 500 hours exposure.

B. Geotextile Cushion

Fabric for Geotextile Cushion shall consist of non-woven filaments of polypropylene, polyester, or polyethylene. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Non-woven fabric may be needle-punched, heat-bonded, or a combination thereof. The filaments shall be dimensionally stable (i.e., filaments shall maintain their relative position with respect to each other) and resistant to delamination. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile. The filaments shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

Fabric shall have the following physical properties:

Physical Properties[1]	**10 oz. (Geotextile Cushion)**
Mass per unit area (oz/yd^2) ASTM D5261	10
Grab Tensile Strength (lb.) ASTM D4632	230
Grab Tensile Elongation (%) ASTM D4632	50
Trapezoidal Tear Strength (lb.) ASTM D4533	95
Puncture (CBR) Strength (lb.) ASTM D6241	700
Puncture (CBR) Elongation (in.) ASTM D6241	1.5
UV Resistance[2] (%) ASTM D4355	70
Apparent Opening Size (Max.) (AOS) Sieve No. - ASTM D4751	---
Roll Width (ft.)	15

Notes

(1) All Values listed are Minimum Average Roll Values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations.

(2) UV Resistance is a minimum value and not a MARV. Evaluation to be on 2.0 inch strip tensile specimens after 500 hours exposure.

C. Geotechnical Fabric for Ground Stabilization

Geotechnical fabric for ground stabilization shall conform to Article 1080.02 of the IDOT Standard Specifications for Road and Bridge Construction.

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D. Thread for Seams

High strength thread should be used such that seam test should conform to ASTM D4884. The thread shall meet the chemical, ultraviolet, and physical requirements of the geotextile, and the color shall be different from that of the geotextile.

E. Securing Devices

Pins, staples, and other devices that project through the geotextile fabric are not permitted for fabrics installed above the geomembrane. Sandbags, stone, or other appropriate means approved by the Owner's Representative shall be used to prevent movement of the geotextile.

2.02 EQUIPMENT

A. Equipment for spreading and compacting granular materials shall be low ground pressure equipment to prevent damage to the underlying geosynthetic liners.

PART 3. EXECUTION

3.01 SAMPLES FOR CQA TESTING

A. Geotextile fabric samples shall be obtained, identified and packaged from rolls designated by the Owner's Representative according to ASTM D4873.

B. Samples shall be 3 ft. wide by the full roll width.

3.02 BASE PREPARATION

A. Surface on which the geotextile will be placed shall be prepared to a relatively smooth surface condition, and shall be free from obstruction, debris, depressions, erosion features, or any irregularities that would prevent continuous, intimate contact of the geotextile with the entire surface. Rills, gullies, and ruts must be graded out of the surface before geotextile placement. Areas on which geotextile are to be placed shall be graded and/or dressed in accordance with Section 02200 – Earthwork and Section 02315 – Granular Materials. Prior to daily placement, the Installer shall provide the CQA Officer daily "certificates of acceptance" which document the Installer's inspection and acceptance of the underlying surface as being suitable for the geotextile installation.

B. Geotextile cushion fabric will be installed directly on the geosynthetic liner. Jointly inspect the liner with the Owner's Representative before commencing fabric installation each day. Notify the Owner's Representative promptly of any damage or defects observed in the liner as fabric installation progresses. Do not place fabric in the damaged or defective area until the liner has been repaired and

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approved by the Owner's Representative. Submit a daily inspection report identifying the area of fabric placement and certifying that there were no visible defects in the area of fabric placement.

C. Do not run heavy vehicle traffic directly on the geosynthetic liner or cushion geotextile. Use vehicles and equipment as specified in paragraph 2.02 to transport and deploy fabric on the liner. Operate the equipment with care, and place protective cover over the geomembrane, if necessary, to avoid damaging the liner. Route traffic and personnel over installed cushion fabric and use the installed fabric as a working platform to the greatest extent possible.

3.03 INSTALLATION

A. General Requirements:

1. Geotextile fabric shall be unrolled and laid out following these requirements to the greatest extent practical:

   a. Orient panels with the longest dimension parallel to the slope.
   b. Minimize the number of seams in corners and odd-shaped areas.
   c. Extend panels on slopes a minimum of 5 ft onto a horizontal surface.

   Geotextile panels shall be unrolled using methods that will not damage the fabric and will protect underlying surface from damage. While unrolling, the geotextile fabric shall be visually inspected for imperfections and faulty or suspect areas marked. Ballast shall be placed on fabric to prevent wind uplift. Expansion and contraction should be allowed for by leaving slack.

   Heavy vehicle traffic shall not be run directly on geotextile fabric. Fabric in areas of heavy traffic shall be protected with protective cover over the fabric.

2. Laps

   Individual panels of geotextile fabric shall be lapped according to manufacturer's instructions and as specified herein. Provide a minimum overlap of 3 in. unless otherwise specified herein or in the plans. Shingle overlaps so that water or other material cannot run down the slope between the two layers of fabric.

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3. Field Seams

Continuously sew all laps on slopes steeper than 10H:1V. This requirement does not apply to the heavy geotextile fabric for envelopment of coarse aggregate around leachate piping.

4. Defects and Repairs

Examine the installed geotextile fabric for defects, holes discontinuous seams, puckered or separated laps, etc. Repair defective laps and seams. Patch holes and defects according to manufacturer's recommendations and as directed by the Owner's Representative. Do not cover suspect or patched areas until they have been inspected and approved by the Owner's Representative.

B. Geotextile Fabric for Separation

1. Use low ground pressure equipment to avoid rutting the granular material.
2. Horizontal seams (parallel to top of slope) will be permitted on cell side slopes to facilitate staged construction of the drainage layer on the side slope.
3. Extend separation geotextile fabric into and across the bottom of the anchor trench and complete backfill of the trench according to Section 02200.

C. Geotextile Fabric for Coarse Aggregate Envelope

1. Geotextile for coarse aggregate envelope will be installed directly on the cushion fabric. Remove any foreign materials from the cushion fabric within the footprint of the coarse aggregate leachate piping encasement before installing the geotextile envelope. Place sufficient width to completely envelop the coarse aggregate and provide a longitudinal lap of at least 6 in.
2. After the coarse aggregate encasement has been completed, according to Section 02315, wrap the geotextile around the mounded aggregate, and cover the lap with at least 6 in. of material before permitting vehicle or equipment on the fabric.
3. Any ballast material other than coarse aggregate, according to Section 02315, that is placed within the envelope will require removal during coarse aggregate construction.

D. Geotechnical Fabric for Ground Stabilization

1. Install Geotechnical Fabric for Ground Stabilization in accordance with Section 210 of the IDOT Standard Specifications for Road and Bridge Construction.

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2. If approved by the Owner's Representative, the Contractor may, at his own expense, install geotextile or geogrid for ground stabilization outside the limits designated by the Owner's Representative.
3. Submit as-built drawings that clearly delineate limits and type of ground stabilization.

3.04 PROTECTION

A. Protect installed fabric until it is covered by at least 1 ft. of overlying material.

B. Any damage to the geotextile during its installation or during placement of overlying materials shall be replaced by the Contractor at no cost to the Owner. Unless otherwise noted, the work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 14 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile. The geotextile shall be protected from damage prior to and during the placement of overlying materials. Before placement of overlying materials, the Contractor shall demonstrate that the placement technique will not cause damage to the geotextile.

3.05 TESTING AND INSPECTION

A. Prequalification Testing

Geotextiles are subject to CQA testing by the Owner's Testing Consultant to verify conformance with the manufacturer's list of guaranteed properties according to the project Construction Quality Assurance Plan, included in Appendix 2. The Contractor shall provide samples as specified herein. Any fabric that does not conform to the list of guaranteed properties shall be removed from the site.

B. Installed fabric shall be inspected by the Owner's Representative. No material shall be placed on the fabric, other than ballast, until the installation has been approved by the Owner's Representative. Ballast shall not obscure seams or significant length of unseamed laps. The Owner's Representative may require removal of ballast to inspect suspect areas.

C. If the Owner's Representative suspects that completed work has been damaged by construction methods that do not conform to the specifications, he may require removal of completed work to verify the integrity of the underlying materials. The Contractor shall bear the cost of removal and subsequent repair as directed by the Owner's Representative, if the integrity of the underlying materials was damaged. If no damage was found, the Owner will pay the Contractor for the investigation work on a time and materials basis.

END OF SECTION 02373

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DIVISION 2 - SITEWORK
Section 02376 – Geosynthetic Clay Liner

PART 1. GENERAL

1.01 DESCRIPTION

A. This section covers furnishing and installation of a reinforced needlepunched Geosynthetic Clay Liner (GCL) at the Gypsum Management Facility and the CCB Landfill.

B. The work includes furnishing all equipment and materials, providing all labor, supervision, administration and management necessary to perform the work as specified herein and as shown on the plans.

1.02 RELATED SECTIONS

None.

1.03 REFERENCES

The following references, or cited portions thereof, govern the work

1. Geosynthetic Institute

   a. GRI-GCL3, Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).

2. American Society for Testing and Materials (ASTM):

   a. ASTM D 4632 (1991; R 2003), Standard Test Method for Grab Breaking Load and Elongation of Geotextiles;
   b. ASTM D 4643 (2000), Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method;
   c. ASTM D 5084 (2003), Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter;
   d. ASTM D 5261 (1992; R 2003), Test Method for Measuring Mass Per Unit Area of Geotextiles;
   e. ASTM D 5321 (2002), Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method;

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f. ASTM D 5887 (2004), Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter;
g. ASTM D 5888 (1995; R 2002), Practice for Storage and Handling of Geosynthetic Clay Liners;
h. ASTM D 5889 (1997; R 2003), Practice for Quality Control of Geosynthetic Clay Liners;
i. ASTM D 5890 (2002), Test Method for Swell Index of Clay Minerat Component of Geosynthetic Clay Liners;
j. ASTM D 5891 (2002), Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

1.04 SUBMITTALS

A. With the bid, the Contractor shall furnish the following information:

1. Conceptual description of the proposed plan for placement of the GCL panels over the areas of installation.
2. GCL Manufacturer's Quality Control (MQC) Plan for documenting compliance with Sections 2.01 and 2.02 of these specifications.
3. GCL manufacturer's historical data for reinforced GCL of a) 10,000-hour creep shear testing per Section 2.01 D. and b) seam flow data at 2 psi confining pressure per Section 2.01 E.
4. A copy of GCL manufacturer's International Standards Organization (ISO) Quality Certificate of Registration.
5. Statement of experience from the proposed GCL supplier.
6. Statement of experience from the proposed GCL installer.

B. At the Owner Representative's or Owner's request, the Contractor shall furnish:

1. A representative sample of the GCLs.
2. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million sq. ft (100,000 sq. meters) in size.

C. Upon shipment, the Contractor shall furnish:

1. The GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.
2. Inventory of materials received.

D. As installation proceeds, the Geosynthetics Installer's Representative shall submit certificates of subgrade acceptance, signed by the Contractor and Construction Quality Assurance (CQA) Inspector (see Sections 1.06 and 3.03) for each area that is covered by the GCL.

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E. Warranty

After construction, the contractor shall submit material and installation warranty certificates.

1.05 QUALIFICATIONS

A. GCL Manufacturer must have produced at least 10 million sq. ft. (1 million sq. meters) of GCL, with at least 8 million sq. ft. (800,000 sq. meters) installed.

B. The GCL Installer must either have installed at least 1 million sq. ft. (100,000 sq. meters) of GCL, or must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.06 CONSTRUCTION QUALITY ASSURANCE (CQA)

A. Construction Quality Assurance of the GCL installation shall be performed as outlined in the project Construction Quality Assurance Plan, included in Appendix 2 of these Specifications.

B. The GCL Installer shall provide his own CQA inspector. The Owner shall provide a third-party inspector for CQA monitoring of the GCL installation. The inspector shall be an individual or company who is independent from the manufacturer and installer and who shall be responsible for monitoring and documenting activities, related to the CQA of the GCL throughout installation.

C. Testing of the GCL as necessary to support the CQA effort shall be performed by a third party laboratory retained by the Owner and independent from the GCL manufacturer and installer.

WARRANTY

The geomembrane material shall be warranted, on a pro-rata basis against manufacturer's defects for a period of five (5) years from the date of liner installation. The installation shall be warranted against defects in workmanship for a period of (1) year from the date of liner completion.

PART 2. PRODUCTS

2.01 MATERIALS

A. The GCL shall be manufactured as a hydraulic barrier consisting of clay bonded between two layers of nonwoven geotextile by needle punching.

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B. The GCL shall be manufactured to conform with the test methods, required properties, and testing frequencies of the GRI-GCL3 specification for Reinforced, Geotextile Related GCL.

C. In addition to the minimum properties given in Table 1(a) of GRI-GCL3, the GCL shall conform to the following specifications.

Test Method	Minimum Value
Bentonite Mass/Area (ASTM D 5993)	0.75 lb./ft^2
GCL Grab Tensile Strength (ASTM D 4632)	90 lb.
GCL Peel Strength (ASTM D 4632)	15 lb.

D. The reinforced GCL shall have seam test data from an independent laboratory showing that the seam flow with a grooved cut in one of the nonwoven geotextiles is less than 1×10^{-8} m^3/m^2/s at 2 psi hydraulic pressure.

E. The minimum acceptable dimensions of full-size GCL panels shall be 150 ft. (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 ft. (21 meters) but less than a full-length roll)] may be supplied at a rate no greater than three (3) per truckload or three (3) rolls every 36,000 sq. ft. (3,500 sq. meters) of GCL, whichever is less.

2.02 PRODUCT QUALITY DOCUMENTATION

The GCL manufacturer shall provide the Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

A. The Manufacturer's Certification that the material was manufactured and tested in accordance with GRI-GCL3 specifications, together with a report of the test results, shall be furnished at the time of shipment.

B. The manufacturers recommended seaming method with seam test data from an independent laboratory showing that the seam flow is less than 1×10^{-8} m^3/m^2/s at 2 psi hydraulic pressure.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

2.03 PRODUCT LABELING

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand product code).

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2. Lot number and roll number.
3. Roll length, width and weight.

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2.04 PACKAGING

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

2.05 ACCESSORY BENTONITE

A. The granular bentonite sealing clay used for overlap seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. Seaming of GCLs shall be conducted in accordance with the manufacturer's guidelines for each particular GCL.

PART 3. EXECUTION

3.01 SHIPPING AND HANDLING

A. The rolls of GCL shall be packaged and shipped by appropriate means to prevent damage to the material and to facilitate off-loading.

B. The Installation Supervisor shall be present during delivery and unloading of the GCL. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage. The Installation Supervisor shall prepare and submit an inventory that includes lot and roll number for materials received.

C. The Installer is responsible for unloading the GCL. The Installer should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

3.02 STORAGE

A. Storage of the GCL rolls and accessory bentonite shall be the responsibility of the Installer.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

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C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

3.03 EARTHWORK

A. The compacted clay liner upon which the GCL is installed shall be prepared and compacted prior to installation. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation.
2. Construction debris.
3. Sticks.
4. Sharp rocks.
5. Void spaces.
6. Ice.
7. Abrupt elevation changes.
8. Standing water.
9. Cracks larger than 0.25 in. (6 mm) in width.
10. Any other foreign matter that could contact the GCL.

B. Immediately prior to GCL deployment, the compacted clay liner shall be final-graded by the contractor to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than 0.5 in. (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

C. Prior to daily GCL placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" which document the Installer's inspection and acceptance of the underlying surface as being suitable for GCL installation.

D. It shall be the Installer's responsibility thereafter to indicate to the Owner's Representative any change in the condition of the compacted clay liner that could cause the subgrade to be out of compliance with any of the requirements listed in this Section. The Installation Supervisor shall certify in the daily report that no GCL was placed over visibly defective low permeability soil surface.

E. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated by the contractor in accordance with the project plans. The trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

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3.04 GCL PLACEMENT

A. GCL rolls shall be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) shall be in accordance with the Owner Representative's recommendations.

B. Equipment which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

C. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

D. The GCL panels shall be placed parallel to the direction of the slope.

E. All GCL panels shall lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.

F. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, the Installer shall remove and replace the hydrated material as directed by the Owner Representative.

3.05 ANCHORAGE

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope. The front edge of the trench shall be rounded so as to eliminate any sharp corners. Loose soil shall be removed from the floor of the trench. The GCL shall cover the entire trench floor, but shall not extend up the rear trench wall.

3.06 SEAMING

A. The GCL seams shall be constructed by overlapping their adjacent edges according to the manufacturer's recommendations. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

B. End-of-roll overlapped seams shall be constructed with a minimum overlap of 24 in. (600 mm). Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff

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flow to enter the overlap zone. End-of-roll overlapped seams for all reinforced GCL seams require bentonite-enhanced seams as described below.

C. Bentonite-enhanced seams shall be constructed between the overlapping adjacent panels as follows. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150 mm) line. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal ft. (0.4 kg/m). A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

3.07 DETAIL WORK

A. There shall be no penetrations through the GCL.

B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.08 DAMAGE REPAIR

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible, if approved by the Owner's Representative, to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 in. (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic shall be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement. Patching shall be certified by the Installer's CQA Inspector and observed by the Owner's Representative.

PART 4. GRI-GCL3 SPECIFICATIONS

Geosynthetics Research Institute (GRI) GRI-GCL3, "Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).", Dated -- May 16, 2005.

END OF SECTION 02376

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Original - May 16, 2005

GRI-GCL3*

Standard Specification for

"Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers the manufacturing quality control (MQC) of geosynthetic clay liners (GCLs), describing types of tests, the proper test methods, minimum and sometimes maximum values, and the minimum testing frequencies.

Note 1: Geosynthetic Clay Liners (GCLs) are also called Clay Geosynthetics Barriers (GBR-Cs).

1.2 There are two general categories of GCLs covered in this specification: reinforced and nonreinforced. Within each category there are geotextile, polymer coated geotextiles, and geomembrane/geofilm related types.

1.3 This specification is intended to aid manufacturers, suppliers, purchasers and users of GCLs in establishing an acceptable level of effort for manufacturing quality control.

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

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1.4 This specification does not address manufacturing quality assurance (MQA), product acceptance testing, or conformance testing. These are independent activities taken by organizations other than the GCL manufacturer.

1.5 The values stated in SI (metric) units are to be regarded as the standard. The U.S. (English) units are calculated values using a "soft" conversion accuracy.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards

D 638 Test Method for Tensile Properties of Plastics
D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D 882 Test Method for Tensile Properties of Thin Plastic Sheeting
D 1141 Practice for Preparation of Substitute Ocean Water
D 1505 Test Method for Density of Plastics by the Density-Gradient Method
D 4354 Practice for Sampling of Geosynthetics for Testing
D 4439 Terminology for Geosynthetics
D 4632 Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4759 Practice for Determining the Specification Conformance of Geosynthetics
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5887 Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using Flexible Wall Permeameter
D 5888 Practice for Storage and Handling of Geosynthetic Clay Liners
D 5889 Practice for Quality Control of Geosynthetic Clay Liners
D 5890 Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
D 5891 Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
D 5993 Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liners
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembrane
D 6102 Guide for Installation of Geosynthetic Clay Liners
D 6141 Guide for Screening the Clay Portion of a GCL for Chemical Compatibility to Liquids

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D 6243 Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
D 6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners
D 6496 Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 6766 Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Liquids
D 6768 Test Method for Tensile Strength of Geosynthetic Clay Liners

2.2 GRI Standards

GM13 Test Properties, Testing Frequency and Recommended Warrant for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
GM18 Test Properties, Testing Frequency and Recommended Warrant for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes (Presently suspended as of May 3, 2004)

2.3 Government Document:

U.S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182. September 1993. 305 pgs.

3. Terminology

3.1 Definition

3.1.1 Geosynthetic Definitions:

3.1.1.1 geotextile, n a permeability geosynthetic comprised solely of textiles. (ASTM D 4439)
3.1.1.2 geomembrane, n—an essentially impermeable geosynthetic barrier composed of one or more synthetic sheets. (ASTM D 4439)
3.1.1.3 geofilm, n—a thin polymeric film which is essentially impermeable having a thickness no greater than 0.25 mm (10 mils).
3.1.1.4 geotextile-polymer, n -a geotextile which has been coated with, or impregnated by, a polymer such as polypropylene

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3.1.1.5 geosynthetic clay liner, n—a manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetic materials. (ASTM D 4439)

Note 1: Geotextile Related GCL is one in which two geotextiles are used respectively as cap and carrier to the bentonite. Cap and carrier designations in this standard refer to respective orientations during manufacturing. This may or may not be the as-placed orientation in the field. It can be internally reinforced by needle punching or stitching, or be nonreinforced.
Geotextile Polymer Coated GCL is one in which two geotextiles are used respectively as cap and carrier to the encased bentonite, however, one of the geotextiles has been polymer coated in a manner that the permeability and flux are decreased. Cap and carrier designations refer to the as manufactured product and not necessarily to the as-placed orientation. It can be internally reinforced by needle punching or stitching, or be nonreinforced.
Geomembrane/Geofilm Related GCL is one in which a geomembrane or geofilm is included in the cross section either above or below the cap geotextile. It can be internally reinforced needle punching or be nonreinforced. Also in the nonreinforced category is bentonite adhesively bonded to a geomembrane.

3.1.2 Material Definitions

3.1.2.1 bentonite—a distinct type of fine-grained clay soil typically containing not less than 80% montmorillionite clay, usually characterized by high swelling upon wetting.

3.1.2.2 Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For geosynthetic materials, a formulation refers to the exact percentages of resin, additives, carbon black and/or other additives. It does not necessarily refer to individual suppliers of each ingredient. The individual suppliers must meet the manufacturer's internal quality control specification.

3.1.3 Organizational Definitions:

3.1.3.1 installer, n—the party who installs, or facilitates installation of, any materials purchased from manufacturers or suppliers.

3.1.3.2 manufacturer, n—the group, corporation, partnership, or individual that manufactures a product.

3.1.3.3 purchaser, n—the person, company, or organization that purchases any materials or work to be performed.

3.1.3.4 supplier, n- the party who supplies material or services.

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3.1.4 Quality Definitions:

3.1.4.1 Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications. ref. EPA/600/R-93/182

3.1.4.2 Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project. ref. EPA/600/R-93/182

3.1.4.3 Construction Quality Control (CQC) - A planned system of inspections that are used to directly monitor and control the quality of a construction project. Construction quality control is normally performed by the geosynthetics manufacturer or installer, or for natural soil materials by the earthwork contractor, and is necessary to achieve quality in the constructed or installed system. Construction quality control (CQC) refers to measures taken by the installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project. ref. EPA/600/R-93/182

3.1.4.4 Construction Quality Assurance (CQA) - A planned system of activities that provide assurance that the facility was constructed as specified in the design. Construction quality assurance includes inspections, verification, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. Construction quality assurance (CQA) refers to measures taken by the CQA organization to assess if the installer or contractor is in compliance with the plans and specifications for a project. ref. EPA.600/R-93/182

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4. Significance and Use

4.1 GCLs must be properly manufactured in a manner consistent with a minimum level of quality control as determined by in-house testing of the final product. This specification presents the types of tests, standard methods of the testing, required (usually minimum) test values, and minimum testing frequencies which should be embodied in the manufacturer's quality control documents. The quoted tests, test methods and test values in Table 1 must appear in the MQC plan and the MQC report.

4.2 It should be clearly recognized that manufacturers may perform additional tests or at greater frequency than required in this specification, or both. In this case, the manufacturer's quality control plan will then take precedence over this specification.

4.3 It should also be recognized that purchasers and installers of GCLs may require additional tests or at a great frequency than called for in this specification, or both. The organization(s) producing such project specific specification or quality assurance plan should recognize that such requirements are beyond the current state-of-the-practice. If such a request is made by purchasers or installers, they should clearly communicate the requirements to the manufacturer or supplier during the contract decisions in order that disputes do not arise at a subsequent time.

5. Procedure

5.1 The procedures embodied in this specification are contained in the respective test methods given in Table 1.

5.1.1 The minimum recommended quality control tests for the manufacture of GCLs are given in Table 1. Specific tests are performed on the bentonite, the geosynthetic component materials, and the finished GCL. Table 1(a) is in S.I. (Metric) units and Table 1(b) is in U.S. (English) units.

Note 2: The conversion from S.I. units into U.S. units is soft.

5.1.2 The individual properties in Table 1 are minimum values; except fluid loss, moisture content, and permeability (or flux). They are maximum values. The manner of taking specimens is described in the appropriate test method. When an average value is indicated, it is listed in the table as "min. ave.", or "max. ave.".

5.2 Bentonite (as received)
Two tests are required; swell index and fluid loss. The latter is a maximum value. These tests should be performed on the bentonite prior to fabrication into a GCL.

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or on bentonite taken from the manufactured product if the bentonite is modified in any way during manufacturing, e.g., if an adhesive is added.

5.3 Geotextile (as received)
Mass per unit area is required on the as-manufactured cap and carrier fabrics, with different values depending on the fabric being nonwoven or woven.

Note 3: These tests are to be performed on the geotextiles before manufacturing into the final GCL. Removal of the geotextiles from the manufactured product and subsequent testing will give erroneous values and is not an acceptable practice. The exception is polymer coated GCLs where the geotextile must be removed to determine its mass per unit area.

5.4 Geomembrane/Geofilm (as received)
The following tests are required; thickness, density, and tensile strength at break. All are minimum required values. Tensile strength at break is the lowest of machine direction and cross machine direction.

Note 4: These tests are to be performed on the geomembrane or geofilm before manufacturing into the final GCL. Removal of the geomembrane or geofilm from the manufactured product and subsequent testing will give erroneous values and is not an accepted practice.

5.5 GCL (as manufactured)
Six tests are required on the as-manufactured GCL with one having an alternative, i.e., hydraulic conductivity or flux. All are minimum values, with the exception of moisture content and hydraulic conductivity or flux.

5.6 GCL (long-term)
The purpose of these long-term or endurance tests is to provide confidence in the continuing acceptable performance of the bentonite and geosynthetic components of the installed GCL.

5.6.1 The durability of the bentonite is evaluated using a permeant consisting of 0.1 M calcium chloride solution. See ASTM D 6141 which is a guide for this particular aspect of the specification. The GCL is to be hydrated with distilled dionized water prior to conducting the tests with the calcium chloride solution. In this regard, ASTM D6766 Scenario 1 and Method C is the procedure to be used. Furthermore, this test is conducted twice at two different normal pressures, i.e., 35 and 500 kPa. The maximum allowable values are listed in Table 1.

5.6.2 The geotextiles in their as-received condition are evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The

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minimum percent in tensile strength retained at break, as measured by ASTM D6768, is 65%. If individual yarns are used in reinforcing GCLs, they must also meet this same endurance criterion.

5.6.3 The geomembrane in its as-received condition is evaluated for durability via the appropriate GRI Specification. For high density polyethylene (HDPE), the specification is GRI GM13. For linear low density polyethylene (LLDPE), the specification is GRI GM17. For flexible polypropylene (fPP), the specification is GRI GM18.

5.6.4 The geofilm in its as-received condition is evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The minimum percent tensile strength retained at break for either MD or XMD, as measured by ASTM D882, is reported accordingly and must meet or exceed the specification value.

Note 5: It should be recognized that the above durability criterion for geofilms is not as stringent as the criteria for geomembranes stated in Section 5.6.3.

6. Workmanship and Appearance

6.1 Waterproof ink overlap lines should be printed on both edges of one of the surfaces (geotextile or geomembrane) of the manufactured GCL.

Note 6: The overlap lines are minimally 150 mm (6.0 in.) from the edges of the GCL. Other design-related situations may require greater overlap distances to be printed on the GCLs, e.g., when not backfilled in a timely manner.

6.2 Needle punched and stitch bonded GCLs shall be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product. There must be continuous needle detection and removal devices, e.g., metal detectors and magnets, used during manufacture of GCL products.

6.3 The manufactured GCL shall have good appearance qualities. It shall be free from such defects that would affect the specified properties and integrity of the product.

6.4 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents. ASTM D5888 and D5889 should be followed in this regard.

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7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Table 1. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width, see ASTM D 4354.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Table 1.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave.". When the property is a maximum value, the designation is "max. ave.".

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marking

9.1 The GCL shall be rolled, clearly labeled, and onto a substantial core, encased in a waterproof wrapper. Packaging must be adequate for safe transportation to the point of delivery.

9.2 The label should include manufacturer, style, lot and/or roll number, weight, length and width.

10. Conformance and Certification

10.1 Conformance of the manufactured GCL to this specification, or agreed-upon variation thereof, shall be performed by the MQA organization or designated by the purchaser/owner. ASTM D 4759 can be used as a general guide, but individual test methods must be clearly stipulated and communicated to the parties involved.

10.2 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

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Table 1(a) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)[1]	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (g/m^2)[2]	D5261	200	200	200	70	100	n/a/70	20,000 m^2
cap fabric -(woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
carrier fabric (nonwoven composite) - mass/(g/m^2)[2]	D5261	240	240	240	90	100	n/a/90	20,000 m^2
carrier fabric (woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
coating - mass/unit area (g/m^2)[3]	D5261	n/a	100	n/a	n/a	100	n/a	4,000 m^2
Geomembrane/Geofilm (as received)								
thickness[5] (mm)	D5199/D5994	n/a	n/a	0.40/0.50/0.10	n/a	n/a	0.40/0.75/0.10	20,000 m^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	20,000 m^2
break tensile strength, MD&XMD (kN/m)	D6693	n/a	n/a	n/a	n/a	n/a	6.0	20,000 m^2
break tensile strength, MD (kN/m)	D882	n/a	n/a	2.5	n/a	n/a	2.5	20,000 m^2
GCL (as manufactured)								
mass of GCL (g/m^2)[6]	D5993	4000	4050	4100	4000	4050	4100	4,000 m^2
mass of bentonite (g/m^2)[6]	D5993	3700	3700	3700	3700	3700	3700	4,000 m^2
moisture content[12] (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	4,000 m^2
tensile str., MD (kN/m)	D6768	4.0	4.0	4.0	4.0	4.0	4.0	20,000 m^2
peel strength (N/m)	D6496	360	360	360	n/a	n/a	n/a	4,000 m^2
permeability[4] (m/sec), "or"	D5887	5×10^{-11}	5×10^{-12}	5×10^{-12}	5×10^{-7}	5×10^{-12}	5×10^{-12}	25,000 m^2
flux[4] ($m^3/sec\text{-}m^2$),	D5887	1×10^{-8}	1×10^{-9}	1×10^{-9}	1×10^{-8}	1×10^{-9}	1×10^{-9}	25,000 m^2
GCL permeability[4][7][8] (m/sec) (max. at 35 kPa)	D6766	1×10^{-8}	1×10^{-9}	1×10^{-9}	1×10^{-8}	1×10^{-9}	1×10^{-9}	yearly
GCL permeability[4][7][8] (m/sec) (max. at 500 kPa)	D6766 mod.	5×10^{-10}	5×10^{-11}	5×10^{-11}	5×10^{-10}	5×10^{-11}	5×10^{-11}	yearly
Component Durability								
geotextile and reinforcing yarns[9] (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec[9]	n/a	n/a	GM Spec[9]	yearly
geofilm/polymer treated[8] (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum)

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs, one, or the other, must contain a scrim component of mass ≥ 100 g/m^2 for dimensional stability

(3) Calculated value obtained from difference of coated fabric to as-received fabric

(4) Value is both site-specific and product-specific and is currently being evaluated

(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm

(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method

(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g CaCl2 in 1-liter water)

(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days

(9) Durability criteria should follow the appropriate specification for the geomembrane type used, i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP

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GRI-GCL3 Spec - U.S. (English) Units

Table 1(b) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)[1]	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (oz/yd^2)[2]	D5261	5.8	5.8	5.8	2.1	2.9	n/a/2.1	25,000 yd^2
cap fabric (woven) - mass/unit area (oz/yd^2)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd^2
carrier fabric (nonwoven composite) - mass/(oz/yd^2)[2]	D5261	5.9	5.9	5.9	2.7	2.9	n/a/2.7	25,000 yd^2
carrier fabric (woven) - mass/unit area (oz/yd^2)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd^2
coating - mass/unit area (oz/yd^2)[3]	D5261	n/a	2.9	n/a	n/a	2.9	n/a	5,000 yd^2
Geomembrane/Geofilm (as received)								
thickness[5] (mils)	D5199/D5994	n/a	n/a	15/20/4	n/a	n/a	15/30/4	25,000 yd^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	25,000 yd^2
break tensile strength, MD&XMD (lb/in.)	D6693	n/a	n/a	n/a	n/a	n/a	34	25,000 yd^2
break tensile strength, MD & XMD (lb/in.)	D882	n/a	n/a	14	n/a	n/a	14	25,000 yd^2
GCL (as manufactured)								
mass of GCL (lb/ft^2)[6]	D5993	0.82	0.83	0.84	0.82	0.83	0.84	5,000 yd^2
mass of bentonite (lb/ft^2)[6]	D5993	0.75	0.75	0.75	0.75	0.75	0.75	5,000 yd^2
moisture content[7] (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	5,000 yd^2
tensile str., MD (lb/in.)	D6768	23	23	23	23	23	23	25,000 yd^2
peel strength (lb/in.)	D6496	2.1	2.1	2.1	n/a	n/a	n/a	5,000 yd^2
permeability[4] (cm/sec), "or"	D5887	5×10^{-9}	5×10^{-10}	n/a	5×10^{-9}	5×10^{-10}	n/a	30,000 yd^2
flux[11] (cm^3/sec-cm^2),	D5887	1×10^{-7}	1×10^{-7}	n/a	1×10^{-6}	1×10^{-7}	n/a	30,000 yd^2
GCL permeability[10][11] (cm/sec) (max. at 5 lb/in.^{2})	D6766	1×10^{-8}	1×10^{-8}	1×10^{-9}	1×10^{-8}	1×10^{-8}	1×10^{-9}	yearly
GCL permeability[10][12] (cm/sec) (max. at 70 lb/in.^{2})	D6766 mod.	5×10^{-8}	5×10^{-8}	5×10^{-9}	5×10^{-8}	5×10^{-8}	5×10^{-9}	yearly
Component Durability								
geotextile and reinforcing yarns[8] (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec[9]	n/a	n/a	GM Spec[9]	yearly
geofilm/polymer treated[8] (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum)

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs: one, or the other, must contain a scrim component of mass > 2.9 oz/yd^2 for dimensional stability

(3) Calculated value obtained from difference of coated fabric to as-received fabric

(4) Value is both site-specific and product-specific and is currently being evaluated

(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm

(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method

(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g CaCl2 in 1-liter water)

(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days

(9) Durability criteria should follow the appropriate specification for the geomembrane used; i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP

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DIVISION 2 - SITE WORK
Section 02640 – HDPE Piping
ADDENDUM #2

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to construction of the HDPE (High Density Polyethylene) Piping for the Leachate Collection System, Process Water Recovery System, ~~***the Slurry Piping and Valves,***~~ and Recycle Pond Decant System at the Gypsum Management Facility and the Leachate Collection System for the CCB Landfill.

1.02 RELATED SECTIONS

None.

1.03 REFERENCES

The following references, or cited portions thereof, govern the work

A. American Society of Testing and Materials:

1. ASTM D 2683 (2004); Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
2. ASTM D 3261 (2003); Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
3. ASTM D 3350 (2005); Specification for Polyethylene Plastics Pipe and Fittings Materials.
4. ASTM F 412 (2001a); Terminology Relating to Plastic Piping System.
5. ASTM F 1055 (1998); Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
6. ASTM F 1056 (2004); Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings.
7. ***ASTM F714-06a Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.***
8. ***ASTM F2164-02 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure***

1.04 SUBMITTALS

A. Qualifications

Submit qualifications of the Welding Supervisor who will be responsible for construction quality control of the pipe joining process.

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B. Material Certifications

Submit manufacturer certifications that the pipe provided complies with the requirements herein.

C. Product Data

1. Submit product data and operating instructions for pipe joining equipment.
2. Submit pipe manufacturer's recommended procedures for storing, handling, and installing pipe and fittings.

1.05 QUALIFICATIONS

A. The Contractor or Subcontractor performing the work under this section shall have in his employ a Welding Supervisor who has completed a minimum of 10,000 ft of pipe joining work using the type of equipment proposed for use in this work. The Welding Supervisor shall be on site at all times during pipe line installation, and shall provide direct supervision over other employees.

1.06 WARRANTY

A. The pipe and fittings shall be warranted, on a pro-rata basis, against manufacturer's defects for a period of five (5) years from the date of pipe installation. The installation shall be warranted against defects in workmanship for a period of one (1) year from the date of completion.

PART 2. PRODUCTS

2.01 MATERIALS

A. Leachate and Process Water Collection Piping

1. Pipe material shall be High Density Polyethylene (HDPE) PE 3408, according to ASTM F412, with minimum cell classification values of 345464C, according to ASTM D3350. Iron pipe size (IPS) and standard dimension ratio (SDR) shall be as indicated in the plans.

2. Size and spacing of holes in perforated pipe shall be as indicated in the plans.

~~B. *Slurry* Sluice Piping~~

~~Pipe for HDPE Sluice Lines shall be manufactured from a PE 3408 resin. The resin material shall meet the specifications of ASTM D3350-02 with a minimum cell~~

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~~classification of PE345464C. Pipe O.D. sizes 4" to 54" shall be available in steel pipe sizes (IPS). Pipe shall have a manufacturing standard of ASTM D3035 and be manufactured by an ISO 9001 certified manufacturer. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.~~

~~***Pipe shall be manufactured from a pipe resin which meets ASTM D 3350-05 with a minimum cell classification of 445474C. Pipe shall be manufactured to the dimensions of ASTM F-714. The service factor to determine the pressure rating shall be 0.63. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.***~~

C. Fittings ***(Leachate and Process Water Collection Piping)***

1. Fittings shall be made of the same material and size as the HDPE piping, and shall have a pressure rating no less than 160 psi.

2. Butt Fusion Fittings

   Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Fabricated fittings are to be manufactured using a Data Logger. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records.

3. Electrofusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99. Electrofusion Fittings shall have a manufacturing standard of ASTM F-1055. Fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans.

4. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D-3350. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D-3261. Fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Flanged and Mechanical Joint Adapters are to be used for Sluice Piping only.

~~D. Valves ***and Valve Piping*** for Sluice ***Slurry*** Piping~~

~~Valves used for Sluice Piping shall be ITT Fabri-Valve XS150-ULV-Urethane~~

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~~Lined Knife Gate Valves. Valve Material: Yet to Be Determined~~

~~*Valves used for the Slurry Piping System shall be Clarkson KGF Knife Gate Valve with ductile iron housing high tear strength gum rubber sleeves, C276 gate rated at 300 psig, with manual handwheel actuation.*~~

~~*Fittings and piping at valve stations shall be SILVER STREAK model fiberglass reinforced plastic (FRP) as manufactured by Fiber Glass Systems. Flanges shall have ANSI B16.5 Class 150 bolt hole patterns. Flanged connections to valves shall have ANSI B16.5 Class 300 bolt hole patterns. ASTM A307, Grade B, hex head bolts shall be supplied. Washers shall be supplied on all nuts and bolts. Gaskets shall be 1/8" thick, 60-70 durometer full-face type suitable for the service shown on the drawings and as recommended in the manufacturer's standard installation procedures. Pipe shall be installed as specified and indicated on the drawings.*~~

~~*E. Fittings for HDPE Slurry Piping*~~

~~*1. Butt Fusion Fittings - Fittings Pipe shall be manufactured from a pipe resin which meets ASTM D 3350-05 with a minimum cell classification of 445474C. Pipe shall be manufactured to the dimensions of ASTM F-714. The service factor to determine the pressure rating shall be 0.63. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material*~~

~~*2. Molded Butt Fusion Fittings shall have a manufacturing standard of ASTM D-3261. Molded & fabricated fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Fabricated fittings must have the same pressure rating as the pipe; a DR less than the pipe shall be used. Fabricated fittings are to be manufactured using a Data Logger to record temperature, fusion pressure, and a graphic representation of the fusion cycle shall be part of the Quality Control records.*~~

~~*3. Electrofusion Fittings - Fittings shall be made from resin or pipe meeting ASTM D 3350-05 with a minimum cell classification of 445474C.; Electrofusion Fittings shall meet the manufacturing standard of ASTM F-1055. Fittings shall have the same pressure rating as the pipe or higher unless otherwise specified on the plans.*~~

~~*4. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be made from materials containing resin that meets ASTM D 3350-05 with a minimum cell classification of 445474C.*~~

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2.02 EQUIPMENT

A. Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400 degrees Fahrenheit, alignment, and an interfacial fusion pressure of 75 PSI. The butt fusion joining will produce a joint weld strength equal to or greater than the tensile strength of the pipe itself. All field welds shall be made with fusion equipment equipped with a Data Logger. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records.

B. Sidewall fusions for connections to outlet piping shall be performed in accordance with HDPE pipe and fitting manufacturer's specifications. The heating irons used for sidewall fusion shall have an inside diameter equal to the outside diameter of the HDPE pipe being fused. The size of the heating iron shall be ¼ inch larger than the size of the outlet branch being fused.

C. Mechanical joining will be used where the butt fusion method can not be used. Mechanical joining will be accomplished by either using a HDPE flange adapter with a Ductile Iron back-up ring or HDPE Mechanical Joint adapter with a Ductile Iron back-up ring.

D. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe.

PART 3. EXECUTION

3.01 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. HDPE pipe and fittings shall be packaged and shipped by appropriate means to prevent damage to the material and to facilitate off-loading. The Owner will provide an on-site storage site. Storage site requirements (size and preferred location) shall be submitted with the bid documents.

B. Storage and handling shall be according to manufacturer's recommendations.

3.02 BASE PREPARATION

HDPE Piping for leachate and process water collection shall be installed on a layer of coarse aggregate placed by the Contractor in accordance with the plans. The grade of the coarse aggregate base shall be verified before installing the piping.

3.03 TRENCH INSTALLATION

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Excavation, Foundation, Bedding and Haunching for the underground installation of HDPE Sluice Piping shall be in accordance with Section 20-2.20 of the "Standard Specifications for Water and Sewer Main Construction in Illinois". The trench shall be backfilled with excavated material to the top of trench surface. Excavations in areas of Structural Fill shall be backfill with and compacted to the specifications of Section 02200-Earthwork for Structural Fill. All other areas shall be backfilled to 92% of the dry density, as determined by the Standard Proctor Test ASTM D698.

3.03 INSTALLATION

All pipe and fittings shall be installed according to the manufacturer's recommendations. Removal of weld beads is not required. Contractor shall place coarse aggregate along the pipe to provide lateral stability. Welds shall not be obscured until they have been approved by the Owner's Representative, the top of pipe shall not be covered until the Construction Quality Assurance (CQA) survey has been completed to verify conformance with specified tolerances.

3.04 INSPECTIONS

A. The Owner's Representative shall shall visually inspect pipe materials to verify that each pipe material is properly stamped (by the manufacturer) for ASTM acceptance before installation. Defective or damaged materials shall be removed from the site.

B. Each weld and connection shall be visually inspected by the Owner's Representative. Defective welds shall be repaired as directed by the Owner's Representative and according to manufacturer's recommendations. Welds and connections shall not be covered until they have been approved by the Owner's Representative.

3.05 TOLERANCES

A. HDPE piping shall be located within 0.5 ft. of plan location, and elevation shall be within 0.1 ft. of plan elevation with no adverse slopes.

~~*3.06 TESTING*~~

~~*A. All Slurry Piping shall be Hydrostatic Tested in accordance with ASTM F 2164, using a Design Pressure of 270 PSIG.*~~

END OF SECTION 02936

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DIVISION 2 - SITEWORK
Section 02700–Storm Drainage
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

A. This section includes installing pipe culverts and end sections for pipe culverts.

B. Storm Drainage installation shall include incidental related work such as topsoil removal, trench excavation, backfill, compaction, tie-in of existing system, etc.,

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 02200 - Earthwork

1.03 REFERENCES

A. The following reference, or cited portions thereof, governs the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007. Payment provisions shall not apply.

PART 2. PRODUCTS

2.01 PIPE CULVERTS

A. ***HDPE*** Pipe Culverts shall be installed in accordance with Article 542 of the Standard Specifications. All piping shall be Corrugated PE (Polyethylene) with a Smooth Interior, in accordance with AASHTO M 294, Type S.

2.02 METAL END SECTIONS

A. Metal End Sections shall be either aluminum or steel in accordance with Article 542.07(c) of the Standard Specifications.

2.03 REINFORCED CONCRETE CULVERT PIPE

A. Reinforced Concrete Culvert Pipe shall be furnished in accordance with Article 1042.06(a) of the Standard Specifications.

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2.03 PRECAST REINFORCED CONCRETE FLARED END SECTIONS

A. Precast Reinforced Concrete Flared End Sections shall be furnished in accordance with Article 1042.07(a) of the Standard Specifications.

PART 3. EXECUTION

3.01 STORM DRAINAGE PIPING INSTALLATION

A. Construct pipe culverts in accordance with the Article 542 of the Standard Specifications. Bedding and Haunching shall be IDOT CA-6 Gradation. Trench excavations are to be backfilled with on-site clayey materials instead of sand. Compact backfill to 95 percent of the maximum dry density as determined by the Standard Proctor test – ASTM D-698.

3.02 ~~METAL~~ END SECTION INSTALLATION

A. End Treatments shall be installed according to Article 542.07 of the Standard Specifications.

END OF SECTION 02700

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DIVISION 2 - SITEWORK
Section 02800 - HDPE Geomembrane
ADDENDUM #1

PART 1. GENERAL

1.01 DESCRIPTION

A. This section includes manufacturing, furnishing, and installing High Density Polyethylene (HDPE) Geomembranes for the Gypsum Management Facility and the CCB Landfill.

B. The work includes furnishing all equipment and materials and providing all labor, supervision, administration and management necessary to perform the work as shown on the plans.

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 02373 – Geotextiles
2. 02376 – Geosynthetic Clay Liner

1.03 REFERENCES

A. The following references, or cited portions thereof, govern the work:

1. American Society for Testing and Materials (ASTM):

a. D 638, Standard Test Method for Tensile Properties of Plastics.
b. D 751, Standard Test Methods for Coated Fabrics.
c. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
d. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
e. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
f. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
g. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
h. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
i. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.

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j. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
k. D 4437, Standard *Practice for* Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
l. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
m. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
n. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.
o. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
p. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
q. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
r. D 5820, Test Method for Air Testing.
s. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
t. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes
u. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test

2. Geosynthetic Research Institute (GRI):

a. GRI GM 6, Pressurized Air Channel Test for Dual Seamed Geomembranes
b. GRI GM 9, Cold Weather Seaming of Geomembranes
c. GRI GM 10, Specification for Stress Crack Resistance of HDPE Geomembrane Sheet
d. GRI GM 13, Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
e. GRI GM 14, Test Frequencies for Destructive SeamTesting

1.04 SUBMITTALS

A. Submit the following to the Engineer or Owner, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:

1. Documentation of manufacturer's qualifications as specified in subsection 1.05A of this Section.

2. Manufacturer's Quality Control program manual or descriptive documentation.

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3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.

4. Sample of the material.

5. Documentation of Installer's qualifications, as specified below and in subsection 1.05B of this Section.
   a. Submit a list of at least ten completed facilities. For each name and type of facility; its location; the date of installation; phone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
   c. Quality Control Program.

6. Example Material Warranty and Liner Installation Warranty complying with subsections 1.07 and 1.08 of this Section.

7. Resin Supplier's name, resin production plant identification, resin brand name and number, production date of the resin, resin Manufacturer's quality control certificates, and certification that the properties of the resin meet the requirements of these specifications.

B. Shop Drawings

1. Submit copies of shop drawings for engineer's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner's Representative. Butt seams on a slope, if allowed, should be staggered.

2. Placement of geomembrane will not be allowed to proceed until Owner's Representative has received and approved the shop drawings.

C. Additional Submittals (In-Progress and at Completion)

1. Manufacturer's warranty (refer to subsection 1.08).
2. Geomembrane installation warranty (refer to subsection 1.09).
3. Daily written acceptance of subgrade surface (refer to subsection 3.01.C).
4. Low-temperature seaming procedures if applicable (refer to subsection 3.03.A)
5. Prequalification test seam samples (refer to subsection 3.05.A.6).
6. Field seam non-destructive test results (refer to subsection 3.05.B.1).
7. Field seam destructive test results (refer to subsection 3.05.C.6).
8. Daily field installation reports (refer to subsection 3.05.G).

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9. Installation record drawing, as discussed in subsection 3.05.G).

1.05 QUALITY CONTOL

A. Manufacturer's Qualifications:

The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 sq. ft. of the specified type of geomembrane or similar product during the last five years.

B. Installer's Qualifications:

1 The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner's Representative to install the geomembrane.

2 The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 5,000,000 sq. ft. of the specified type of geomembrane or similar during the last three years.

3 Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 5,000,000 sq. ft. of geomembrane of the type specified or similar product.

4 Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 3,000,000 sq. ft. of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming, patching, other welding operations, and testing is performed.

5 All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

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C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

D. Rolls shall not be stacked more than three high.

1.07 PROJECT CONDITIONS

Geomembrane shall not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.03.

1.08 MATERIAL WARRANTY

As required by specification. or as required in GRI GM 13 (attachment A)

1.09 GEOMEMBRANE INSTALLATION WARRANTY

The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.10 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A. Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative (Engineer and/or CQA Firm), and the General Contractor.

B. Topics for this meeting shall include:

1. Responsibilities of each party.
2. Lines of authority and communication. Resolution of any project document ambiguity.
3. Methods for documenting, reporting and distributing documents and reports.
4. Procedures for packaging and storing archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels and seams including details for marking on geomembrane.
7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation.
9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
10. Deployment techniques including allowable subgrade for the geomembrane.
11. Plan for controlling expansion/contraction and wrinkling of the

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geomembrane.

12. Covering of the geomembrane and cover soil placement.
13. Measurement and payment schedules.
14. Health and safety.

C. The meeting shall be documented by the Owner's Representative and minutes shall be transmitted to all parties.

PART 2. PRODUCTS

2.01 SOURCE QUALITY CONTROL

Manufacturing Quality Control

A. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM13, or modified as required for project specific conditions.

B. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.01.C of this Section, must be supplied to the Owner's Representative. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

C. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project have the same base resin and material properties.

2.02 GEOMEMBRANE

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE- Density >0.94g/cm) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. Smooth Geomembrane shall meet the property requirements shown in Table 1(a) of the GRI GM13 Specifications included at the end of this Section. Textured Geomembrane shall meet the property requirements shown in Table 2(a) of the GRI GM13 Specifications included at the end of this Section.

B. Material shall be reviewed for conformance to the project specifications by the Owner's Representative.

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PART 3. EXECUTION

3.01 SUBGRADE PREPARATION

A. Geomembrane installed over geosynthetic clay liner (GCL) (Gypsum Stack and CCB Landfill).

The area of GCL to be covered with geomembrane shall be jointly inspected by the Geosynthetics Installer's CQA Representative daily with the Owner's Representative before commencing geomembrane installation for the day, and the condition of the GCL shall be continuously observed as geomembrane installation progresses. Rocks, stones, sticks, sharp objects and debris of any kind shall be removed from the surface of the GCL. The Owner's Representative shall be notified of any discontinuities, premature hydration, or otherwise defective GCL. Geomembrane shall not be placed over suspect areas until they have been repaired to the satisfaction of the Owner's Representative. The Geosynthetics Installer's CQA Representative shall submit a certificate of acceptance to the Owner's Representative daily, stating that the GCL surface was acceptable at the time of geomembrane installation.

B. Geomembrane installed over cushion dirt.(Gypsum Stack only) ***or Earth Fill Material (Recycle Pond only)***

The area of cushion dirt to be covered with geomembrane shall be prepared in accordance with the Section 02200 – Earthwork. The surface shall be smooth and free of ruts and holes, rocks, stones, sticks, sharp objects and debris of any kind.

C. The Geomembrane installer shall provide daily, a certificate of acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.

D. All subgrade damaged by construction equipment and deemed unsuitable by the Owner's Representative for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be reviewed by the Owner's Representative and approved by the Geomembrane Installer. This damage, repair, and the responsibilities of the contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.02 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.04 of this Section are submitted to and approved by the Owner's Representative. Should geomembrane material be deployed prior to approval by the Owner's Representative it will be at the sole risk of the Geomembrane Installer and/or Contractor. If the material does not meet project specifications it shall be removed from the work area at no cost to the

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owner.

B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.

C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F). Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure All Terrain Vehicle or equivalent.

E. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably - expected wind conditions. Sand bag material shall be sufficiently close- knit to prevent soil fines from working through the bags and discharging on the geomembrane.

F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations will be defined in the preconstruction meeting.

G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.

H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. In these areas, the subgrade shall be prepared to allow the geomembrane to rest in intimate contact with the subgrade.

I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.10 B11.

J. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade.

K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to effect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 in.).

3.03 SEAMING PROCEDURES

A. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F).

B. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple.

C. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.

D. Fishmouths or excessive wrinkles at the seam overlaps, shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to

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effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The key hole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

3.04 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown in the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The pre-fabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.05.B. Alternatively, where field non destructive testing can not be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM 6365. Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.
2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.
3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.
4. Care should be taken if flammable gases are present in the area to be tested.

3.05 FIELD QUALITY CONTROL

The Owner's Representative shall be notified prior to all pre qualification and production welding and testing, or as agreed upon in the pre construction meeting.

A. Prequalification Test Seams

1. Test seams shall be prepared and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.
2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The

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test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, tests seams should be made by each technician 1 time every 4–6 hours; additional tests may be required with changes in environmental conditions.

3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen shall fail in the parent material and not in the weld, "Film Tear Bond"(F.T.B. failure). Seam separation equal to or greater than 10% of the track width shall be considered a failing test.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.05.C.4 of this Section. All four specimens shall pass for the test seam to be a passing seam.
5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.
6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner's Representative for archiving.

B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner's Representative.
2. Testing should be done as the seaming work progresses, not at the completion of all field seaming. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.
3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.
4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Owner's Representative all test methods to verify the test procedures are valid.
5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:
    a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket

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attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.

b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).

c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.

d. All areas where soap bubbles appear shall be marked, repaired and then retested.

e. At locations where seams cannot be non destructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.04.B) or equivalent should be substituted.

f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:

a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.

b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed,. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of

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the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.

c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.

d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner's Representative. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner's Representative as seaming progresses.

2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner's Representative as an archive sample; one section given to the Owner's Representative for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.

4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from his sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.02 with less than 10% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.

5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437 or GRI GM 6.

6. Reports of the results of examinations and testing shall be prepared and submitted to the Owner's Representative.

7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall

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then be taken by the Geomembrane Installer at locations indicated by the Engineer, typically 3 m (10 ft) on either side of the failed sample and laboratory seam tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 M in length (150 FT) shall be destructively tested.

D. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Owner's Representative during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

E. Evaluation of Defects: Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.05.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.
2. Defective seams, tears or holes shall be repaired by reseaming or applying a extrusion welded cap strip.
3. Reseaming may consist of either:
   a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
   b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.
4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.
5. All repairs shall be measured, located and recorded.

F. Verification of Repairs on Seams: Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

G. Daily Field Installation Reports: At the beginning of each day's work, the Installer shall provide the Engineer with daily reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;

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2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4. Results of pre-qualification test seams;
5. Results of non-destructive testing; and
6. Results of vacuum testing of repairs.

H. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.06 LINER ACCEPTANCE

A. Geomembrane liner will be accepted by the Owner's Representative when:

1. The entire installation is finished or an agreed upon subsection of the installation is finished;
2. All Installer's QC documentation is completed and submitted to the owner
3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.07 ANCHOR TRENCH

A. Construct as specified on the project drawings.

3.08 DISPOSAL OF SCRAP MATERIALS

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in a location designated by the Owner's Representative, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. Scrap sections larger than 5 feet on each edge shall be segregated from smaller scraps and retained by the Owner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4. GRI GM13 SPECIFICATIONS

Geosynthetics Research Institute (GRI) Test Method GM13 – "Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes", Revision 8, Dated July 10, 2006.

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ATTACHMENT A:

Minimum Average Weld Properties for Smooth and Textured HDPE Geomembranes (English units)								
Property	**Test Method**	**30 mil**	**40 mil**	**50 mil**	**60 mil**	**80 mil**	**100 mil**	**120 mil**
Peel strength (fusion & extrusion) lb/in.	ASTM 4437	39	52	65	78	104	130	156
Shear strength (fusion & extrusion) lb/in.	ASTM 4437	60	80	100	120	160	200	239

END OF SECTION 02800

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Revision 8: July 10, 2006
Revision schedule on pg. 11

GRI Test Method GM13*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

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values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet
GM 11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device
GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

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2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities." EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

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5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength

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associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 8: There are several GRI tests currently included in this standard. Since these topics are not covered in ASTM standards, this is necessary. They are the following:

- UV Fluorescent Light Exposure
- Asperity Height Measurement

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 9: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

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6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

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ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 63 lb/in. 114 lb/in. 12% 700%	 84 lb/in. 152 lb/in. 12% 700%	 105 lb/in. 190 lb/in. 12% 700%	 126 lb/in. 228 lb/in. 12% 700%	 168 lb/in. 304 lb/in. 12% 700%	 210 lb/in. 380 lb/in 12% 700%	 252 lb/in. 456 lb/in. 12% 700%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days or (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	GM 11 D 3895 D 5885	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

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SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	11 kN/m 20kN/m 12% 700%	15 kN/m 27 kN/m 12% 700%	18 kN/m 33 kN/m 12% 700%	22 kN/m 40 kN/m 12% 700%	29 kN/m 53 kN/m 12% 700%	37 kN/m 67 kN/m 12% 700%	44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM-10
Carbon Black Content - %	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 3895 D 5885	N. R. *(8)* 50%	N.R. *(8)* 50%	N R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

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ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in 45 lb/in 12% 100%	84 lb/in 60 lb/in 12% 100%	105 lb/in 75 lb/in 12% 100%	126 lb/in 90 lb/in 12% 100%	168 lb/in 120 lb/in 12% 100%	210 lb/in 150 lb/in 12% 100%	252 lb/in 180 lb/in 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT or (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(7)* *(8)* (a) Standard OIT (min. ave.) - % retained after 90 days - or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils, also see Note 6

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

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SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	11 kN/m 8 kN/m 12% 100%	15 kN/m 10 kN/m 12% 100%	18 kN/m 13 kN/m 12% 100%	22 kN/m 16 kN/m 12% 100%	29 kN/m 21 kN/m 12% 100%	37 kN/m 26 kN/m 12% 100%	44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 2004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GR1 GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings, 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm, also see Note 6.

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views
9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

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Adoption and Revision Schedule

for

HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.

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DIVISION 2 - SITE WORK
Section 02936 - Topsoil, Seeding, and Mulching

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to seeding and placing mulch or erosion control blanket over seeded areas.

1.02 RELATED SECTIONS

A. Specified elsewhere:

1. 02200 - Earthwork

1.03 REFERENCES

The following reference or cited portions thereof, current at date of bidding documents unless otherwise specified, governs the work.

A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SPECIFICATIONS

A. Work shall conform to the applicable requirements of Sections 250 and 251 of Standard Specifications for Road and Bridge Construction and to the requirements hereinafter specified.

B. Exceptions: All references in the IDOT specifications to methods of measurement and payment shall not apply.

1.05 WARRANTY

A. Warranty for one (1) year plus one growing season from date of substantial completion shall be provided.

PART 2. PRODUCTS

2.01 MATERIALS

A. Seed: Seed shall conform to Article 1081.04 of the IDOT Standard Specifications where IDOT seed mixtures are specified. In areas where Ameren Energy

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Generating hay seeding mix is specified, it shall be composed as follows:

Seed Type	Pounds/Acre
Vernal Alfalfa	12
Wrangler Alfalfa	8
Medium Red Clover	6
Timothy	4

B. Mulch Material and Erosion Control Blanket: Mulch material shall conform to Article 1081.06 and the excelsior blanket/knitted straw mat shall conform to Article 1081.10 of the IDOT Standard Specifications.

C. Fertilizer and agricultural ground limestone will not be permitted.

PART 3. EXECUTION

3.01 CONSTRUCTION

A. Seed bed preparation and seeding methods shall conform to Section 250 of the IDOT Specifications. Seeding of areas disturbed by construction activities after September 30, 2008 may be deferred until Spring 2009 at no additional cost to the Owner.

B. Seed shall be applied to the perimeter berm ditch, to disturbed portions of the perimeter berm, and to all disturbed earth surfaces outside of the existing perimeter berm. IDOT seeding mixture 7 shall be used on stockpiles. IDOT seeding mixture 1A shall be used on the gypsum stack perimeter earthen berm, the recycle pond dam embankment and on slopes that are 4H:1V or steeper. The Ameren hay seed mix shall be used on slopes flatter than 4H:1V.

C. Application rates for IDOT seed mixtures shall be as specified in Section 250 of the IDOT Specifications. The application rate for the Ameren Energy Resources Generating's seed mix shall be as specified in the Ameren Energy Resources Generating's hay seeding mix.

D. Seeded areas shall be mulched in accordance with Article 251.03. The Contractor may use either Method 2 or Method 3.

3.02 MAINTENANCE OF COMPLETED WORK

A. All areas seeded by the Contractor shall be maintained by the Contractor during the period between completion of such work and final completion and acceptance of the Contractor's work by the Owner. This maintenance shall be such that the completed work, at time of acceptance, complies in all respects with the requirements herein

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specified.

B. The areas seeded will be required to germinate. If the seed does not germinate, the Contractor will be required to regrade and reseed at no additional cost to the Owner.

END OF SECTION 02936

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DIVISION 3 - CONCRETE
Section 03100 - Concrete Formwork

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of the formwork for cast-in-place concrete, with shoring, bracing and anchorage, openings for other work, form accessories, form stripping.

1.02 RELATED SECTIONS

A. Section 03200 - Concrete Reinforcement.

B. Section 03300 - Cast-In-Place Concrete.

C. Section 03400 – Concrete Embedment Liner.

1.03 REFERENCES

A. ACI 347 - Recommended Practice For Concrete Formwork.

B. ACI 301 - Specifications For Structural Concrete For Buildings.

1.04 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 347 and 301.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for design, fabrication, erection and removal of formwork.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

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1.08 COORDINATION

A. Coordinate this Section with other Sections of work which require attachment of components of formwork.

B. If formwork is placed which results in insufficient concrete cover over reinforcement, request instructions from Owner's Representative before proceeding.

PART 2. PRODUCTS

2.01 WOOD FORM MATERIALS

A. Softwood Plywood: 3/4 in. PS 1-83 "B-B" (concrete form) plywood, Class I, exterior grade or better, mill-oiled and edge sealed with each piece bearing legible inspection trademark.

B. Architectural Plywood: 3/4 in. PS 1-83 "B-B" plyform, Class I, with High Density smooth overlay, 1 surface, edge sealed with each piece bearing legible inspection trademark.

2.02 MANUFACTURERS - PREFABRICATED FORMS

A. Weyerhauser Concrete Form.

B. Georgia Pacific, G-P Exterior Soft Wood Plywood Product.

C. Plywood and Door Corporation's Finn-Form.

2.03 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

2.04 FORMWORK ACCESSORIES

A. Form Ties: Snap-off type, galvanized metal, adjustable length, 1 in. back break dimension, free of defects that could leave holes larger than 1 in. in concrete surface; Dayton-Sure Grip snap-in-form ties, as manufactured by Dayton Superior

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Corp., Symons Ties as manufactured by Symons Corporation, Snap-Tys as manufactured by Richmond Corporation. Ties shall be removed after forms are removed, and holes filled with mortar that matches the adjacent surfaces.

B. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture; by Magic Kote manufactured by Symons Manufacturing Co., Form Coat manufactured by Concrete Services Co., Formcel manufactured by Lambert Corp.

C. Corners: Chamfered, wood strip type; 3/4 x 3/4 in. size on all exterior corners, 3 x 3 in. size where shown on the drawings; maximum possible lengths.

D. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

E. Concrete Embedment Liner, where required, shall be installed in accordance with Section 03400 – Concrete Embedment Liner.

PART 3. EXECUTION

3.01 EXAMINATION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

A. Earth forms are not permitted, except for footings.

3.03 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301. Metal forms shall be installed in strict accordance with manufacturer's directions and specifications.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Obtain approval before framing openings in structural members which are not indicated on drawings.

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3.04 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in or passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate work of other Sections in forming and placing openings, slots, reglets, recesses, chases, sleeves, bolts, anchors, and other inserts.

D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

A. Clean and remove foreign matter within forms as erection proceeds.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts or water to clean out forms. Use compressed air or other means to remove foreign matter.

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3.07 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 301.

3.08 FIELD QUALITY CONTROL

A. Inspect erected formwork. shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

B. Do not reuse wood formwork more than three times for concrete surfaces to be exposed to view. Do no patch formwork.

3.09 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finished concrete surfaces scheduled for exposure to view.

C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION 03100

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DIVISION 3 - CONCRETE
Section 03200 - Concrete Reinforcement

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of the reinforcing steel bars and accessories for cast-in-place concrete.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork.

B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.

B. ACI 318 - Building Code Requirements For Reinforced Concrete.

C. ACI SP-66 - American Concrete Institute - Detailing Manual.

D. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

E. CRSI - Concrete Reinforcing Steel Institute Manual of Practice.

1.04 SUBMITTALS

A. Submit under provisions of Section 01010.

B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel, and bending and cutting schedules. Contract drawings shall not be reproduced as the basis for shop drawings.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with CRSI Manual of Standard Practice.

B. Submit certified copies of mill test report of reinforcement materials analysis.

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1.06 COORDINATION

A. Coordinate with placement of formwork, formed openings and other work.

PART 2. PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars.

2.02 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage, annealed steel wire, epoxy coated when used with epoxy-coated reinforcement.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions.

C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel type; size and shape as required.

2.03 FABRICATION

A. Fabricate concrete reinforcing in accordance with CRSI Manual of Standard Practice and ACI SP-66.

B. Splice reinforcement on at locations indicated on drawings. Indicate location of splices on shop drawings.

PART 3. EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Clean reinforcement of foreign particles or coatings.

B. Accommodate placement of formed openings.

C. Conform to ACI 318 code for concrete cover over reinforcement.

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3.02 FIELD QUALITY CONTROL

A. Contractor shall notify the Owner's Representative at least 24 hrs. in advance of concrete placement. Placement of reinforcing shall occur in such sequence that the Owner's Representative has sufficient time to inspect the correctness of the reinforcing within the placement area. The Owner's Representative retains the right to require necessary revisions be made before concrete is placed.

END OF SECTION 03200

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DIVISION 3 - CONCRETE
Section 03300 - Cast-In-Place Concrete

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of cast-in-place concrete structures, including joint sealants.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork: Formwork and accessories.

B Section 03200 - Concrete Reinforcement.

C. Section 03400 – Concrete Embedment Liner

1.03 REFERENCES

A. ACI 301 – Structural Concrete for Buildings.

B. ACI 302 - Guide for Concrete Floor and Slab Construction.

C. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

D. ACI 305R - Hot Weather Concreting.

E. ACI 306R - Cold Weather Concreting.

F. ACI 308 - Standard Practice for Curing Concrete.

G. ACI 318 - Building Code Requirements for Reinforced Concrete.

H. ASTM C31 - Concrete Test Specimens.

I. ASTM C33 - Concrete Aggregates.

J. ASTM C94 - Ready-Mixed Concrete.

K. ASTM C150 - Portland Cement.

L. ASTM C260 - Air Entraining Admixtures for Concrete.

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M. ASTM C494 - Chemical Admixtures for Concrete.

1.04 SUBMITTALS

A. Product Data: Provide data on joint devices, attachment accessories, admixtures.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Acquire cement and aggregate from same source for all work.

C. Conform to ACI 305R when concreting during hot weather.

D. Conform to ACI 306R when concreting during cold weather.

1.06 COORDINATION

A. Coordinate this Section with other Sections which require embedment of components in cast-in-place concrete.

1.07 PRODUCT DATA

A. Submit proposed mix design to Owner's Representative for review prior to commencement of work. Identify source and provide material certificates for cement, fine and coarse aggregates. Provide recent laboratory gradation for fine and coarse aggregates and mix design information in accordance with ACI 301.

B. Submit Construction joint plan.

PART 2. PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I - Normal Portland Type, Gray Color.

B. Fine and Coarse Aggregates: ASTM C33.

C. Water: Potable.

2.02 ADMIXTURES

A. Air Entrainment: ASTM C260.

B. Chemical: ASTM C494. Maximum 0.05% Chloride Ion Contents.

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C. The use of calcium chloride in any concrete is not permitted.

2.03 ACCESSORIES

A. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

B. Curing Compound: Dress and Seal No. 18 by L&M Construction Chemicals, MB-429 by Master Builders, or Sikagard Cure/Hard by the Sika Corporation.

C. Epoxy Grouted Adhesive Anchors: Hilti, Red Head, Simpson, or Rawl.

2.04 CONCRETE MIX

A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.

B. Select proportions for normal weight concrete in accordance with ACI 301.

C. Provide normal weight concrete of the following characteristics:

1. Compressive strength at 28 days: 4,000 psi.

2. Slump: 4 in. - A tolerance of up to 1 in. above the maximum shall be allowed for one batch in any five consecutive batches tested.

3. Water/cement ratios: 0.4 (max).

D. Use accelerating admixtures in cold weather only when approved by Owner's Representative. Use of admixtures will not relax cold weather placement requirements.

E. Use set-retarding admixtures during hot weather only when approved by Owner's Representative.

F. Water-reducing admixtures may be used in all concrete except footings and in strict compliance with the manufacturer's directions.

G. Add air-entraining agent to concrete mix for air content of 6% (± 1%).

PART 3. EXECUTION

3.01 EXAMINATION

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A. Verify requirements for concrete cover over reinforcement.

B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.02 PLACING CONCRETE

A. Place concrete in accordance with ACI 301.

B. Notify Owner's Representative minimum of 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, and embedded parts are not disturbed during concrete placement.

D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

E. Place concrete continuously between predetermined expansion, control, and construction joints.

F. When air temperature is between 80°F and 90°F, reduce the mixing and delivery time specified in ASTM C94 from 1-1/2 hours to 75 minutes. When the air temperature is above 90°F, reduce the mixing and delivery time to 60 minutes.

G. Cold weather concreting. Comply with ACI 306 except as follows:

1. In freezing weather, provide suitable means for maintaining concrete temperature at a minimum of 70°F for three days, or 50°F for five days after placing.

2. Cooling of concrete to outside temperature: Not faster than 1° per hour for first day and 2° per hour thereafter until outside temperature is reached.

3. Maximum temperature of concrete produced with heated aggregated, heated water, or both, at any time during its production or transportation: 90°F.

4. Do not mix chemicals or other foreign materials in concrete to prevent freezing or to accelerate hardening of concrete, unless approved in writing by Owner's Representative.

H. Hot weather concreting. Comply with ACI 305R.

1. ACI recommendations shall be observed when any combination of high air

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temperature, low relative humidity and wind velocity tend to impair the quality of fresh or hardened concrete.

2. Retarding and water reducing admixtures shall be approved in writing for each concrete mix design prior to placement.

3.03 CONCRETE FINISHING

A. Provide exterior concrete formed surfaces to be left exposed with smooth rubbed finish in accord with ACI 301. All other formed surfaces shall have fins, projections and offsets removed.

B. Provide Class A tolerances to exterior concrete slabs according to ACI 301.

1. Broom finish all exterior slabs. Broom out all tool marks.

C. Pitch slabs to drain.

3.04 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for a period necessary for hydration of cement and hardening of concrete in accordance with ACI 308.

C. Cure and protect finished concrete slabs in accordance with ACI 308.

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of Section 01010, paragraph 8.0.

B. Testing firm will take cylinders, perform slump and air entrainment tests in accordance with ACI 301.

C. Provide free access to Work and cooperate with appointed firm.

D. Submit proposed concrete mix design to Owner's Representative firm for review 14 days prior to commencement of Work.

E. Testing frequency shall be as specified in Section 01010, paragraph 8, except that one additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

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3.06 PATCHING

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by Owner's Representative and performed by the Contractor at no additional cost to the project.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Owner's Representative for each individual area.

END OF SECTION 03300

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DIVISION 3 - CONCRETE
Section 03400 - Concrete Embedment Liner

PART 1. GENERAL

1.01 WORK INCLUDES

A. Specifications and guidelines for manufacturing and installing high-density polyethylene embedment liners.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork.

B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
2. D 1603 Test Method for Carbon Black in Olefin Plastics
3. D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
4. D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
5. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
6. D 1204 Standard Test Method for Linear Dimensional Changes of Nongrid Thermoplastic Sheeting or Film at Elevated Temperature
7. D 696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
8. D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
9. D 570 Standard Test Method for Water Absorption of Plastics
10. E 96 Standard Test Method for Water Vapor Transmission of Material

1.04 SUBMITTALS

A. All work for and in connection with the installation of the lining, field seaming and welding joints shall be completed in strict conformity with all applicable instructions and recommendations of the liner manufacturer.

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B. Included with the shipment of liner, submit certified test reports that the liner and material are manufactured in accordance with standards specified herein.

1.05 QUALIFICATIONS

A. The HDPE liner specified in this section shall be furnished by a manufacturer who is fully experienced, reputable and qualified in the manufacturing of the materials. The manufacturer must at least 10 years of manufacturing experience.

B. Locking devices must be extruded to the sheet as a one step process.

C. Liner shall be GSE StudLiner as manufactured by GSE Lining Technology, Inc.

D. Liner shall be 8 feet in width.

E. Liner shall demonstrate a minimum pull-out strength of 14,000 psf.

1.06 COORDINATION

A. Coordinate with placement of formwork, formed openings and other work.

PART 2. PRODUCTS

2.01 ROLL DIMENSIONS

A. Embedment sheets shall be produced in rolls that are 8.0 ft (2.4 m) in width and a thickness range of 80 mils (2.0 mm) to 200 mils (5.0 mm) in thickness. Roll lengths vary according to thickness.

B. Locking studs of the same material as that of the liner shall be integrally extruded with the sheet. Stud spacing shall be on approximate 1.25 in (30 mm) centers, such that there are approximately 110 studs per square foot (1200 per square meter).

2.02 MATERIAL PROPERTIES

A. The material used in the embedment liner and in all welding strips shall be made from 97-98% virgin high density polyethylene and 1.5-3% carbon black or pigmentation for the purpose of an otherwise specified color.

B. Plasticizer shall not be added to the resin formulation.

C. Embedment sheet and welding strips shall be free of holes, pinholes, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

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D. The HDPE cap strips shall be made from HDPE, have good impact resistance and have an elongation sufficient to bridge up to 1/4 inch settling cracks.

E. Cap strips shall be approximately 4 inches wide or greater and shall be equivalent to that of the liner.

F. Material shall maintain a repairable state through it's lifecycle by methods approved and recommended by the manufacturer.

G. Embedment sheets shall have the following physical properties when tested in accordance with Table 1.

H. Raw resin shall have the following properties when tested in accordance with Table 2.

Table 1: Material Properties

Property	Test Method	Nominal Value				Testing Frequency
Thickness, mm (mil)	ASTM D 5199	2.00 (80)	3.00 (120)	4.00 (160)	5.00 (200)	Every 5th roll
Density, g/cm³	ASTM D 1505	0.94	0.94	0.94	0.94	1/100,000 ft²
Tensile Properties Strength@Yield,lb/in² (MPa) Elongation @ Break, %	ASTM D 6693 Type IV, Dumbell G.L. = 2.0in.	2,200 (14.5) 500	2,200 (14.5) 500	2,200 (14.5) 500	2,200 (14.5) 500	1/100,000 ft²
Stud Pull-Out Strength[1], lb/ft² (kN/m²)		>14,000 (669.89)	>14,000 (669.89)	>14,000 (669.89)	>14,000 (669.89)	1/ product
Carbon Black Content/ Pigment Content, % Black Liner Gray Liner	ASTM D 1603, mod. ASTM D 5630, mod.	2-3 1.5 – 2.5	2-3 1.5 – 2.5	2-3 1.5 – 2.5	2-3 1.5 - 2.5	1/100,000 ft²
Carbon Black Dispersion[2]	ASTM D 5596	Note 2	Note 2	Note 2	Note 2	1/100,000 ft²
Notched Constant Tensile Load, hours	ASTM D 5397	400	400	400	400	1/ formulation
Coefficient of Linear Thermal Expansion, per °C	ASTM D 696	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1/ product
Low Temperature Brittleness, °C	ASTM D 746	-77	-77	-77	-77	1/ product
Dimensional Stability, % (each direction)	ASTM D 1204	± 1.0	± 1.0	± 1.0	± 1.0	1/ product
Water Absorption, %	ASTM D 570	0.1	0.1	0.1	0.1	1/ product
Water Vapor Transmission, (g/m²/day)	ASTM E 96	<0.01	<0.01	<0.01	<0.01	1/ product

[1]Note: Concrete must have a compressive strength of at least 5,000 lb/in² (34,500 kPa).

[2]Note: Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view for category 3.

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Table 2: Raw Material Properties

Property	Test Method	Value	Testing Frequency
Density, g/cm3	ASTM D 1505	0.932	1/ resin lot
Melt Flow, g/10 min	ASTM D 1238 (190/2.16)	≤ 1.0	1/ resin lot
OIT, minutes	ASTM D 3895 (1atm/200°C)	100	1/ formulation

2.03 MATERIAL SUPPLY

A. Embedment sheets shall be supplied in roll form, sheets, pre-fabricated tubes or panels.

B. Cap strips shall be supplied in 4 inch widths or greater.

PART 3. EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Clean reinforcement of foreign particles or coatings.

B. Accommodate placement of formed openings.

C. Conform to ACI 318 code for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

A. Contractor shall notify the Owner's Representative at least 24 hrs. in advance of concrete placement. Placement of the Concrete Embedment Liner shall occur in such sequence that the Owner's Representative has sufficient time to inspect the correctness of the placement within the concrete formwork area. The Owner's Representative retains the right to require necessary revisions be made before concrete is placed.

END OF SECTION 03200

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APPENDIX 2

CONSTRUCTION QUALITY ASSURANCE PLAN

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1.0 INTRODUCTION

This Plan describes the Construction Quality Assurance (CQA) program for the proposed Gypsum Management and CCB Landfill Facilites at the Ameren Duck Creek Power Plant in Fulton County, Illinois. The plan has been developed in accordance with the requirements of 35 IAC Part 811, Subpart E entitled *Construction Quality Assurance* Programs.

The Plan requires a scheduled program of CQA monitoring, inspection, sampling and testing to verify compliance with project plans and specifications. The Plan also addresses the testing requirements for test soil liners that will be constructed to verify materials and construction methods for the full-scale liners. The goal of this program is to achieve a reasonable degree of certainty that the construction of the facilites meets the specified designs.

Appendix A lists the testing methods, acceptance requirements and testing frequencies that shall guide the implementation of this plan. Also listed is the party responsible for conducting the testing for each of the constucted components of the landfill. The plan requires oversight by the CQA Officer for all testing carried out by the geosynthetic installers.

The CQA Plan also requires preparation by the CQA Officer of a final report at the end of construction that provides all inspection and testing documentation and certifies that the facilites have been constructed in accordance with the engineering design.

This Plan is intended to supplement, the project plans and specifications. Where a conflict exists, the approved CQA Plan will govern.

2.0 RESPONSIBILITY AND AUTHORITY OF PROJECT PERSONNEL

The project participants involved in the construction and quality assurance oversight of the construction are shown in Figure 2.1 *Project Organization Chart*. The Owner is the Ameren Energy Resources Generating Company (AERG or Ameren) who will retain a General Contractor to construct the facilities and a CQA Officer to provide the quality assurance oversight services. The following list the responsibilities and authority of each of the participants shown in Figure 2.1.

2.1 Owner

Ameren Energy Resources Generating Company (Ameren) is responsible for obtaining all necessary permits for construction and operation of the facilities. Ameren retains under contract all parties for the construction including the General Contractor, the Design Engineer (Hanson Professional Services Inc.), the CQA Officer, and the CQA testing and monitoring firms.

The Ameren Construction Manager will be in charge of coordinating overall construction activities and will act as Ameren's primary interface with the General Contractor. The Construction Manager coordinates all matters involving contract issues with the Ameren Project Manager including approving field changes to the project plans and specifications.

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2.2 Design Engineer

The Design Engineer (Hanson Professional Services Inc.) is responsible for development of plans and specifications that fulfill the needs of the Owner and meet the requirements of the regulatory agencies. The Design Engineer is also responsible for responding to Contractor requests for information (RFIs) during the construction process as may be required to clarify the plans and specifications or to address identified conflicts in the documents. The Design Engineer is further responsible for developing any modifications to the plans and specifications as may be required to address changed field conditions, field cost savings, design improvements or other necessary or desired modifications as approved by the Owner.

2.3 CQA Personnel

2.3.1 Key Personnel (Owner's Representative)

Ameren will retain a CQA Officer for the project who will report directly to Ameren's Construction Manager (see Figure 2.1 *Organization Chart*). The CQA Officer shall be a professional engineer registered in the State of Illinois, who is a person other than the operator or an employee of the operator, and who will supervise and be responsible for all inspection, testing, and other activities required to be implemented as part of the CQA program. The CQA Officer will also be responsible for, and will provide direct supervision to, the testing and monitoring firms shown in Figure 2.1 who will perform the monitoring, testing, sampling, and inspections required by the CQA program as described more specifically in Section 6.0. The CQA Officer will be present at the outset of major undertakings and at critical times during the construction. The time that the CQA Officer must be at the project site will be dependent upon the type of construction being conducted. The CQA Officer will exercise his/her own professional judgment to be present at the project site as required to assume full responsibility for the inspection and testing performed by those persons under his/her direct supervision. The CQA Officer shall have sufficient on-site full-time staff to adequately carry out the quality assurance activities specified herein.

If the CQA Officer is unable to be present to perform duties as outlined, then the CQA Officer will provide, in writing, reasons for his/her absence including designation of the person who will exercise professional judgment in carrying out the duties of a CQA Officer as the designated CQA Officer-in-absentia. A signed statement shall be provided and recorded that the CQA Officer assumes full responsibility for all inspections performed and reports prepared by the designated CQA Officer-in-absentia during any absence of the CQA Officer.

It is required that the CQA Officer (or his designated representative), with on-site support personnel as required, provide oversight of the monitoring, inspection, testing and/or sampling of the following construction activities for the facilities:

- Test Liner,
- Excavation, grading, and preparation of the subgrade and foundation,
- Placement of the compacted soil liner,
- Placement of geosynthetic components,

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- Installation of the leachate drainage and collection systems.
- Construction of surface water ditches, channels, berms, and drainage structures, and
- Placement of concrete structures.

The CQA Officer (or his designated representative) must certify that the sampling, inspection and test results for the major elements of the construction are in compliance with established design requirements before subsequent sequential items of the construction can be initiated. The major elements of Work requiring compliance certification include:

- Subgrade prior to placement of soil test liner (CCB landfill facility only),
- Soil test liner prior to placement of the low permeability soil liner,
- Subgrade prior to placement of the low permeability soil liner (CCB landfill facility only),
- Low permeability soil liner prior to placement of the geosynthetic clay liner (GCL),
- GLC liner prior to placement of the geomembrane,
- Geomembrane prior to placement of the geotextile cushion,
- Geotextile cushion prior to placement of the drainage layer,
- Piping installation prior to completed placement of the drainage layer,
- Drainage layer prior to placement of geotextile fabric,
- Cushion Dirt prior to placement of the geomembrane (gypsum facility only), and
- Geosynthetic installations in anchor trenches prior to backfilling.

Certification will require a through review of all inspection, sampling and testing completed for the work item to ensure that all design requirements have been met, a visual inspection of the work item, and the completion and signing of form CQAP 2.1 *CQA Certification* by the CQA Officer. The Contractor or Installer for the immediately following item of work shall not be allowed to initiate work until completion of the signed form by the CQA Officer.

The completed and signed forms CQAP-2.1 shall be filed as a project records in accordance with the provisions of Section 11.0

2.3.2 *Document Controller*

The staff of the CQA Officer shall include a Document Controller who will be responsible for: (1) control of the CQA Plan to ensure that only current documents are being employed by the CQA staff and (2) filing of all CQA records related to the monitoring, sampling, inspecting and testing specified in the CQA Plan.

Requirements for control of the CQA Plan and for filing of project records are presented in Section 11.0.

2.4 Testing and Monitoring Firms

The testing and monitoring firms, under the direction of the CQA Officer (see Figure 2.1), shall be responsible for conducting the quality assuranace sampling, inspection and testing required by Section 6.0 of the CQA Plan except that only monitoring and limited (independent) sampling and testing shall be required for the geosyntheties (i.e., geomembranes, geothensytic clay liners and

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geotextiles). The suppliers and installers shall be responsible for all the sampling and testing required by Section 6.0 for the geosynthetics (see Section 2.6).

2.4.1 Soil/Concrete Testing (Lab and Field)

One or more soil/concrete testing firms that has been qualified by the Illinois Department of Transporation (IDOT) will be retained to perform the field and laboratory sampling and testing required by the CQA Plan. Materials sampled and tested will include fine-grained soils, coarse grained soils, aggregates, rip rap and concrete.

Each firm shall be required to provide "certificates of calibration" (or other proof of calibration) to the CQA Officer for each of the measuring and/or test equipment used in the laboratory or field; except that such certificates are not required for commercial grade equipment such as rulers, tape measures or other devices that provide adequate accuracy for their intended purpose.

All field and laboratory forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise shall be modified to meet the intent of the CQA Plan.

2.4.2 Surveyor

One or more surveyors will be retained to verify attainment of specified elevations, slopes and grades within the tolerances required by the CQA Plan. The firm(s) selected shall have the capacity to complete all work by or under the supervision of an Illinois Professional Land Surveyor.

Each surveyor will be required to provide "certificates of calibration" (or other proof of calibration) to the CQA Officer for each surveying device used; except that such certificates are not required for commercial grade equipment such as rulers, tape measures or other devices that provide adequate accuracy for their intended purpose.

All field forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise unacceptable shall be modified to meet the intent of the CQA Plan.

2.4.3 Geosynthetics Monitor and Geosynthetics Testing Laboratory

A geosynthetics monitoring firm will be retained to conduct oversight of the quality assurance inspections, testing and sampling carried out in the field by the suppliers and installers for the geosynthetics (see Section 2.5) to ensure that the requirements of the CQA Plan are met including directing additional inspection, sampling and testing as may be deemed necessary by the monitoring firm. The monitoring firm will also collect its own representative samples of the geosynthetics for independent testing by a geosynthetics testing laboratory. The monitoring firm shall have previous experience in installation oversight of at least 10,000,000 sq. ft. of similar geosynthetic materials.

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The laboratory will be independent of both the manufacturer and the installer of the geosynthetics and will be required to have its own QA plan for the project work. The QA Plan shall be subject to review by Ameren prior to start of services.

All field and laboratory forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise unacceptable shall be modified to meet the intent of the CQA Plan.

2.5 Contractors, Suppliers and Installers

The contractor, subcontractors, suppliers and installers are responsible for completing their portions of the work within specified schedules and in accordance with the requirements of the plans and specifications. They additionally shall accommodate the monitoring, sampling, inspections and testing that are the responsibility of the CQA Officer under the QCA Plan.

The geosynthetic Suppliers and Installers shall provide the quality assurance inspection, sampling and testing as required by Section 6.0 of the CQA Plan. Additionally, the geosynthetic suppliers shall be required to submit "certificates of acceptance" for certain items of work that precede their construction activities. The "certificates" are more specifically discussed in Section 4.0.

3.0 PROJECT MEETINGS

Periodic meetings will be held during the life of the project to enhance coordination among the various parties involved. Meetings will include preconstruction meetings, routine progress meetings and, as needed, problem or work deficiency meetings.

3.1 Preconstruction Meetings

Preconstruction meetings shall be held at the site for the major earthwork, items and geosynthetic installations. At a minimum, the Ameren Construction Manager, the CQA Officer, representatives of the testing firms, and the earthwork contractor or geosynthetic installer should attend. In addition to the topics for discussion as listed in the project specifications, the following CQA items will be covered:

- Discuss the established protocol for inspections, tests and sampling including use of form CQAP 8.1 *Daily Inspection Report* (see Section 8.0).
- Discuss items of work requiring CQA Officer certification or Installer acceptance before subsequent work items can be initiated (see Section 4.0), and
- Discuss the established protocol for handling construction deficiencies, corrective measures, and retesting (see Section 7.0).

The meeting shall be conducted by the Ameren Construction Manager or CQA Officer and will be documented by CQA personnel with distribution to all attendees. Meeting minutes will be filed as project records in accordance with Section 11.0.

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3.2 Progress Meetings

At the discretion of the Ameren Construction Manager or the CQA Officer, brief progress meetings will be scheduled to discuss on-going and up-coming construction activities. The meeting will be attended by the Ameren Construction manager, the CQA Officer, and the appropriate site foreman (i.e. when earthwork is being performed, the earthwork foreman will be present; when geosynthetics are being installed, the installer foreman will be present, etc.). In addition to the CQA Officer topics of discussion regarding progress, the following CQA items should be reviewed:

- Discuss the established protocol for inspections, tests and sampling including use of form CQAP 8.1 *Daily Inspection Report* (see Section 8.0).
- Discuss items of work requiring CQA Officer certification or Installer acceptance before new work items can be initiated (see Section 4.0), and
- Discuss the established protocol for handling construction deficiencies, corrective measures, and retesting (see Section 7.0).

These meetings will be documented by the CQA Officer with distribution to all attendees including the Ameren Project Manager. Meeting minutes will be filed as project records in accordance with Section 11.0.

3.3 Problem or Work Deficiency Meetings

Special meetings will be approved by the CQA Officer when a problem or work deficiency is present (or is likely to occur) that is (or could be) of a serious nature. At a minimum, the meeting should be attended by theAmeren Construction Manager, earthwork or installer foremen as appropriate, and the CQA Officer. The Ameren Project Manager should attend those meetings that include discussions of severe and/or recurring problems or deficiencies. The purpose of these meetings is to define and resolve the problem or work deficiency in the following manner:

- Define the problem or deficiency and its probable causes,
- Discuss alternative actions to address the problem or deficiency ,
- Implement the selected action to resolve the problem or deficiency, and
- Verify that the implemented action has been effective.

The meeting will be documented by the CQA Officer with distribution to all attendees including the Ameren Project Manager. Meeting minutes will be filed as project records in accordance with Section 11.0.

4.0 IN-PROGRESS ACCEPTANCE OF WORK

4.1 Introduction

It is very important during placement of the geosynthetics not to entrap fugitive clay, stones, sand, etc. that could damage the geosynthetic, cause clogging of drains or filters, or hamper seaming of the geosynthetic. The geosynthetic installers shall accept responsibility for inspecting

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the substrate (on a daily basis) to ensure such entrapments are not present within the substrate area to be covered each day. When found acceptable, the installer shall complete and sign form CQAP-4.1 *Installer Certificate of Acceptance* that documents (on a daily basis) acceptance of the substrate for geosynthetic placement. The Installer shall provide the original signed document to the CQA Officer for his signature of receipt.

Completed and signed forms CQAP-4.1 shall be filed as project records in accordance with the provisions of Section 11.0.

4.2 Elements of Work Requiring Prior Acceptance

The following table cites the elements of work that shall require daily "certificates of acceptance" for the substrate including the installer responsible for providing the certification. Any other areas of geosynthetic installation not included in the table shall still be subject to the requirements of this section.

Table 4.1 Installer Certifications for Acceptance of Work

Substrate to Be Accepted by Installer	Installer
1. Surface of Low Permeability Soil Liner	Geosynthetic Clay Liner (GLC) Installer
2. Surface of Geosynthethic Clay Liner (GCL)	Geomembrane Installer
3. Surface of Geomembrane	Geotextile Cushion Installer
4. Surface of Drainage Layer	Geotextile Filter Installer
5. Surface of Cushion Dirt	Geomembrane Installer

5.0 TEST SOIL LINER

5.1 Introduction

A compacted low permeability soil test liner shall be constructed within the footprint of the proposed soil liner prior to any work being initiated on the full scale construction. The purpose of the test liner is to verify that the materials and methods of construction proposed for the full scale liner will provide the quality of construction required by the CQA Plan. Additional soil test liners shall be constructed for each time the material properties from a new borrow source are found to be significantly different or there is a significant change in the methods of construction and/or equipment.

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The test liner will be constructed on a competent foundation from the same prequalified soil material sources, to the same design specifications, and with similar equipment and procedures as are proposed by the contractor for the full scale liner. The foundation (subgrade) for the soil test liner shall be subject to the requirements of Section 6.2.1 and sampling/testing for material prequalification and placement shall be that provided in Section 6.2.2 except that:

1. The survey grid for foundation grade verification and for liner thickness verification shall be as established by the CQA Officer.

2. The frequencies for placement testing shall be as established by the CQA Officer.

3. The testing for hydraulic conductivity shall be as provided in Section 5.2.

5.2 Sampling and Testing Program

The soil test liner shall be sampled and tested under the direction of the CQA officer as described below for each of the physical properties listed.

1. At least five (5) two-stage field tests (ASTM designation D 6391-06) shall be used on the test liner to determine the hydraulic conductivity. Both the vertical hydraulic conductivity (k1) and the horizontal hydraulic conductivity (k2) shall be calculated.

2. Undisturbed samples (Shelby tubes) will be tested in the laboratory for vertical hydraulic conductivity to determine if there is a statistical correlation to the field testing results. At least two (2) samples should be tested.

3. The determination of other engineering parameters including, but not limited to, particle size analysis, liquid limits, plastic limits, water contents, and unconfined compressive strengths that are needed to evaluate the full scale liner shall be as directed by the CQA Officer.

5.3 Requirements for CQA Certification of Test Soil Liner for Landfill Construction

1. At least four of the five field hydraulic conductivity tests shall result in a measured vertical hydraulic conductivity of 5.0×10^{-7} cm/sec or less. No test shall have a hydraulic conductivity greater than 1.0×10^{-6} cm/sec.

2. The laboratory hydraulic conductivity tests shall indicate a measured vertical hydraulic conductivity of 1.0×10^{-6} or less.

5.4 Requirements for CQA Certification of Test Soil Liner for Gypsum Stack

1. At least four of the five field hydraulic conductivity tests shall result in a measured vertical hydraulic conductivity of 5.0×10^{-5} cm/sec or less. No test shall have a hydraulic conductivity greater than 1.0×10^{-4} cm/sec.

3. The laboratory hydraulic conductivity tests shall indicate a measured vertical hydraulic conductivity of 1.0×10^{-5} or less.

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5.5 Report of Results and Certification

The CQA Officer shall prepare reports describing the test programs carried out and the results obtained. The reports shall be filed as project records in accordance with Section 11.0.

The CQA Officer shall review the sampling and test results for the test soil liners and, if found in agreement with requirements, provide certification for the work using form CQAP 2.1.

6.0 SAMPLING AND TESTING REQUIREMENTS

6.1 Introduction

Prequalification and placement sampling/testing requirements for the various materials and construction activities are as summarized in Table A.1. Frequencies for material placement testing listed in Table A.1 are based on the volume of material used in construction and are to be considered minimums. The CQA Officer shall select the specific locations for testing on a random basis exercising professional judgment to ensure that testing and sampling fairly represent the construction.

The testing firms under the direction of the CQA Officer shall be responsible for the sampling and testing listed in Table A.1 for: (1) the Soils Prequalification and Placement Testing, (2) the Drainage Media Prequalification and Placement Testing, *and (3) the* Other Material Placement Testing. The geosynthetic installers shall be responsible for the sampling and testing listed in Table A.1 for the Geosynthetics Prequalification and Placement Testing with daily overview (and some independent laboratory testing) by the geosynthetic firms and the CQA Officer.

The results of the sampling and testing shall be documented on a daily basis by each agency or installer providing the quality assurance activities and the originals of the sampling and testing results provided to the CQA Officer. The CQA officer shall complete form CQAP 8.1 *Daily Inspection Report* (see Section 8.0) for each of the testing firms or installer proving results and attach the results to the form. The completed form CQAP 8.1 and attached results shall be incorporated into the *Daily Summary Report* (see Section 8.0).

6.2 Soils

6.2.1 Foundation (Subgrade) – Low Permeability Soil Liner

6.2.1a. Foundation Grade Verification

Following excavation for the low permeability soil liner, the CQA Officer shall direct the surveyor to verify that actual depths and grades of the foundation (subgrade) are in accordance with the plans and specifications. Elevations shall be surveyed on a 100 ft grid pattern for the bottom of the cell. The points surveyed for side slopes will be at the top, midpoint, and toe. In addition, all breaks in grade will be surveyed. Foundation excavation grading shall meet a control tolerance requirement of 0 ft to -0.4 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

The CQA Officer shall review the survey data for conformance to requirements and, if found in agreement with requirements, provide certification for the work using form CQAP 2.1.

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6.2.1b. Foundation Fill

Foundation (subgrade) materials not meeting the requirements of the plans and specifications are required to be excavated and replaced with suitable foundation fill to develop a stable foundation for the landfill. The CQA Officer shall make a foundation inspection with the soil testing firm and direct any sampling and testing necessary to identify areas requiring removal and replacement. The CQA Officer shall inform the earthwork contractor of unsuitable areas requiring removal and replacement.

Foundation fill used by the contractor for replacement shall be sampled and tested by the soil testing firm to check compliance with the prequalification and placement requirements listed in Table A-1. The CQA Officer shall direct the *surveying firm* to determine the locations and extent of all removal and replacement activity and to document all such information on "as built" drawings to be furnished to the CQA Officer.

The CQA Officer shall review the sampling and test results for the foundation fill and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1. The certification for foundation fill may be provided on the same form providing the certification for foundation grade.

6.2.2 Low Permeability Soil Liner

6.2.2a. Prequalification Testing

Table 1.1 requires that prequalification testing for each soil type being used for liner construction at the landfill include the development of an "acceptable zone" of moisture-density for the compacted soil that will result in a liner with a minimum hydraulic conductivity of 1.0×10^{-6} cm/sec. The resulting "acceptable zone" then serves as the major control for material placement during construction.

The CQA officer shall direct the soil testing agency to determine the "acceptable zone" for each soil type to be used for landfill liner construction and provide the results in a written report to be available for comparisons with the material placement testing results. The determination of the "acceptable zone" shall be in accordance with Appendix B or other published methodology used in the profession. The report will be filed as a project record in accordance with Section 11.0.

There is no prequalification testing required for the soil materials to be used for the gypsum stack liner construction except that the materials selected shall have sufficient fines to achieve the in-place hydraulic conductivity specified in Section 5.4.

6.2.2b. Material Thickness Testing

The CQA Officer shall direct the survey agency to determine elevations at the foundation of the soil liner and at the final constructed surface using a 100 ft grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify liner thickness, all horizontal survey coordinates shall be the same for the foundation and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points.

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The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor agency.

6.2.2c. Moisture/Density Testing

Moisture/density testing of the compacted soil liner shall be conducted by the soil testing agency under the requirements and at the frequencies specified in TableA.1. During construction of the soil liner the CQA Officer shall confirm the following:

- Use of the same construction equipment as used in the test soil liner.
- Use of same procedures, such as number of passes and speed,
- Uniformity of coverage by compaction equipment,
- Consistent achievement of density, water content and permeability of each successive lift.
- Use of methods to bond successive lifts together.
- Achievement of liner strengths on sidewalls,
- Contemporaneous placement of protective covering to prevent drying and desiccation, where necessary,
- Prevention of placement of frozen material or the placement of material on frozen ground,
- Prevention of damage to completed liner sections, and
- That construction proceeds only during favorable climatic conditions.

6.2.2d. Hydraulic Conductivity Testing

Samples of the in-place liner shall be obtained and tested for hydraulic conductivity under the requirements and at the minimum frequency as specified in Table A.1. Multiple samples may be collected at a given test location for the purpose of retesting in the event of unacceptable hydraulic conductivity results from the initial sample.

Boreholes, excavations or other disturbances to the soil liner resulting from the obtainment of samples shall be backfilled as directed by the CQA Officer.

6.2.2e. Certification of Work

The CQA Officer shall review the sampling and test results for the low permeability soil liner and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.2.3 Berms

6.2.3a. Landfill Containment Berms

The CQA Officer shall direct verification of excavated foundation (subgrade) depths and grades as specified in Section 6.2.1a except that the foundation grid shall be as directed by the CQA Officer. Foundation fills shall be as specified in Section 6.2.1b.

Prequalification testing for material sources shall meet the requirements in Table A.1.

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The CQA Officer shall direct the soil agency to conduct the following inspection activities during berm construction:

- Observation of fill material characteristics.
- Observation of loose lift thickness.
- Observation of clod size reduction and material homogenization, and
- Placement testing as specified in Table A.1.

Documentation of construction on "as-built" plans shall be as specified in Section 6.5.2.

The CQA Officer shall review the sampling and test results for the landfill containment berms and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.2.3b Temporary Cell Separation Berms

The CQA Officer shall direct verification of excavated foundation (subgrade) depths and grades as specified in Section 6.2.1a except that the foundation grid shall be as directed by the CQA Officer. Foundation fills shall be as specified in Section 6.2.1b.

Prequalification testing for material sources shall meet the requirements in Table A.1.

The CQA Officer shall direct the soil agency to conduct the following inspection activities during berm construction:

- Observation of fill material characteristics,
- Observation of loose lift thickness.
- Observation of clod size reduction and material homogenization,
- Placement testing as specified in Table A.1, and
- Measurements of berm slopes.

6.3 Geosynthetics

6.3.1 Geosynthetic Clay Liner (GCL)

6.3.1a. Prequalification Testing

The geosynthetic clay liner (GCL) installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the GCL for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

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The results of laboratory testing shall meet the GCL manufacturer's specifications as shown in the following table.

GCL Laboratory Testing Methods/Minimum Values Required	
Test Method	Minimum Value
Bentonite Mass/Area (ASTM D5993)	0.75 lb./ft^2
GCL Grab Tensile Strength (ASTM D4632)	90 lb.
GCL Peel Strength (ASTM D4632)	15 lb.

The installer shall direct the test laboratory to submit the results of all laboratory test results and certification to the Document Controller for filing as project records in accordance with Section 11.0.

6.3.1b. Installer Certification of Placement Surface

Prior to daily clay liner placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the GCL installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.1c Deployment

The CQA Officer shall direct the geosynthetic QA monitor firm to oversee activities of the installer during placement and field testing of the GCL.

Incoming rolls of GCL shall be inventoried and inspected by the installer. Manufacturer's certifications will be inspected for conformance with the requirements of this plan. Holes or other visible defects shall be recorded in the CQA Officer's daily report and clearly marked on the GCL roll for identification of necessary repairs or rejection of the roll.

GCL shall be placed such that all seams run parallel to the slope. GCL should be dry when installed. Wet or hydrated GCL shall not be used. GCL panels shall be laid with a minimum 6 in. overlap on longitudinal seams and a minimum 12 in. overlap on panel end seams. Seam overlaps shall be placed such that the direction of flow is from the top panel to the underlying panel to form a shingle effect. Direct contact with GCL shall be minimized.

6.3.1d. Seaming

The GCL shall be sealed in accordance with the recommendations of the GCL manufacturer. Dry bentonite having the same chemical and material properties as the GCL shall be evenly dispersed from the panel edge to the lap line continuously along the seam or overlap areas. All dirt, gravel, or other debris shall be removed from the seam or overlap areas.

Prior to covering the GCL, the installer shall verify all exposed seams or overlaps and examine the GCL for any defects. At the judgment of the installer, a panel or section that becomes seriously damaged or hydrated shall be replaced. All repairs shall be made by placement of a

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patch of the same material over the damaged area at least 1 ft beyond the repair area. The GCL will be immediately covered and protected from precipitation by the overlaying geomembrane.

6.3.1e. Shear Strength Conformance Testing

Shear strength conformance tests shall be performed on the GCL to verify the interface shear strengths of the GCL with the appropriate material (HDPE geomembrane or compacted clay). The results of the shear strength conformance tests will be used to confirm that the actual interface shear strengths are equal to or greater than the interface shear strengths used in the stability analyses. Shear strength conformance tests on subsequent phases and/or cell development need not be performed if the same manufacturer and materials are used in the construction of the subsequent phase and/or cell. Conformance testing shall be in accordance with ASTM D 5321 or other suitable method.

6.3.2 Geomembrane

6.3.2a. Prequalification Testing

The geomembrane installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the geomembrane for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

The installer shall direct the test laboratory to submit the results of all laboratory results and certification to the Document Controller for filing as project records in accordance with Section 11.0.

6.3.2b. Installer Certification of Placement Surface

Prior to daily geomembrane placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the geomembrane installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.2c. Placement Testing for Seam Overlap

The contractor and installer shall arrange geomembrane sections such that the use of field seams is minimized and that horizontal seams are not used on side slopes. Seam overlaps shall be field measured by the installer to verify the requirement in Table A.1 is met for all seams within the geomembrane footprint. The CQA Officer shall direct the geosynthetics QA monitor firm to

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make independent measurements of a representative number of seam overlaps for additional verification of the requirement in Table A.1.

At completion of geomembrane placement, the installer shall provide the CQA Officer with "as-built" drawings of the geomembrane installation showing all seam locations and seam measurement locations.

6.3.2d. Placement Non-Destructive Testing

The installer shall conduct non-destructive testing of seams at the frequency specified in Table A.1. All seams shall be nondestructively tested over their full-length using a vacuum test unit, air pressure test or other method approved by the CQA Officer. Continuity testing will be completed as the seaming progresses.

The CQA Officer shall direct the geosynthetics QA monitor firm to monitor all non-destructive testing carried out by the installer.

The installer shall submit all non-destructive field testing results to the CQA Officer for filing as project records in accordance with Section 11.0.

Vacuum testing and air pressure testing procedures shall be as given in the following sections.

Vacuum Testing (Extruded Welds)

The following procedures are applicable to those processes which produce an extruded weld.

Equipment

The following equipment shall be used when conducting vacuum tests:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a port hole or valve assembly, and a vacuum gauge,
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections,
- A rubber pressure/vacuum hose with fittings and connections,
- A bucket, and
- A soapy solution.

Procedures

The following procedures will be followed:

1. Energize the vacuum pump and reduce the tank pressure to approximately minus 5 psi (10 in. of Hg) gauge.
2. Wet a strip of geomembrane approximately 12 in. wide by 48 in. long (an area larger than the coverage size of the vacuum box) with the soapy solution.
3. Place the box over the wetted area.
4. Close the bleed valve and open the vacuum valve.
5. Verify that a leak tight seal is created.

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6. For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
7. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area, repeat the process.
8. All areas where soap bubbles appear will be marked and repaired and then retested until passing test results are obtained.

Air Pressure Testing (For Double Fusion Seam Only)

The following procedures are applicable to those processes which produce a double seam with an enclosed space.

Equipment

The equipment will be comprised of the following:

- An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 psi to 30 psi and mounted on a cushion to protect the geomembrane,
- A rubber hose with fittings and connections, and
- A sharp hollow needle, or other approved pressure feed device.

Procedures

The following procedures will be observed:

1. Both ends of the seam to be tested will be sealed.
2. A needle or other approved pressure feed device will be inserted into the tunnel created by the fusion weld.
3. A protective cushion will be inserted between the air pump and the geomembrane.
4. The air pump will be energized to a pressure between 25 psi and 30 psi. The valve will be closed, and the pressure will be sustained for approximately 5 minutes.
5. If loss of pressure exceeds 3 psi or does not stabilize, the faulty area will be located, then repaired and retested until passing test results are obtained.
6. At the conclusion of a passing air pressure test, the opposite end of the seam will be slit and subsequent drop in pressure will be monitored. This will ensure that the entire seam was completely tested.
7. Remove needle or other approved pressure feed device and seal.

6.3.2e. Placement Destructive Testing

General

Destructive seam tests shall be performed at randomly selected geomembrane locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

The CQA Officer shall direct the geosynthetics QA monitor firm to monitor all destructive testing carried out by the installer.

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The installer shall submit the results of all destructive testing to the CQA Officer for filing as project records in accordance with Section 11.0.

Location and Frequency

The installer shall select locations where seam samples will be cut out for testing. Those locations shall be established as follows:

1. Selection will be at a minimum frequency of one test location per 500 ft of seam length. This minimum frequency is to be determined as an average taken throughout the entire area of placement.

2. Test locations will be determined during seaming at the installer's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The CQA Officer shall direct the geosynthetics QA monitor firm to select and cut out a representative number of additional samples for independent laboratory testing.

Sampling Procedure

Samples will be cut as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The installer shall:

- Assign a number to each sample, and mark it accordingly.
- Record sample location on layout ("as-built") drawing, and
- Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired. The continuity of the new seams in the repaired area shall be vacuum tested.

Field Testing

The installer shall test in the field, by tensiometer, two 1 in. wide sample strips from the samples identified for destructive testing; one for peel and one for shear. This testing shall include the independent samples obtained by the geosynthetics QA monitor firm. Field testing will prequalify samples for laboratory testing. The requirements and frequency for field testing shall be as provided in the table at the end of this section.

The installer shall conduct all field tests and mark all samples and portions with their number. The installer shall also log the date, time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

Geosynthetic Quality Assurance Laboratory Testing

Prequalifying field tests shall identify samples for laboratory testing. The installer's quality assurance laboratory shall be as selected by the installer with concurrence of the CQA Officer.

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Testing shall include shear strength and peel adhesion. At least five specimens shall be tested by the installer's laboratory for each method. Specimens shall be selected alternately by test from the samples (i.e., peel, shear). All laboratory testing shall be accordance with ASTM D 4437.

The CQA Officer shall direct the geosynthetic QA monitor firm to have additional samples tested for peel and strength by the monitor's independent geosynthetics laboratory as deemed necessary.

Procedures for Destructive Test Failure

The following procedures will apply whenever a sample fails a destructive test, whether the test was conducted in the laboratory or by field tensiometer. The installer has two options:

1. The installer may reconstruct the seam between any two passed test locations.

2. The installer may trace the welding path to an intermediate location at least 10 ft from the point of the failed test in each direction, and take a small sample for an additional field test at each location. If these additional samples pass the tests, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

All acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 ft of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing.

The installer will document all actions taken in conjunction with destructive test failures.

Geomembrane Destructive Seam Tests and Frequency

Property	Test Method	60-mil HDPE	40-mil HDPE	40-mil LLDPE	Frequency
Seam Shear Strength	ASTM D 4437	120 ppi	80 ppi	44 ppi	See Note 1
Seam Peel Strength (hot wedge fusion)	ASTM D 4437	78 ppi	52 ppi	40 ppi	See Note 1
Seam Peel Strength (fillet extrusion)	ASTM D 4437	72 ppi	45 ppi	40 ppi	See Note 1

Notes:
1. Destructive testing of seams shall occur at a minimum frequency of once per 500 ft of seam length.
2. Values apply for both smooth and textured geomembranes.

6.3.3 Geotextile

6.3.3a. Prequalification Testing

The geotextile installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal

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shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the geomembrane for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

The installer shall submit the results of all laboratory results and certification to the CQA Officer for filing as project records in accordance with Section 11.0.

6.3.3b. Installer Certification of Placement Surface

Prior to daily geotextile placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the geotextile installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.3c. Deployment

Incoming rolls of geotextile shall be inventoried and inspected by the installer. Manufacturer's certifications will be inspected for conformance with the requirements of this plan. Holes, tears, or other visible defects will be recorded in the CQA Officer's daily report and clearly marked on the synthetic for identification of necessary repairs.

The installer shall check that the geosynthetic installation conforms to the construction requirements and manufacturer's recommendations. The CQA Officer shall direct the geosynthetics QA monitor firm to oversee the inspections by the installer.

On slopes steeper than 10H:1V, all geotextiles shall be continuously sewn. Geotextiles shall be overlapped a minimum of 3 in. prior to seaming. This requirement does not apply to the leachate system filter fabric. All sewing shall be done using thread with physical, chemical, and ultraviolet high resistance properties equal to or exceeding those of the geotextile. The CQA Officer shall direct the geosynthetics QA monitor firm to make independent measurements of a representative number of seam overlaps for additional verification of the requirement in Table A.1.

The 10-oz. cushion geotextile (immediately above the geomembrane liner and beneath the drainage layer) shall be placed with vertical seams running up the slopes and into the anchor trench. Horizontal seams (perpendicular to the slope) shall be allowed on side slopes for the 4-oz. filter geotextile overlaying the drainage layer to facilitate staged construction of the drainage layer going up the slope. All overlaps shall be "shingled" so that water or other material can not run down the slope between the geotextile seams.

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6.4 Drainage Media

6.4.1 Granular Drainage Layer

6.4.1a. Prequalification Testing

Each source of material for the drainage layer shall be tested for hydraulic conductivity and grain size analyses in accordance with Table A.1 to determine suitability of the source.

6.4.1b. Material Thickness Testing During Placement

The CQA Officer shall direct the survey firm to determine elevations at the top of the geotextile cushion and at the final constructed surface of the granular drainage layer using a 100 ft grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify liner thickness, all horizontal survey coordinates shall be the same for the top of the cushion and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points.

The CQA officer may approve the use of thickness plates as an alternative method to surveying.

In no instance shall the field determined thickness be less than 1.0 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

6.4.1c. Gradation and Hydraulic Conductivity Testing During Placement

The CQA officer shall direct the soil test firm to take an initial sample of the granular drainage layer within the first 100 cu. yds. of material placement and test for hydraulic conductivity and grain size to confirm suitability of the source. Continuing sampling and testing shall be completed at the frequencies specified in Table A.1.

Compaction of the drainage layer shall not be allowed during placement to avoid breakdown of materials

Gradation tests may be considered passing provided the hydraulic conductivity requirements are met and the specified percentage of fines is not exceeded.

6.4.d. Certification of Work

The CQA Officer shall review the sampling and test results for the granular drainage layer and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.4.2 Coarse Aggregate

6.4.2a. Prequalification Testing

Each source of material for the coarse aggregate shall be tested for hydraulic conductivity and grain size analyses in accordance with Table A.1 to determine suitability of the source.

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6.4.2b. Material Placement

The CQA Officer shall direct that inspection of piping as provided in Section 6.5.1 be completed prior to placement of coarse aggregate around the piping. Compaction of the coarse aggregate shall not be allowed during placement to avoid breakdown of materials.

The CQA officer shall direct the soil test firm to take an initial sample of the coarse aggregate within the first 100 cu. yds. of material placement and test for hydraulic conductivity and grain size to confirm suitability of the source. Continuing sampling and testing shall be completed at the frequencies specified in Table A.1.

Gradation tests may be considered passing provided the hydraulic conductivity requirements are met and the specified percentage of fines is not exceeded.

6.4.2c. Certification of Work

The CQA Officer shall review the sampling and test results for the coarse aggregate and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.5 Other Material Placement Testing

6.5.1 Placement testing of Leachate Piping System

The CQA Officer shall direct the surveyor to check the invert elevations and plan coordinates for the constructed piping system at the locations and frequencies specified in Table A.1.

The CQA Officer or other CQA staff shall inspect pile size, materials and connections including all components of the leachate collection and management systems to verify compliance with plan and specification requirements.

The measured grades and coordinates shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

The CQA Officer shall review the survey results for the leachate piping system and management systems and, if found in agreement with the placement requirements, provide certification for the work using form CQAP 2.1.

6.5.2 Placement Testing of Surface Water Management System

The CQA Officer shall direct the survey agency to determine the elevations and grades of the constructed berms and channels in accordance with the requirements and frequency specified in Table A.1.

The measured elevations and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

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6.5.3 Placement Testing of Concrete

The CQA Officer shall direct the soil test firm to carry out placement testing for concrete in accordance with the requirements and frequency specified in Table A.1.

The contractor shall submit proposed concrete mix designs to the CQA Officer for review prior to ordering of concrete.

The CQA Officer shall review the concrete testing results and, if found in agreement with the placement requirements, provide certification for the work using form CQAP 2.1.

7.0 CORRECTIVE MEASURES

The CQA Officer shall reject and require replacement of all materials for which sampling, testing or inspection results show that prequalification requirements are not met. The CQA Officer shall also reject workmanship (and require corrective rework) for which sampling, testing or inspection results show that material placement requirements are not met. The lateral and/or vertical extent of corrective measures for rework shall be based on the frequency of testing and judgment of the CQA Officer.

The CQA Officer may neglect the occasional occurrence of failed moisture/density tests or laboratory hydraulic conductivity tests carried out for the low permeability soil liner provided the failed tests can be shown to be outliers and are not concentrated in one area or lift. The CQA officer shall provide written justification in the Daily Summary Report for assignment of failed tests as outliers.

8.0 DOCUMENTATION OF SAMPLING AND TESTING

8.1 Daily Summary Reports

A daily summary report shall be prepared by the CQA Officer, or under the direct supervision of the CQA Officer, during each day of activity. Form CQAP 8.1 *Daily Summary Report* shall serve as the base document to which the daily inspection reports (see Section 8.2) are to be attached.

Each report shall be signed and dated by the CQA Officer and CQA Officer-in-absentia. The original report (and attachments) shall be submitted to the Document Controller and filed as a project record in accordance with Section 11.0.

8.2 Daily Inspection Reports

A daily inspection report shall be prepared by the CQA Officer, or under the direct supervision of the CQA Officer. for each day that materials, or placement of materials, are being inspected, sampled or tested. Form CQAP 8.2 *Daily Inspection Report* shall serve as the base document to which the test data, photographic records, test results, etc. are to be attached.

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Each report shall be signed and dated by the CQA Officer or CQA Officer-in-absentia. The original report (and attachments) shall be submitted to the CQA Officer who shall incorporate the report into the daily summary report.

8.3 Photographs

Photographs may be incorporated into the daily inspection report or daily summary report to provide a visual record of work progress, inspection/testing activity, construction work, or other items considered important to the report. The photographs, at a minimum, shall be furnished with the following information:

- The location, date and time of the photograph,
- A description of the item photographed including direction of view (N,S,E or W),
- Personnel, testing agencies, installers or contractors present, and
- Name of photographer.

9.0 FINAL CERTIFICATION REPORT

Upon completion of the construction contract (but before the landfill or gypsum stack is placed into service), the CQA Officer shall submit an acceptance report to the Illinois Environmental Protection Agency. The acceptance report shall contain the following:

- A certification by the CQA officer that the construction has been prepared and constructed in accordance with the engineering design.
- As-built drawings as specified herein, and
- All daily summary reports.

10.0 CONSTRUCTION MANAGEMENT ACTIVITIES

10.1 Requests for Information (RFIs)

The general contractor or installer may, after exercising due diligence to locate required information, request from the CQA Officer clarification or interpretation of the contract documents. The general contractor or installer shall make specific reference to the contract drawing(s) or specification(s) in question and include estimates of any cost or schedule impacts that could possibly be associated with the requested clarification or interpretation.

The general contractor or installer shall initiate the RFI in a timely manner using form CQAP-10.1 *Request for Information*. The CQA Officer shall, with reasonable promptness, respond to the RFI on the same form CQAP-10.1 and return a copy of the completed form to the party making the request as final disposition of the matter.

Additional copies of the completed form shall be distributed as directed by the CQA Officer. All RFI's shall be filed as project records in accordance with Section 11.0.

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10.2 Review of Contractor Submittals

The Contractor shall submit shop drawings, product data and samples to the CQA Officer in accordance with the requirements of the project specifications and with such promptness as to cause no delay of the work. The Contractor shall not authorize purchase, fabrication, erection, processing or shipping of any items associated with the submittal until review of the shop drawings, product data or samples has been completed by the CQA Officer and no resubmittals are required by the CQA Officer.

All submittals from subcontractors shall be reviewed first by the Contractor to satisfy the contractor's responsibilities for lengths, dimensions, quantities, means and methods, and other such items.

The CQA Officer and/or Design Engineer shall review the submittals for conformance with design concepts and conformance with the information shown in the contract documents. Upon completion of review, the CQA Officer shall return the submittal to the Contractor with one of the following notations for each item in the submittal:

- No exceptions taken.
- Furnish as corrected.
- Revise and resubmit.
- Submit specified item, or
- Rejected.

The Contractor shall resubmit corrected shop drawings, product data or samples for those items noted as requiring revision or submission or noted as rejected.

The CQA Officer shall maintain copies of all submittals and a log documenting submittal descriptions, dates of receipt, dates of return, review personnel, and actions taken on the submittals. Copies of submittals and the log shall be filed as project records in accordance with Section 11.0.

10.3 Field Change Order Process

The Contractor shall be responsible for preparing requests for field change order (FCO) in accordance with AREG procedures and submitting the FCO requests on the appropriate AREG FCO form to the CQA Officer.

The CQA Officer shall be responsible for reviewing the FCO with the Design Engineer, determining agreement or non-agreement with the requested change, and submitting the documented decision to the Contractor on the appropriate AREG CFO form with copies to the Ameren Project Manager. Agreement to the FCO shall require signature approval of the Ameren Project Manager.

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The CQA Officer shall maintain an on-going log of authorized FCOs and running balance of project costs. Copies of the FCOs and log of authorized FCOs shall be retained as project records in accordance with Section 11.0.

11.0 DOCUMENT CONTROL AND PROJECT RECORDS

11.1 CQA Plan

The CQA officer shall control the preparation, issue and revisions of the CQA Plan so that correct documents are being employed by the project participants. The CQA Plan, including all changes thereto, shall be reviewed for adequacy and approved for release by the CQA Officer and Ameren Project Manager.

The Document Controller shall issue controlled copies of the CQA Plan and maintain all records associated with its preparation, issue and revisions.

11.2 Project Records

The maintenance of project records during construction of the landfill shall be the responsibility of the Document Controller and shall be protected against damage, deterioration, and loss. Records shall be maintained in a manner as to be readily identifiable and retrievable.

Control of CQA documents and samples during the construction process shall be as shown in Figure 11.1. All original CQA documents from both the field and laboratories shall be ultimately furnished to the Document Controller for filing and maintenance. Samples may be discarded after testing and documentation of results is complete.

Project records shall be made available to the Ameren Project Manager as requested during construction and, when requested, shall be turned over to AERG at completion of the construction contract.

Records shall include, but not be limited to, the following:

- CQA Plan (all revision levels),
- CQA Plan documentation (reviews, issuance and revisions),
- Meeting minutes,
- Daily inspection reports (form CQAP 8.1),
- Daily summary reports (form CQAP 8.2),
- Certificates of acceptance by geosynthetic installers,
- CQA certifications (form CQAP 2.1),
- Certificates of calibration for inspection, measuring and test equipment,
- Report for test soil liner,
- Report for compacted soil liner "acceptable zone",
- "As-built" drawings,
- Laboratory test results for soils, drainage media, and concrete,
- Laboratory test results for geosynthetics,
- Laboratory certifications of manufacturer's guaranteed properties for geosynthetics,
- Contractor Requests for Field Change Order (AERG FCO form),

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- Log of Authorized Field Change Orders,
- Shop drawing submittals,
- Log of shop drawing submittals,
- Requests for information from contractor/installers,
- Responses to requests for information, and
- Final certification report.

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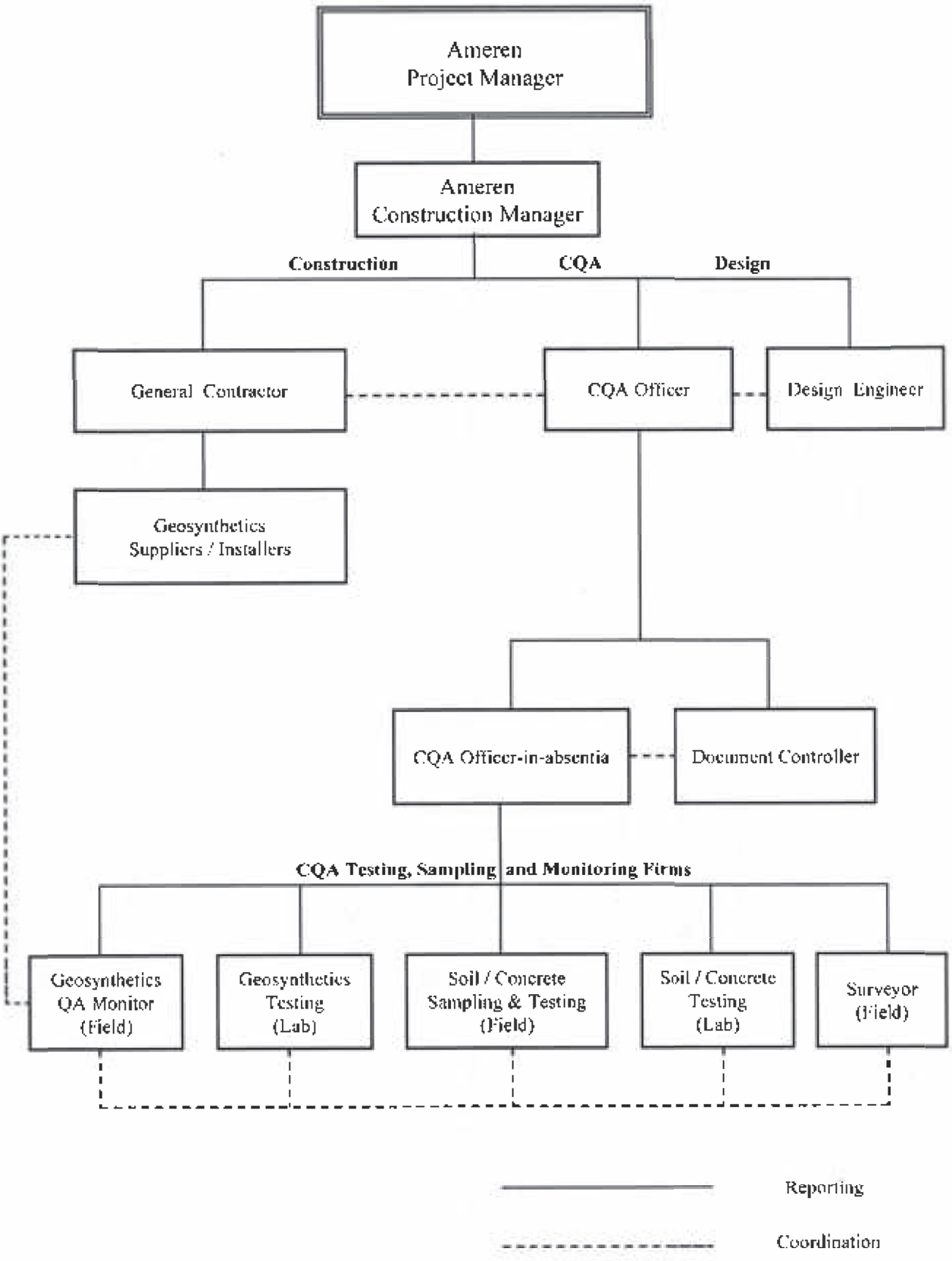

Figure 2.1 Project Organization Chart

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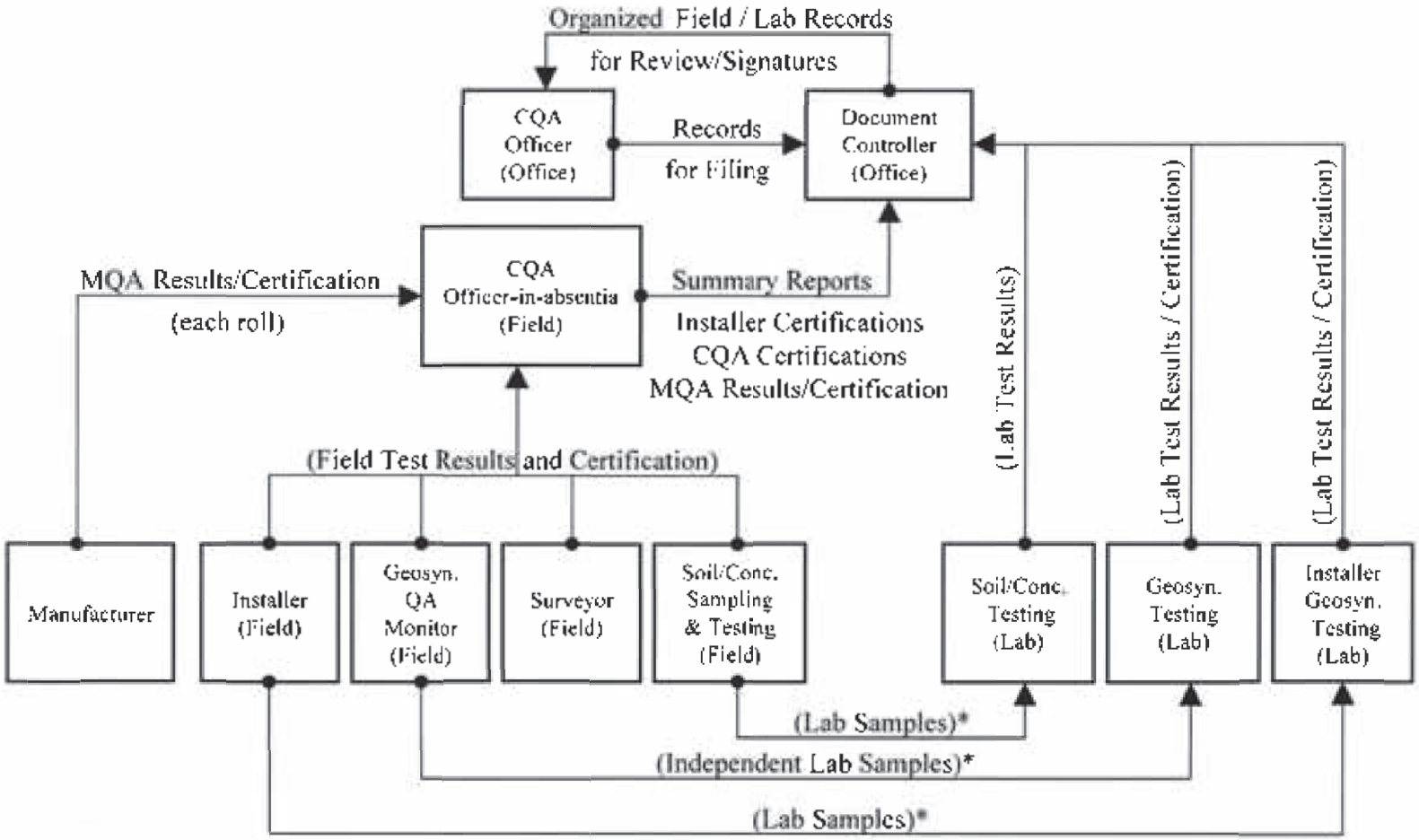

Figure 11.1 Control of CQA Documents and Samples

* Transmittal letters shall direct the original lab test results/certifications to be sent to Document Controller with copies to submitting installer or testing/monitoring agency.

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Appendix A

Material Testing and Frequency

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
SOILS - PREQUALIFICATION TESTING			
FOUNDATION FILL & BERMS			
Standard Proctor Curve - ASTM D698		Per soil type (See Note 2)	CQA Officer
Atterberg Limits - ASTM D4318	PI > 5, LL > 20%	Per soil type	
Grain Size Analysis - ASTM D422	200 Sieve > 50%	Per soil type	
Hydraulic Conductivity - ASTM D5084	See Note 1	Per soil type	
		Per soil type	
SOIL LINER			
Standard Proctor Curve - ASTM D698	"Acceptable Zone" see Appendix B	Per soil type	CQA Officer
Atterberg Limits - ASTM D4318	USCS Classification	Per soil type	
Grain Size Analysis - ASTM D422	USCS Classification	Per soil type	
Hydraulic Conductivity - ASTM D5084	1.0×10^{-7} cm/sec	Per soil type	
Develop "Acceptable Zone"	"Acceptable Zone" see Appendix B	Per soil type	
PROTECTIVE FINAL SOIL COVER			Not Applicable to this Contract
Standard Proctor Curve - ASTM D698*	"Acceptable Zone" see Appendix B	Per soil type*	
Atterberg Limits - ASTM D4318*	USCS Classification	Per soil type*	
Grain Size Analysis - ASTM D422*	USCS Classification	Per soil type*	
Hydraulic Conductivity - ASTM D5084	See Note 1	Per soil type*	
Develop "Acceptable Zone"*	"Acceptable Zone" see Appendix B	Per soil type*	
Suitable for Vegetation	Visual Acceptance	Per soil type	

* On the first two feet of the protective layer only. (The third foot is topsoil.)

Note 1: There is no specific requirement for hydraulic conductivity for the foundation, berms and final cover soils as they are not part of the liner system. However, insitu materials on the site generally exhibit hydraulic conductivities in the range of 1×10^{-4} cm/sec to 1×10^{-5} cm/sec. The construction contractor will attempt to utilize the most impermeable materials available (as identified visually) when constructing foundation fill and berms. For purposes of a complete construction record, hydraulic conductivity of placed foundation fill and side berms will be field tested at a rate of 1 test per each 10,000 cubic yards of material placed, although no specific threshold values are required.

Note 2: "Soil Type" refers to differences in soil color and/or textural consistency that would be indicative of differences in soil characteristics.

Note for Geosynthetics: See Section 6.0 of the CQA Plan for additional GCL and geomembrane testing requirements.

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
SOILS - MATERIAL PLACEMENT TESTING			
FOUNDATION			CQA Officer
Survey	0 to -0.5 feet Design Grade	100-foot grid	
FOUNDATION FILL & BERMS			CQA Officer
Density/Moisture - ASTM D2922 & D3017	90% Standard Proctor Density and -1% to Optimum Moisture Content	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Strength	0.5 tsf (hand-held penetrometer)	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Hydraulic Conductivity - ASTM D5084	See Note 1	1 per 10,000 cubic yards	
Sieve and Hydrometer Analysis of Soils - ASTM D422	200 Sieve > 50%	Per Soil Type	
Liquid Limit, Plastic Limit and Plasticity Index (Atterberg Limits) - ASTM D4318	PI > 5, LL > 20	Per Soil Type	
SOIL LINER			CQA Officer
Thickness	5 feet minimum thickness (base), 1 foot minimum thickness (cover), and maintain design grade	100-foot grid	
Density/Moisture - ASTM D2922 & D3017	95% Standard Proctor Density and Optimum to +5% Moisture Content in accordance with "Acceptable Zone" (see Note 3)	1 per acre per lift or 1 per 1,000 cubic yards	
Strength	0.5 tsf (hand-held penetrometer)	1 per acre per lift or 1 per 1,000 cubic yards	
Hydraulic Conductivity - ASTM D5084	See Note 4	1 per 10,000 cubic yards	
PROTECTIVE FINAL SOIL COVER			Not Applicable to this Contract
Thickness	3 feet minimum total thickness including 1 foot of topsoil - maintain design grade	100-foot grid	
Density/Moisture* - ASTM D2922 & D3017	90% Standard Proctor Density and -3% to Optimum Moisture Content	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Strength*	0.5 tsf (hand-held penetrometer)	1 per 10,000 cubic yards (minimum 1 per compacted lift)	

* On the first two feet of the protective layer only. (The third foot is topsoil.)

Note 1 There is no specific requirement for hydraulic conductivity for the foundation, berms and final cover soils as they are not part of the liner system. However, insitu materials on the site generally exhibit hydraulic conductivities in the range of 1×10^{-4} cm/sec to 1×10^{-5} cm/sec. The construction contractor will attempt to utilize the most impermeable materials available (as identified visually) when constructing foundation fill and berms. For purposes of a complete construction record, hydraulic conductivity of placed foundation fill and side berms will be field tested at a rate of 1 test per each 10,000 cubic yards of material placed, although no specific threshhold values are required.

Note 3 Acceptable Zone" restriction applies only to the soil liner for the landfill. The gypsum stack soil liner shall only be required to meet the compaction and moisture content specification.

Note 4 The hydraulic conductivity for the landfill soil liner is 1.0×10^{-7} cm/sec(maximum) and for the gypsum stack soil liner is 1.0×10^{-6} cm/sec (maximum).

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
GEOSYNTHETICS - PREQUALIFICATION TESTING			
GEOMEMBRANES (60 mil smooth, 60 mil textured, 40 mil textured)			Installer
Raw Materials	Manufacturer's List of Guaranteed Properties	All rolls	
Geomembrane Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Puncture Resistance - ASTM D4833	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Tear Resistance - ASTM D1004	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Thickness - ASTM D5199/D5994	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Tensile Strength and Elongation - ASTM D638 (Modified) or D6693	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
GEOTEXTILES (Non-Woven, 4 ounce, 10 ounce, 16 ounce)			Installer
Geotextile Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Mass per Unit Area - ASTM D3776	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Grab Tensile Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Trapezoidal Tear Strength - ASTM D4533	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Apparent Opening Size - ASTM D4751	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Puncture Resistance - ASTM D3787	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Permittivity - ASTM D4491	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
GEOSYNTHETICS - PREQUALIFICATION TESTING			
GEOSYNTHETIC CLAY LINER (GCL)			Installer
GCL Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Bentonite Mass/Area - ASTM D5993	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Grab Tensile Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Peel Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch whichever is greater. Sample 3 feet wide by the full roll width	
GEOSYNTHETICS - MATERIAL PLACEMENT TESTING			
GEOMEMBRANES (60 mil smooth, 60 mil textured, 40 mil textured)			Installer
Seam Overlap	3" to 4"	All Seams	
Non-Destructive Testing	As per Section 6.3.2c of CQA Plan	All Seams	
Destructive Testing	As per Section 6.3.2e of CQA Plan	Maximum One Every 500 Feet	
GEOTEXTILES (Non-Woven, 4 ounce, 10 ounce, 26 ounce)			Installer
Seam Overlap	3" to 4"	All Seams	
Installation	Physical Installation per Section 6.3.3c of CQA Plan	None	
GEOSYNTHETIC CLAY LINER (GCL)			Installer
Seam Overlap	As per Section 6.3.1d of CQA Plan	All Seams	
Installation	Physical Installation per Section 6.3.3c of CQA Plan	None	

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
DRAINAGE MEDIA - PREQUALIFICATION TESTING			
GRANULAR DRAINAGE LAYER			
Hydraulic Conductivity - ASTM D2434	1.0 x 10^{-3} cm/sec (Minimum)	One Test per Source	CQA Officer
Grain Size Analysis - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200<5%)	One Test per Source	
COARSE AGGREGATE			
Hydraulic Conductivity - ASTM D2434	1.0 x 10^{-1} cm/sec (Minimum)	One Test per Source	CQA Officer
Grain Size Analysis - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200<5%)	One Test per Source	
DRAINAGE MEDIA - MATERIAL PLACEMENT TESTING			
GRANULAR DRAINAGE LAYER			
Thickness	One Foot Minimum Thickness	100 Foot Grid	CQA Officer
Gradation - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200 < 5%)	1 per 3,000 cubic yards	
Hydraulic Conductivity - ASTM D2434	1.0 x 10^{-3} cm/sec (Minimum)	1 per 10,000 cubic yards	
COARSE AGGREGATE			
Gradation - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200 < 5%)	1 per 3,000 cubic yards	CQA Officer
Hydraulic Conductivity - ASTM D2434	1.0 x 10^{-1} cm/sec (Minimum)	1 per 10,000 cubic yards	

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TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
OTHER MATERIAL PLACEMENT TESTING REQUIREMENTS			
LEACHATE PIPING SYSTEM ELEVATIONS & LOCATIONS			CQA Officer
Survey	Elevation +/- 0.1 feet with no adverse slopes. Plan location +/- 0.5 feet.	Every 100 feet and connections	
Welds and Connections	Visual Inspection	Each connection	
SURFACE WATER MANAGEMENT SYSTEM			CQA Officer
Survey	Field established for positive drainage (+/- 0.4 feet)	Inlet and Outlet and every 100 lineal feet along ditch channel	
CONCRETE			CQA Officer
Slump - ASTM C143	2" to 4" at time of placement	1 per 25 cubic yards or minimum 1 per day	
Air Entrainment - ASTM C231	5% to 7% at time of placement	1 per 100 cubic yards or minimum 1 per day	
Compressive Strength - ASTM C31 and C39	3,500 psi at 28 days	2 cylinders per 50 cubic yards or minimum 2 cylinders per day	
Delivery Time - ASTM C94	Total Mixing and Delivery Time Less than 1.5 Hours	Each Delivery	

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Appendix B

Acceptable Zone Procedure

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PROCEDURE FOR DETERMINATION OF SOIL LINER ACCEPTABLE ZONE OF COMPACTION AND MOISTURE CONTENT

INTRODUCTION

One of the most significant factors affecting the performance of compacted soil liners is the adequate control of water content and dry unit weight during construction. A carefully written compaction specification will result in a compacted soil liner achieving the required hydraulic conductivity while also satisfying other factors affecting performance such as strength, compressibility, and resistance to desiccation. Because a soil liner is meant to be a hydraulic barrier, hydraulic conductivity requirements are the primary factor affecting the criteria of a compaction specification. The specification should be then tightened as necessary to meet other performance standards.

For this project, the specification will require that the soil be compacted to at least 95 percent maximum dry density as obtained from the Standard Proctor test per ASTM D 698, with a moisture range of optimum to 5 percentage points wet of optimum. Testing of the proposed liner soils will be performed to determine its acceptable density and moisture content zone for a maximum hydraulic conductivity of 1.0×10^{-6} cm/sec for the final cover and base liner. Research work performed by Benson and Daniel (1990) shows that the acceptable zone can be expected to parallel a "line of optimums." This procedure should be run when a new source of soil is selected for liner construction or when the Proctor density changes by 10 pcf or more.

PROCEDURE

The following steps will be performed during prequalification of a soil source for liner construction. The source investigation will identify consistency of the soil and have completed soil index tests including grain size distribution and Atterberg Limit determinations. Once the initial index testing is complete, a proper value for Proctor density can be selected, and then the following steps can be followed.

- Compact three samples at a controlled moisture of ±1 percent of optimum moisture at approximately 97 percent to 93 percent of standard Proctor maximum dry density. These samples should be tested for hydraulic conductivity using ASTM D 5084. If all samples pass, it can be assumed as confirmation that the specified 95 percent of maximum dry density is an appropriate lower density range.

- If all three initial hydraulic conductivity test results are $\leq 1.0 \times 10^{-6}$ cm/sec for the base liner and the final cover, then three more samples shall be prepared to confirm the moisture content range. Using approximately 93 percent to 95 percent dry density, prepare one sample at -1 points (dry of optimum), one at +3 points and one at +8 points of optimum moisture content. Test these new samples for hydraulic conductivity using ASTM D 5084. If all samples pass, it can be assumed as confirmation that the optimum to +5 percentage points is an appropriate moisture content range.

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- If the first two steps do not confirm the permeability window, the CQA Officer will determine if the soil will be used for construction. If it will be used, then further testing can be performed to define a smaller acceptable zone.

- In some cases, the borrow sources may be so variable that composting of the soil will be required for testing. In these cases, three or four Proctor tests should be performed to determine the range of maximum dry density. If the range of maximum dry densities is less than 10 pcf, a composite can be tested as outlined above. If the range of maximum dry densities is greater, the highest and lowest soil values should be tested to determine an acceptable range.

Selection of density value shall be based on inspector's identification of soil percentages. Prequalification testing will assure the conformance of permeability.

USE OF THE ACCEPTABLE RANGE

During construction, the acceptable window will be verified by the specified interval of construction sample testing. Each sample will be tested for density, moisture, grain size, and Atterberg Limits when submitted for hydraulic conductivity testing. The results can then be compared to prequalification testing to verify soil consistency and passing hydraulic conductivity. These tests can also be plotted on the Proctor curve as documentation of acceptable zone or as a demonstration that the zone can be enlarged.

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Appendix E: Operation and Maintenance Manual, Duck Creek Energy Center, Gypsum Management Facility

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Operation and Maintenance Manual
Illinois Power Resources Generating, LLC
Duck Creek Energy Center
Gypsum Management Facility
Fulton County, Illinois

Prepared For:

Illinois Power Resources Generating, LLC
Duck Creek Energy Center
Fulton County, Illinois

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Revised August 2014

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OPERATION AND MAINTENANCE MANUAL
DUCK CREEK ENERGY CENTER
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS

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SECTION 1.0
GENERAL

This operation and maintenance (O&M) manual outlines objectives, proposed policies, responsibilities, and procedures for Illinois Power Resources Generating, LLC (IPRG) and Contractor personnel who are responsible for the management of the Duck Creek Energy Center Gypsum Management Facility (GMF). The GMF incorporates two reservoirs, the Gypsum Stack and the Recycle Pond, for processing and storing gypsum.

1.1 REASONS FOR DEVELOPMENT OF THE O&M MANUAL

In addition to providing guidance to the IPRG and Contractor personnel who are responsible for the operations and maintenance of Duck Creek GMF, this manual has been prepared in accordance with state regulations. The State of Illinois Rivers, Lakes and Streams Act, (615 ILCS 5) Paragraph 23a includes the statement "The Department is authorized to carry out inspections of any dam within the State, and to establish standards and issue permits for the safe construction of new dams and the reconstruction, repair, operation and maintenance of all existing dams." (emphasis added).

Part 3702 of the 17 Illinois Administrative Code, Chapter I entitled the "Construction and Maintenance of Dams" details the requirements to obtain a permit for the construction, operation, and maintenance of a dam. Section 3702.40 b) includes the following statement:

> "5) As a condition of each permit, the dam owner shall submit a maintenance plan detailing the procedures and schedules to be followed to maintain the dam and its appurtenances in a reasonable state of repair."

Thus it is a requirement of all dam owners who have dams which fall under the jurisdiction of the Illinois Department of Natural Resources to operate and maintain them safely.

As a dam owner, IPRG is responsible for the safety of the public and for maintaining the structures at the facility for both safety and economy. The overall public interest is served by providing a document to serve as a basis for the safe and economical operation and maintenance of the dam during both emergency and day-to-day conditions.

1.2 GENERAL RESPONSIBILITIES CONCERNING DAMS

IPRG is responsible for the operation and maintenance of the Gypsum Stack Dam and the Recycle Pond Dam. These responsibilities include general maintenance (mowing, removing debris from decants, placing riprap where needed, etc.), operation, inspection and emergency action decisions. IPRG plans to enter into an agreement with an independent contractor to perform certain aspects of the operation and maintenance of the GMF.

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SECTION 2.0
DEFINITIONS

Abutment - That part of the valley side or concrete walls against which the dam is constructed. Right and left abutments are those on respective sides of an observer when viewed looking downstream.

Appurtenant Works - The structures or machinery auxiliary to dams which are built to operate and maintain dams; such as outlet works, spillways, gates, valves, channels, etc.

Boil - A stream of water discharging from the ground surface downstream of the dam carrying with it a volume of soil which is distributed around the hole formed by the discharging water.

Berm - A horizontal step or bench in the sloping profile of an embankment dam.

Breach - A break, gap, or opening (failure) in a dam which releases impoundment water.

Dam - A barrier built for impounding or diverting the flow of water.

Dike (Levee) - An embankment, usually applied to embankments or structures built to protect land from flooding.

Drain, Layer or Blanket - A layer of pervious material in a dam to facilitate the drainage of the embankment including such items as a toe drain, a weephole, and a chimney drain.

Drawdown - The resultant lowering of the water surface level due to the release of water from the impoundment.

Duck Creek Plant Datum - the Duck Creek Station horizontal and vertical coordinate system ("Plant System") on which the design and construction survey information, and elevations used in this document is based. Reference the control points shown on the construction drawings (Drawing C180-C102-04, Rev 3, or later) for horizontal and vertical control information.

Embankment - Fill material, usually rock or earth, placed with sloping sides.

Earthen Dam - Any dam constructed of excavated natural materials.

Failure - An incident resulting in the uncontrolled release of water from the dam.

Freeboard - The vertical distance between a stated water level and the top of the dam.

Gate or Valve - In general, a device in which a leaf or member is moved across the waterway to control or stop the flow.

Groin - The junction of the upstream or downstream face of the dam with the valley wall.

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Maintenance - The upkeep, involving labor and materials, necessary for efficient operation of dams and their appurtenant works.

Operation - The administration, management, and performance needed to operate the dam and appurtenant works.

Operation and Maintenance Inspection - Inspections conducted by the dam Operator. These inspections are frequent visual "Walk-around" inspections of the dam surface and appurtenant works.

Outlet - An opening through which water can freely discharge for a particular purpose from an impoundment.

Phreatic Surface - The upper surface of saturation in an embankment.

Piping - The progressive development of internal erosion by seepage, appearing downstream as a hole or seam, discharging water that contains soil particles.

Riprap - A layer of large stones, broken rock or precast blocks placed in a random fashion usually on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel as a protection against wave and ice action.

Silt/Sediment - Soil particles and debris in an impoundment.

Slump/Slide Area - A portion of earth embankment which moves downslope, sometimes suddenly, often with cracks developing.

Spillway System - A structure or structures over or through which flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway. If the elevation of the spillway crest is the only control of the flows, it is considered an uncontrolled spillway.

Emergency Spillway - A spillway designed to operate very infrequently, only during exceptionally large floods, usually constructed of materials expected to erode slowly.

Principal Spillway - The main spillway which controls both normal and flood flows and is usually constructed of non-erodable materials.

Auxiliary Spillway - A spillway which works in conjunction with the principal spillway to control flood flows and is usually constructed of non-erodable materials.

Stilling Basin - A basin constructed to dissipate the energy of fast flowing water, such as from a spillway, and to protect the streambed from erosion.

Toe of Embankment - The junction of the face of the dam with the ground surface in the floodplain upstream or downstream of the dam.

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SECTION 3.0
INFORMATION ABOUT THE DAMS

3.1 LOCATION

The Gypsum Stack and Recycle Pond Dams are located in the NW 1/4 of Section 18, Township 6 North, Range 5 East of the Forth Principal Meridian in Fulton County, Illinois. More specifically, the dams are located east of Bethel Cemetery Road approximately 2 miles southeast of Canton, Illinois. A map showing the location of the dams is included in Appendix A.

3.2 DESCRIPTION OF DAM AND APPURTENANCES

The gypsum stack dam has a maximum earthen embankment height of 32 ft and a maximum impounding capacity of 773 acre-ft, measured at the top of the earthen dam elevation of 620 ft per Duck Creek Plant Datum (EL 620). However, due to the "stacking" of gypsum above the top of the earthen dam, the total volume within the completed gypsum stack will be approximately 2256 acre-ft. The recycle pond dam has a maximum embankment height of 41 ft and a maximum impounding capacity of 150 acre-ft (measured at the top of dam elevation of 615 ft).

The gypsum stack dam has a single high density polyethylene (HDPE) lined spillway (transfer channel) which discharges to the recycle pond. The transfer channel is a trapezoidal channel with 3H:1V side slopes. The transfer channel transitions from a 16-ft bottom width at an invert elevation of 614.0 ft at the upstream end, to a 35-ft bottom width at an invert elevation of 609.0 ft at the downstream end. A 2-ft tall HDPE covered concrete weir, located near the upstream end of the transfer channel, is fitted with stop logs capable of raising the discharge control elevation to 616.0 ft. To protect the HDPE liner from abrasion during flows, the transfer channel and a portion of the recycle pond dam incorporate an additional sacrificial layer of HDPE at the location where the transfer channel discharges to the recycle pond.

The emergency spillway for the recycle pond consists of four 42-inch diameter HDPE pipes which discharge into a riprap lined plunge pool. The upstream inverts of the pipes are at EL 610.0 and the downstream inverts are at EL 607.0. The emergency spillway has been provided in the event of an accidental overfilling of the recycle pond or catastrophic rainfall only. It is not expected to be activated during the life of the facility.

Pertinent data about the dams, appurtenant works, and reservoirs are presented in Appendix B.

3.3 SIZE CLASSIFICATION

The gypsum stack earthen dam has a maximum embankment height of 32 ft and a maximum impounding capacity of 773 acre-ft (measured at the top of dam elevation of 620 ft). Based on IDNR criteria, the gypsum stack earthen dam is classified as a small-size dam. However, since the gypsum stack is planned to ultimately meet or exceed 100 ft in height, the gypsum stack will eventually be classified as a large-size dam.

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The recycle pond dam has a maximum embankment height of 41 ft and a maximum impounding capacity of 150 acre-ft (measured at the top of dam elevation 615 ft). Since the recycle pond dam embankment exceeds 40 ft in height, it is classified as an intermediate-size dam.

3.4 HAZARD CLASSIFICATION

The breach wave resulting from a failure of either dam is expected to be contained within the Duck Creek Reservoir located immediately downstream. Considering the low probability for causing loss of life or economic loss to adjacent landowners, both dams are classified as CLASS III, LOW HAZARD POTENTIAL dams.

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SECTION 4.0
OPERATIONS ACTIVITIES

The operations plan describes the proposed operation of the Duck Creek Gypsum Management Facility (GMF) which includes the gypsum stack and the recycle pond.

4.1 SITE OPERATIONS

The GMF will receive flue gas desulfurization sludge (gypsum) from the Duck Creek Energy Center (the Plant). Gypsum will be transported to the GMF in slurry form (approximately 20 percent solids) and allowed to settle. Clarified process water will then be siphoned or decanted to the recycle pond and returned to the Plant for reuse via pipeline.

The GMF will potentially receive gypsum slurry 24 hours per day, seven days per week. Routine operation and maintenance activities are expected to be conducted during day shift hours. The filling times and staging chronology included in this document are calculated from gypsum production rates estimated at 23,500 tons per month, which is based on the plant burning high sulfur coal (6.8 lbs of SO_2 per million BTU) at a 90% capacity factor. The sluice and process water return rates referenced in this document are per the Hitachi Power Systems America, Ltd. MATERIAL BALANCE Case Study: 4,131 mmBtu/hr Drawing No. 0013-361-110-0381 Rev. B dated 3-19-07. Variations in these parameters would result in variations in the estimated chronology and flow rates.

The Plant is a restricted access location. A series of fences and gates exist to prevent unauthorized access to the property. The proposed GMF is located within the restricted plant confines, and is, therefore, not accessible to the general public.

4.2 PERSONNEL

The proposed GMF will be owned and operated by IPRG. Corporate offices are located in Houston, Texas. IPRG plans to enter into an agreement with an independent Contractor to perform certain aspects of the operation and maintenance of the GMF. The contractual operator (Operator) of the gypsum stack will be responsible for daily operation and maintenance of the gypsum stack, recycle pond and peripheral areas.

4.3 OPERATION OF VAULTS AND VALVES

IPRG personnel will be responsible for the operation of the valves which control the flow of slurry and water between the Plant, recycle pond and gypsum stack to the first valve vault located at the recycle pond entrance road. Beyond that point, the Operator will be responsible for distribution of gypsum slurry to various areas of the gypsum stack (this includes the valve vaults on the mid-western side of the gypsum stack and the north side of the gypsum stack). Two redundant pipes will carry the gypsum slurry from the plant. Although only one pipe will be in use at any time, conditions at the plant may result in a discharge pipe switch at any time. BOTH PIPES MUST BE AVAILABLE TO DISCHARGE GYPSUM AT ALL TIMES WHEN

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THE PLANT IS OPERATING. Valves to both pipes must be open, and the ends of both pipes must be positioned so that there would be no restrictions to gypsum discharge at any time.

4.4 GYPSUM MANAGEMENT FACILITY STARTUP

The major components of the GMF consist of:

- The gypsum stack;
- The recycle pond;
- The HDPE-lined earthen transfer channel that connects the two structures, and through which clarified process water will be decanted from the gypsum stack into the recycle pond; and
- The recycle pond decant system and pump-house, through which process water will be returned to the Plant for reuse.

Upon completion of the recycle pond construction, the recycle pond will be partially filled with water pumped from the Plant or from Duck Creek Reservoir. The recycle pond pumps will be commissioned and then shut off pending the introduction of slurry into the gypsum stack. Procedures for these operations are discussed in the following sections.

4.4.1 Siphon Installation and Operation

The bottom of the gypsum stack is approximately 29 ft below the transfer channel invert elevation of 614 ft. During the period when the gypsum sluicing and stacking operations are conducted below the transfer channel elevation, clarified water must be siphoned from the gypsum stack to the recycle pond. Based on a slurry discharge rate of 653 gal/minute (gpm), and an average reclaim water return rate of 626 gpm, a minimum of two redundant (2) 10-inch diameter HDPE siphons should be primed and operable at all times. Installation of the siphon pipes and valves is included in the original GMF construction.

Each of the siphon pipes will pass through the transfer channel and the outlet end of the siphon pipes shall be laid on the bottom of the recycle pond at elevation 590 ft. Ballast will be required at the outlet of the pipe to prevent the pipes from potentially floating to the surface and breaking the siphon. Ballast or other means of restraint may also be required in the transfer channel to hold the pipes in place. For a 300 ft long, 10-inch diameter HDPE siphon, the water level in the gypsum stack will need to be approximately 4.5 ft higher than the water level in the recycle pond in order to pass the equilibrium process water return rates discussed above.

4.4.2 Initial Filling of Recycle Pond With Water

The recycle pond will initially be partially filled with water pumped from Duck Creek Reservoir or the plant. The recycle pond will be filled to a water surface elevation of 598 ft in order to accommodate proper pump functioning during commissioning and startup of the slurry discharge to the gypsum stack. Duck Creek plant personnel will monitor and regulate the water level in the recycle pond.

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4.4.3 Commissioning the Pumps and Siphons

Once the recycle pond and gypsum stack have operational levels of water, the siphons, the recirculation pump system (recycle pond to gypsum stack), and the recycle pump system (recycle pond to plant) will be primed and tested. IPRG will be responsible for operation and maintenance of the recycle / recirculation pumps.

4.5 GYPSUM MANAGEMENT FACILITY OPERATION

The gypsum slurry (approximately 20 percent solids) will be pumped from the Plant to the gypsum stack via piping. Piping will be HDPE with a pressure rating for the design hydraulic and static head. The HDPE pipe will discharge the slurry into the gypsum stack, and the gypsum will settle by gravity.

The water level in the recycle pond should be maintained at a minimum elevation of 598 ft in order to insure uninterrupted pumping of water back to the plant. However, at times, there will be intermittent outages at the plant. During an outage, bottom drains in the gypsum stack will continue to discharge water to the recycle pond and the recycle pumps will continue to recirculate water from the recycle pond to the gypsum stack. The recirculation of water is required during outages in order to utilize the water storage capacity of the gypsum to help maintain sufficient storage capacity in the recycle pond to accommodate all precipitation runoff from the entire gypsum stack/recycle pond area during an expected maximum 12-week maintenance outage at the Plant.

At a placement rate of 23,500 tons per month, it will take approximately 3 years to fill the gypsum stack with gypsum to the invert of the HDPE-lined transfer channel at EL 614. Until that time, clarified return water will be siphoned into the recycle pond using one of two redundant 10-inch diameter siphon pipelines. Water that flows from the gypsum stack to the recycle pond will be pumped back to the Plant for reuse, or recirculated to the top of the gypsum stack during periods when the plant is shutdown.

In order to stack the gypsum material with the required factors of safety for slope stability, a system of strategically placed perimeter ditches and dikes must be constructed. Interior dikes will also need to be constructed to accommodate the installation of ring drains and the development of cells located within the gypsum stack. Key components of the gypsum stacking process are described in the following sections to highlight the effort required to successfully stack gypsum with the required factors of safety against slope failure.

4.5.1 Initial Filling With Gypsum Slurry

There are two redundant gypsum slurry pipelines which will be capable of discharging midway along the north side or west side of the of the gypsum stack at a maximum rate of 1.5 cfs (675 gal/min). The initial construction of the GMF includes a ring drain system on the HDPE liner on the bottom of the gypsum stack. When gypsum slurry is initially discharged into the gypsum stack, **extreme care must be taken to prevent any erosion of the sand layer over the ring drain**. **Any displacement of sand may impair the function of the ring drain.** If necessary, the sand layer may be protected with a layer of larger aggregate or temporarily

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covered with an approved geotextile wherever necessary to prevent erosion of the sand layer. It may be preferable to use a flange-connected pipe extension to extend the slurry discharge line to the interior side of the ring drain so that the bottom troughs will collect the water and prevent erosion of the sand layer. The pipe extension can be removed when the ring drains are covered and protected by settled gypsum. If any ring drain sand is displaced, the Operator shall immediately notify Ameren so that an appropriate response and repair method can be determined. Please see Figure A for details and a general depiction of the ring drain assembly.

Settled gypsum will gradually create a plane of material (gypsum beach) sloping gently towards the south end of the gypsum stack. Please see Figure B for a depiction of the gypsum beach. Clarified water will collect in the south end of the gypsum stack and will be siphoned into the recycle pond when it reaches EL 602.5, the level necessary to provide the head to siphon the process water at the system equilibrium rates. The GMF Operator will be responsible for operation and maintenance of the siphons. At the design flow rates, it will take approximately 95 days of operation in order for the water in the gypsum stack to reach this level.

4.5.2 Gypsum Dike and Cell Construction

The bottom slope of the gypsum stack liner, and the siphoning of water from the gypsum stack to the recycle pond, will partially drain the gypsum to allow for "early stacking" of material below the crest of the earthen dam. This is advantageous for several reasons. One reason is that the construction of compacted dikes at a lower elevation may improve foundation conditions for the remainder of the stack. Employing stacking procedures at a lower elevation also affords the opportunity for the Operator to become familiar with the material and develop confidence in a construction routine which will maximize stability when stacking the material above the top of the earthen embankment. Early stacking also allows Ameren the opportunity to complete preliminary testing on proposed piezometer locations for development of a piezometer installation and monitoring plan, as discussed in Section 4.5.8, which will be refined prior to stacking above the top of the earthen embankment.

The procedures for controlling the deposition of gypsum will begin once the gypsum beach at the north end of the gypsum stack reaches an elevation of approximately 605 ft, NGVD, which is 10 ft above the HDPE liner (7.5 ft above the top of the ring drain assemblies). Based on an assumed deposited gypsum slope of 0.3%, and a water level of 602.5 ft, the gypsum beach which will be visible above water is predicted to span half the length of the gypsum stack (reference Figure B). At full production (16.7 acre-ft deposited per month), the time required for the gypsum beach to reach this configuration is estimated at five to six months. .

The first procedural steps in controlling the deposition of (stacking) gypsum are the construction of a perimeter ditch, a perimeter dike, a rim ditch, and a rim dike. The perimeter ditch is the ditch which will be formed between the earthen embankment and the gypsum. The perimeter dike is the gypsum dike on the interior side of the perimeter ditch. The rim ditch is a ditch which will be formed on the interior side of the perimeter dike. The rim dike is a gypsum dike which will be formed on the interior side of the rim ditch. These basic components of the gypsum stack are illustrated in Figure C. Specific details pertaining to the ditches are provided in Sections 4.5.3 and 4.5.4.

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During the initial stages of stacking, the perimeter ditch, perimeter dike, rim ditch and rim dike will be constructed simultaneously. They will be constructed by building two elevated dikes on the gypsum beach beginning at the middle of the north side and proceeding both clockwise and counterclockwise around the perimeter of the gypsum beach (see Figure D). Access to the beach will be provided by carefully pushing an approved fill material onto the beach from the crest of the earthen embankment to create an access pad. The thickness of the fill layer will need to be at least 24-inches over the geomembrane liner to avoid damage to the liner, and will need to be at least 36-inches over the gypsum beach. Once the fill material has been placed far enough out onto the beach to allow excavation of the gypsum without damaging the liner, the access pad can be completed using gypsum excavated from the beach (see Figure E).

Gypsum excavated from the beach is expected to be soft and saturated and must be windrowed and allowed to dewater before it can be spread and compacted to form the roadway. The gypsum is expected to dewater sufficiently in 24 hours to allow spreading and compacting. Adequate compaction is expected to be achieved by tracking with a D-6 dozer or similar equipment.

After construction of the dikes and ditches has begun, the slurry discharge lines should be relocated to discharge to the rim ditch. This will allow the rim ditch to be refilled each day to provide gypsum for raising the roadway as the excavator retreats from the most recently placed windrow. The rim ditch will also serve as the primary means of diverting slurry around the stack to the location where deposition is desired.

When the initial perimeter dike is completed, the top of the perimeter dike should be at least 30 ft wide, at least 10 ft above the beach and the side slopes graded to be 3.0H:1.0V (see Detail A on Figure B). The top of the initial rim dike should be at least 3.5 ft above the beach. Additional interior dikes may also be constructed as needed to create cells which facilitate the settling process. The exterior side slope of the rim dike shall be 3.0H:1.0V. The interior side slope of the rim dike and the side slopes on any interior dikes may be allowed to form at the angle of repose for the gypsum material. **A minimum freeboard of 3.5 ft must be maintained between the slurry level in the rim ditch and the crest of the perimeter dike. Subsequently, the perimeter dike must always be maintained at an elevation at least 3.5 ft higher than the rim dike or any other interior dike.**

The rim and perimeter dikes should be raised in lift increments of approximately 1 foot and may be moved laterally each lift as needed to maintain the required design slopes of 3.0H:1.0V on the perimeter dike. The slopes can be graded with a smooth-edged excavator bucket, e.g., a finish or cleanup bucket. **Under no circumstances should the slopes of the gypsum stack be graded using a toothed excavator bucket**.

Clarified water will be transferred from the rim ditch to the perimeter ditch where it will be carried to the transfer channel for discharge to the recycle pond. The GMF construction included installation of a stop log system for the transfer channel. The stop logs may be used for **temporary** reductions in flow to the Recycle Pond and increases in water levels in the gypsum stack for water balance purposes during operation. During the initial stacking process, when a siphon must be used to transfer water to the recycle pond, the transfer of water from the rim ditch

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to the perimeter ditch may be achieved with an open cut through the perimeter dike. However, once the perimeter dike rises above elevation 614 ft (the invert of the transfer channel), decants, stilling wells and splash pads (see Sections 4.5.5 and 4.5.7) are required for the purpose of transferring clarified water from the rim ditch to the perimeter ditch.

4.5.3 Perimeter Ditch

Throughout the stacking operations, a perimeter ditch must be constructed and maintained around the toe of the gypsum stack. The perimeter ditch will be located between the perimeter dike (outer gypsum slope) and the HDPE lined earthen embankment. This ditch will collect water from the ring drains, decants and rainfall runoff, and convey it to the transfer channel where it will be discharged to the recycle pond. The perimeter ditch shall be constructed by covering the HDPE liner with a 2 ft thick protective layer of gypsum and shaping the channel to the required dimensions. The perimeter ditch is required to have a maximum invert elevation of 614 ft (6 ft below the top of the earthen perimeter dam) and a bottom width of at least 5 ft. A larger ditch bottom width may be utilized to reduce the frequency of any dredging necessary to maintain the minimum required dimensions.

4.5.4 Rim Ditch

The rim ditch will be the primary means of diverting slurry from the slurry discharge pipes to the desired deposition area. The rim ditch will also transport clarified water to the decant structures so the water can be discharged to the perimeter ditch. Consequently, the width of the rim ditch will vary according to the needs at any particular location on the gypsum stack. There may also be cases were blocking the rim ditch is desirable to divert water into a particular cell. There are only two primary constraints on the construction of the rim ditch: (1) the outer slope shall not be steeper than 3.0H:1.0V (this is the inner slope of the perimeter dike); and (2) the normal operating water level shall be at least 3.5 ft below the top of the perimeter dike.

4.5.5 Installation and Operation of Decants and Stilling Wells

The progressive stacking of gypsum will require the installation of at least four (4) decant structures (2 redundant sets of 2) in the rim ditch to convey water to the lower perimeter ditch without eroding the gypsum stack slopes. A minimum of two (2) decant structures are required in order to maintain the water level in the rim ditch and provide adequate discharge capacity for design precipitation events. An additional redundant set of two (2) decant structures will also be required to be installed. The decant structures will consist of 16-inch diameter solid wall HDPE IPS DR 11 pipe sections with 12-inch diameter screw-capped tees installed at 6 ft intervals along the length of the pipe. (When installed on a 3H:1V slope, the tees at 6 ft intervals will translate to 2 ft elevation intervals.) The decant structures will each discharge to a stilling well located in the perimeter ditch at the toe of the outer gypsum stack slope.

During construction of the first gypsum dike above elevation 614 ft (the invert elevation of the perimeter ditch and transfer channel), a 16-inch diameter solid wall HDPE IPS DR11 pipe will be installed as shown in Figure F**Error! Reference source not found.**. The horizontal portion of the pipe will be approximately 80 ft long with an invert at EL 614. The inlet end of the horizontal pipe will be attached to the first decant pipe section with an 18.4 degree angle

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fitting. Prior to backfilling over the horizontal portion of the pipe, a 20 ft wide geogrid must be installed over the entire horizontal portion of the pipe, to prevent the pipe from potentially floating out of the saturated gypsum layer during the initial stages of the stacking operation.

The outlet end of the decant pipe will be welded to, and discharge into, a 48-inch diameter HDPE stand pipe with a 1-inch thick HDPE plate welded to the bottom. The stand pipe will have a top elevation of 618 ft and a bottom elevation of 611 ft. The stand pipe will be filled with concrete ballast to EL 614 (see Detail A on Figure F). Additionally, a 4-inch diameter low flow drain will be installed in the stand pipe at elevation 614 ft in order to allow for the cleanout of any gypsum which might accumulate in the stand pipe. In order to allow for proper function of the stilling well, the low flow drain pipe should not be installed in line with the 16-inch decant pipe, but rather offset to one side.

Each time the perimeter gypsum dike is raised, a new decant pipe section will be butt welded to the decant structure. The decant pipe section will be supported by the interior 3H:1V slope of the rim ditch. The water level in the rim ditch will be progressively raised through the stacking operation by capping the appropriate tees in the decant pipe sections. As previously stated, the normal water level shall be at least 3.5 ft below the crest of the perimeter gypsum dike.

4.5.6 Installation of Upper Ring Drains

Upon completion of the first gypsum dike above elevation 614 ft, and prior to construction of the next progressively stacked dike, two interior ring drains must be installed concurrent with development and operation of the interior gypsum cells. Additional ring drains will be required as the height of the gypsum stack increases. Final details and specifications for the upper ring drains will be provided by the design engineer at the time of installation. The upper ring drains are required to control the phreatic surface which will develop within the stack. A preliminary design for the upper ring drains is as follows, as shown on Figure C: A 3 ft tall gypsum dike will be constructed along the centerline of the proposed ring drain using the same techniques as for gypsum dike construction. After construction of the dike, a 4 ft deep channel with a 4 ft bottom width will be excavated along the center of the dike. Side slopes on the cut should be no steeper than 1:1. The bottom and sides of the cut should be filled with IDOT FA1 gradation sand to form a layer which is 1 ft thick. After the sand is placed, the channel will then be lined with non-woven geotextile to be specified by the design engineer. The geotextile will be covered with coarse granular material (to be specified) 2 ft wide by 2 ft deep, with a perforated HDPE pipe imbedded in the center. The fabric will then be wrapped over the top of the coarse granular material and covered with an additional 1 ft thick layer of FA1 gradation sand. The gypsum must not be in direct contact with the non-woven geotextile. The upper ring drains will discharge to the perimeter ditch via solid-wall HDPE pipe.

4.5.7 Splash Pads at Ring Drain & Decant Discharge Locations

At each location where a ring drain and/or a decant structure discharges to the perimeter ditch, the ditch shall be lined with a material capable of resisting the erosive velocities. Materials such as concrete, cable stayed concrete blocks or a geogrid backfilled with washed

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aggregate may be acceptable. Operator-proposed methods shall be submitted to Ameren for approval prior to placement. The splash pads shall be installed concurrently with or immediately after construction of the perimeter ditch, ring drain outlets and decant stilling wells.

4.5.8 Piezometer Installation and Monitoring

The side slopes of the gypsum stack will be constructed with 3.0H:1.0V side slopes. (After consolidation of the settled gypsum over time, the final slopes are expected to approach 3.75H:1.0V.) The stability of the gypsum stack slopes is critically dependent on the location of the phreatic surface which will develop within the gypsum stack. Proper installation and functioning of the ring drains will ensure that the phreatic surface is located an adequate distance from the surface of the slope as necessary to maintain a stable slope. In order to monitor the phreatic surface within the gypsum stack, piezometers will be installed on each side of the gypsum stack. A preliminary piezometer detail is included on Figure C. The location and depth of each piezometer will be determined by the design engineer prior to installation, and an installation and monitoring plan will be developed based on information obtained during the initial gypsum stacking operations below the level of the earthen berm. "Critical elevations" corresponding to the anticipated readings at various stages during the progressive raising of the gypsum stack will be established for each piezometer. The water level in each piezometer will be read and recorded in accordance with a specified schedule. If at any time a reading is recorded higher than the "critical elevation" for that stage of operation, Ameren and the design engineer must be contacted immediately for evaluation of the reading. It is imperative that the piezometers are installed and monitored in accordance with the plan and the design engineer's specifications. Depending on the piezometer readings, it may also be necessary to install additional seepage collection drains to maintain the phreatic surface at or below the critical level within the gypsum stack.

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Figure A – Bottom Ring Drain Assembly

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Figure B - Initial Gypsum Dike Construction

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Figure C - Components of Gypsum Stack

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Figure D - Progression of Ditch and Dike Construction

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Figure E - Access Pad Extension onto Gypsum Beach

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Figure F - Decant Pipe and Stilling Well Details

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SECTION 5.0 DAM INSPECTIONS

The inspection program includes two types of dam inspections which are required to be performed in accordance with IDNR/OWR's Rules for Construction and Maintenance of Dams. The first type of inspection is regularly conducted by the dam Operator and is referred to as an Operation and Maintenance Inspection. The second type of inspection, referred to as the Engineering Inspection, is conducted by a qualified engineer approved by Ameren.

Inspections shall be conducted throughout the operating life of the structures. The "operating life of the structure" will be considered to cease upon receipt of written affirmation from IDNR/OWR indicating that the structure is no longer considered a dam. Copies of all inspection reports shall be maintained at the Plant for the operating life of the structures.

5.1 OPERATION AND MAINTENANCE INSPECTION

"Walk-around" inspections of the dams and appurtenant works are to be made by the dam Operator. During these inspections, a checklist of items to be maintained and items to be observed should be recorded. The checklist provided in Appendix B shall be utilized for these inspections. **If any of the following items are found to be unusual or are cause for concern, the Ameren Shift Supervisor should be immediately notified.**

Frequency: Weekly. Also, during and after unusual events such as heavy rainfall or after an earthquake.

Inspection Items: During each inspection the following items should be noted in particular.

1. Water Level - Maximum levels as a result of heavy rainfall should be recorded.

2. Earth Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides, and animal burrows. These are described as follows:

    - Surface Erosion - Removal of vegetative cover by water action or pedestrian or vehicle usage forming deep ruts or gullies.

    - Seepage - The passage of water through and/or underneath the earth embankment abutment and natural groundline or at the contact between the embankment and outlet works. It can be indicated by cattails or other wet environmental vegetation, erosion, channelization, or slumping on the embankment face.

    - Cracks - Deep cracks usually indicate the movement of the dam and/or the foundation and can be in either the longitudinal (along the length of the dam) or transverse (across the dam) directions. Cracking can be an indicator of the

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beginning of slumps. Shallow cracks may develop during the summer when the surface soils of the embankment become severely dried and are usually of no concern in regard to the safety of the dam.

- Settlement - Settlement is indicated by depressions or low spots and can be signs of consolidation of the dam or foundation or the loss of material beneath the settlement area.

- Slumps/Slides - A slow or sudden movement of the earth embankment slope on either face toward the toe of the dam.

- If seepage indicates the presence of soil particles, or if deep cracks, settlement, slumps, or slides are noticed, a qualified engineer should be contacted immediately for consultation.

- Animal Burrows - Animal burrows result in a loss of earth embankment material and can provide seepage paths for water through the embankment.

3. Gypsum Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides and animal burrows. The descriptions for these are the same as for earth embankment.

4. Vegetation - Grass should be a thick vigorous growth to stabilize the earth embankment soils and prevent erosion from occurring. Note the height of the grass; if greater than 1 foot a mowing of the area should be scheduled before the next inspection. There should be NO trees on the earth embankment and NONE within a minimum of 20 ft of the embankment toes or other structures. The gypsum embankment will not be seeded and is not expected to have any vegetation.

5. Gypsum Stack piezometers should be inspected for any damage or loss of function. Damaged piezometers must be promptly repaired or replaced since their function is critical to ensuring stability of the gypsum stack.

6. The water level in each Gypsum Stack piezometer must be measured and recorded. If the water level in any piezometer is above the “critical elevation” as discussed in Section 4.5.8, Ameren should be notified and the **design engineer should be immediately consulted for guidance on an appropriate course of action**.

7. Gypsum Stack LD/LCRS Drains - The change in location or amount of flows discharging from the Leak Detection/Leachate Collection Recovery System (LD/LCRS) should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

8. Gypsum Stack Ring Drains - The change in location or amount of flows discharging from the Ring Drains should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

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9. Gypsum Stack Fixed Decant – Check the alignment and supports for the pipe. Record the amount of flows discharging from the pipe and any erosion or scour around the discharge point.

10. Gypsum Stack Perimeter Ditch – The perimeter ditch should have a consistent prismatic shape for the entire length. Inspect the perimeter ditch for evidence of erosion, sediment deposition and irregularity in channel geometry, especially in the vicinity of siphon, decant or ring drain outfall structures. If irregularities are noted, repairs should be scheduled and completed.

11. Stop Logs - Check to make sure that the stop logs in the transfer ditch are undamaged, and, if installed, are operating well and allowing for the free flow of water over them.

12. Transfer Channel - Check for any debris or other obstructions which may block or restrict the free flow of water. Check for any pools or undulation of the floor of the channel.

13. Recycle Pond Decant - Check for any debris or other obstructions around the Recycle Pond decant which may block or restrict the free flow of water. The emergency dewatering valve should be lubricated. If there is no return water in the pipe, the emergency dewatering valve should be exercised. Record the physical and operating conditions of the system.

14. Recycle Pond Drop Inlet Spillways - Check for any debris or other obstructions around the inlet crest and at the bottom of the drop inlet which may block or restrict the free flow of water. Check for the development of any rusty areas on the concrete, and seepage, cracking, breaking, or spalling of the concrete. Check for settlement or cracking of the crest. Check for any debris in the pipes which may restrict the flow of water. Check for any tears or leaks in the HDPE liner covering the concrete.

15. Recycle Pond Rip Rap Basin - Check for any debris or other obstructions in the riprap basin which may block or restrict the free flow of water. Check to make sure that the rip rap is remaining in a uniform position. Freeze/thaw action or flow over the rip rap may tend to lift or fracture, thus requiring replacement or leveling to maintain the necessary level of protection. NO trees or woody vegetation should be growing through the rip rap.

16. Fences - Check for damage, accumulated debris, operation of gates and locks, and adequacy of locations (this may change with time as people access the area or development occurs in the area).

17. Perimeter - Check the perimeter of the dams for a distance of at least 100 ft beyond the toe for signs of seepage or boils.

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18. HDPE Liner – Wherever exposed, the HDPE Liner should be inspected for tears, gouges, protrusions under the liner and abrasion.

Records: Log books of activities occurring at the dam is to be kept current by the dam Operator. The log books shall be made available for review by the inspecting engineer during the Engineering Inspection. The log books should contain at the least the following documentation:

1. Completed operation and maintenance inspection checklists
2. Readings from all piezometers on the Gypsum Stack
3. Additional visual observations
4. A list of maintenance performed
5. A list of any unusual occurrences at the dam
6. A copy of the engineering inspection reports

5.2 ENGINEERING INSPECTION

The engineering inspection is to be conducted by a qualified engineer approved by IPRG. The inspection will provide a thorough evaluation of the dam and appurtenant structures. The forms provided in Appendix C shall be utilized for these inspections.

Frequency: The Gypsum Stack Dam and Recycle Pond Dam are classified as CLASS III, LOW HAZARD POTENTIAL dams. Class III dams are to be inspected at least once every five years.

Inspection Items: The engineer will thoroughly inspect all of the items noted under Operation and Maintenance Inspection.

Records: The Dam Inspection Report form, Appendix C, will be completed by the inspecting engineer and will be signed and sealed by an Illinois Registered Professional Engineer. This report will document any deficiencies; recommend remedial actions; and establish time requirements for addressing the deficiencies. The original report will be retained in Ameren's file and a copy of the report will be submitted to the Illinois Department of Natural Resources, Office of Water Resources.

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SECTION 6.0
MAINTENANCE ACTIVITIES

Timely repairs are a must after problem areas have been identified. The dam Operator is to perform the work required to correct items noted in the operation and maintenance and engineering inspections. Such items include mowing, seeding, tree and brush removal, replacing rip rap, repairing fences and locks, clearing debris, etc. The maintenance activities specified in the following sections are minimum requirements. NOTE: NO alterations or repairs to structural elements should be made without the assistance of a qualified engineer and the concurrence of the Illinois Department of Natural Resources, Office of Water Resources.

6.1 ROUTINE MAINTENANCE

Debris: Remove all trash, logs and other debris which may obstruct flow into the principal spillway pipes and drop inlets, or block passage from their discharge channels.

Rip Rap: Replace rip rap as needed to provide adequate protection against erosion.

Vegetation Control:

1. Maintain a good grass cover on the embankment by seeding, fertilizing and mulching areas which are refilled, barren, or thinly vegetated. Seeding mixtures used for maintenance reseeding shall result in a cover compatible with adjacent cover. The seeding mixture specified at the time of the dam's construction was IDOT Standard Specifications Class 1A (Salt Tolerant Lawn Mixture) as follows:

   IDOT Class 1A Salt Tolerant Lawn Mixture
   Bluegrass .....60 lb/acre
   Perennial Ryegrass .....20 lb/acre
   Dawsons Red Fescue.....20 lb/acre
   Scaldis Hard Fescue .....20 lb/acre
   Fults Salt Grass .....60 lb/acre

2. Grassed areas such as the embankment and the areas beyond the embankment toes for a distance of at least 20 ft should be mowed at least twice annually or at any time the height of the grass exceeds 1 foot.

3. All erosion areas will be filled and compacted, reseeded, fertilized and mulched to establish a thick erosion resistant cover.

4. Remove all trees and brush growing on the dam embankment to prevent development of a root system which could provide seepage paths. Herbicides utilized for tree and brush control are discussed in Appendix D.

5. Keep the riprap basin clear of weeds, brush, and trees.

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6. Remove all trees and brush growing on the dam embankment to prevent development of a root system which could provide seepage paths. Herbicides utilized for tree and brush control are discussed in Appendix D.

7. Clear all brush and trees to a distance of approximately 20 ft beyond both toes of the dam.

Animal Damage: Fill rodent holes and other animal burrows with compacted clayey dirt and reseed. If rodents become a nuisance, an effective rodent control program as approved by the Illinois Department of Natural Resources District Wildlife Biologist should be implemented.

Signs: All warning sings shall be maintained (repaired, painted, or replaced) as needed.

6.2 EROSION AND DUST CONTROL

As stacking operations commence, the dewatered gypsum is expected to form a thin layer of "crust" which will resist erosion and prevent the migration of fugitive dust from the gypsum stack. (This expectation is based on a case study of flue-gas desulfurization by-product (gypsum) stacking by the Electric Power Research Institute entitled Evaluation of Chiyoda Thoroughbred 121 FGD Process and Gypsum Stacking, Volume 3 Addendum, dated March 1981.) Should a protective layer of crust fail to form or fail to provide adequate erosion and dust control, appropriate measures for addressing these concerns will be implemented.

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APPENDIX A
LOCATION MAP

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APPENDIX B
PERTINENT DATA ABOUT THE DAMS

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Gypsum Stack Dam

DAM		
Top of Dam Elevation	620	ft
Invert of Reservoir Elevation	585	ft
Reservoir Area at Invert	0.7	acres
Reservoir Area at Top of Dam	31.6	acres
Total Reservoir Volume	773.2	acre-ft
Total Watershed Area	31.6	acres

TRANSFER CHANNEL		
Bottom Width	16.00	ft
Top Width	16.00	ft
Depth	6.00	ft
Upstream Invert	614.00	ft
Downstream Invert	609.00	ft
Weir Elevation	616.00	ft
Weir Length	16.00	ft

PERIMETER DITCH		
Bottom Width	5.00	ft
Top Width	44.00	ft
Depth	6.00	ft
Outer Side Slope	3.5:1	H:V
Inner Side Slope	3:1	H:V
Upstream Invert	615.16	ft
Downstream Invert	614.00	ft
Ditch slope	0.00050	ft/ft
Bank Full Cross-sectional Area	147.00	sf
Length of Each Ditch (Centerline)	2322.00	ft
Bank Full Volume of Each Ditch	7.84	acre-ft
Total Ditch length (Centerline)	4644.00	ft
Total Ditch Bank Full Volume	15.67	acre-ft

0.5 PMF STORM EVENT		
Critical Storm Duration	24	hours
Peak Inflow	374.7	cfs
Peak Outflow	190	cfs
Total Inflow	54.88	acre-ft
Total Outflow	54.91	acre-ft
Peak Storage	9.46	acre-ft
Peak WSEL (HEC-HMS)	618.5	ft
Peak WSEL (HEC-RAS)	618.31	ft
Freeboard over Max WSEL	1.5	ft
Wave Runup/Wind Setup	1.48	ft

100-YR STORM EVENT		
Critical Storm Duration	0.5	hours
Peak Inflow	274.7	cfs
Peak Outflow	91.4	cfs
Total Inflow	21.08	acre-ft
Total Outflow	21.12	acre-ft
Peak Storage	6.31	acre-ft
Computed WSEL (HEC-HMS)	617.54	ft
Computed WSEL (HEC-RAS)	617.66	ft
Freeboard over Max WSEL	2.34	ft
Wave Runup/Wind Setup	1.48	ft

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Recycle Pond Dam

DAM		
Top of Dam Elevation	615	ft
Invert of Reservoir Elevation	592	ft
Reservoir Area at Invert	4.87	acres
Reservoir Area at Top of Dam	8.21	acres
Total Reservoir Volume	150.4	acre-ft
Total Watershed Area	39.81	acres

SPILLWAY		
Pipe Length	60	ft
Pipe Diameter (Inside)	42	inch
Number of Pipes	4	
Pipe Slope	0.03333	Ft/ft
Upstream Invert	610	ft
Downstream Invert	607	ft
Entrance Loss Coefficient	0.9	

0.5 PMF Storm Event - Starting WSEL @ 610		
Critical Storm Duration	24	hours
Peak Inflow	252.4	cfs
Peak Outflow	123.6	cfs
Total Inflow	65.96	acre-ft
Total Outflow	62.88	acre-ft
Peak Storage	135.79	acre-ft
Peak WSEL (HEC-HMS)	612.99	ft
Peak WSEL (HEC-RAS)	613.00	ft
Freeboard over Peak WSEL	2.01	ft
Wave Runup/Wind Setup	1.77	ft
Peak Spillway Outlet Velocity	12.73	fps

100-yr Storm Event - Starting WSEL @ 610		
Critical Storm Duration	2	hours
Peak Inflow	107.1	cfs
Peak Outflow	29.5	cfs
Total Inflow	27.22	acre-ft
Total Outflow	24.15	acre-ft
Peak Storage	125.25	acre-ft
Peak WSEL (HEC-HMS)	611.37	ft
Computed WSEL (HEC-RAS)	611.37	ft
Freeboard over Peak WSEL	3.63	ft
Wave Runup/Wind Setup	1.77	ft
Peak Spillway Outlet Velocity	9.92	fps

0.5 PMF Storm Event - Starting WSEL @ 599.5		
Critical Storm Duration	24	hours
Peak Inflow	252.1	cfs
Peak Outflow	0	cfs
Total Inflow	65.96	acre-ft
Total Outflow	0	acre-ft
Peak Storage	114.47	acre-ft
Peak WSEL (HEC-HMS)	609.70	ft
Freeboard over Peak WSEL	5.3	ft
Wave Runup/Wind Setup	1.77	ft

100-yr Storm Event - Starting WSEL @ 604		
Critical Storm Duration	24	hours
Peak Inflow	32.3	cfs
Peak Outflow	0	cfs
Total Inflow	36.46	acre-ft
Total Outflow	0	acre-ft
Peak Storage	114.07	acre-ft
Peak WSEL (HEC-HMS)	609.64	ft
Freeboard over Peak WSEL	5.36	ft
Wave Runup/Wind Setup	1.77	ft

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APPENDIX C
OPERATION AND MAINTENANCE INSPECTION CHECKLIST

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OPERATION AND MAINTENANCE INSPECTION CHECKLIST

Dam Name (circle one): Gypsum Stack Dam Recycle Pond Dam

Date: _____ Time: _____

Name of Inspector: _____

Reservoir Elevation: _____ ft

ITEM	NO	YES	IF YES
Record Piezometer Readings for Gypsum Stack. Are any readings above the critical level? (see section 4.8.2 of O&M)			Contact Engineering Manager and notify Hanson Professional Services
Note the condition of the Piezometers on the Gypsum Stack. Any damage?			Contact Engineering Manager
Deep Surface Cracks			Contact Engineering Manager
Slump or Slide on the upstream or downstream face			Contact Engineering Manager
Erosion from runoff, wave action or traffic			Repair and stabilize
Wet areas on the gypsum or earthen embankment indicating seepage			Contact Engineering Manager
Flows of cloudy water from seepage areas on the gypsum or earthen embankment			Contact Engineering Manager
Uneven settlement			Contact Engineering Manager
Trees, brush or burrow holes on the embankment or in the riprap basin			Remove trees and brush, fill holes
Transfer channel or Spillway pipes blocked			Clear immediately
Damage to stop logs			Repair or replace
Tear in Liner			Repair and schedule engineer inspection
Settlement or displacement of Gypsum Stack siphon decant pipes or outlets			Schedule engineer inspection
Settlement or displacement of Gypsum Stack fixed decant pipes or outlets			Schedule engineer inspection
Discharge from Gypsum Stack LD/LCRS Drains?			Record discharge rate for each outlet (time to fill bucket)
Discharge from Gypsum Stack Ring Drains?			Record discharge rate for each outlet (time to fill bucket)
Gypsum Stack Perimeter Ditch erosion			Schedule repair
Problems with Recycle Pond decant			Contact Engineering Manager
Height of grass (inches		inches	If more than 1 foot, schedule mowing

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APPENDIX D
ENGINEERING INSPECTION FORM

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Dam Inspection Report

Name of Dam IPRG Duck Creek Gypsum Stack & Recycle Pond Dams Dam ID No. IL50573 & IL50574

Permit Number DS2007125 Class of Dam III

Location NW 1/4 Section 18 Township 6N Range 5E 4th P.M.

Owner

Name Telephone Number (Day)

Street Telephone Number (Night)

City Zip Code County Fulton

Type of Dam Homogeneous earthen embankment (gypsum stack is homogeneous gypsum embankment)

Type of Spillway

Date(s) Inspected

Weather When Inspected

Temperature When Inspected

Pool Elevation When Inspected

Tailwater Elevation When Inspected

Inspection Personnel:

Name Title

Name Title

Name Title

Name Title

Professional Engineer's Seal

The Department of Natural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5 (1994 State Bar Edition). Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 702.160 of the "Rules for Construction and Maintenance of Dams". This form has been approved by the State Forms Management Center.

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CONDITION CODES

EC	**-**	**Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; such as, pool draw down, work stoppage, plant stoppage.**
NE	**-**	**No evidence of a problem**
GC	**-**	**Good condition**
MM	**-**	**Item needing minor maintenance and/or repairs within the year, the safety or integrity of the item is not yet imperiled**
IM	**-**	**Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should be completed within 1 month.**
EC	**-**	**Emergency condition which if not immediately repaired or other appropriate measures taken could lead to failure of the dam**
OB	**-**	**Condition requires regular observation to ensure that the condition does not become worse**
NA	**-**	**Not applicable to this dam**
NI	**-**	**Not inspected - list the reason for non-inspection under deficiencies**
EC	**-**	**Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; such as, pool draw down, work stoppage, plant stoppage.**

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GYPSUM STACK - EARTH EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of Outer Embankment Slopes			
Upstream Face Slope Protection (HDPE Liner)			
Seepage			
Animal Damage			

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GYPSUM STACK - EARTH EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Vegetative Cover			

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GYPSUM STACK - GYPSUM EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of **Outside** Embankment Slopes			
Sloughing or Erosion of **Inside** Embankment Slopes			
Seepage			
Animal Damage			

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GYPSUM STACK - GYPSUM EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Condition of Piezometers on Gypsum Stack			
Piezometer Readings on Gypsum Stack Above Critical Level?			

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GYPSUM STACK – PERIMETER DITCH

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Ditch Geometry (15 ft bottom width, 3:1 slopes, 8-9 ft depth)			
Concrete Apron at ring drain outlets			
Ring Drain Discharge Pipes			
Stilling Wells for Fixed Decants			

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TRANSFER CHANNEL - (between gypsum stack and recycle pond)

[ ] Drop Inlet Structure [X] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Debris			
Side Slope Stability			
HPDE Liner			
HDPE Liner Welds			
Stop Logs			
Differential Settlement			

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RECYCLE POND - EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of Outer Embankment Slopes			
Upstream Face Slope Protection (HDPE Liner)			
Seepage			
Animal Damage			

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RECYCLE POND - EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Vegetative Cover			

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RECYCLE POND - PRINCIPAL SPILLWAY (Left, Looking Downstream)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

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RECYCLE POND - PRINCIPAL SPILLWAY (Left, Looking Downstream)

(Continued)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

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RECYCLE POND - PRINCIPAL SPILLWAY (Center)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

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RECYCLE POND - PRINCIPAL SPILLWAY (Center)

(Continued)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

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RECYCLE POND - PRINCIPAL SPILLWAY (Right, Looking Downstream)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

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RECYCLE POND - PRINCIPAL SPILLWAY (Right, Looking Downstream)

(Continued)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

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RECYCLE POND - ENERGY DISSIPATOR

[X] Principal Spillway [ ] Outlet Works Type: Riprap Basin

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Riprap			
Outlet Channel			
Debris			

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RECYCLE POND - DECANT STRUCTURE

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment			
Connection to Bollard			
Debris in Inlets			
Condition of Pipe			
Condition of Liner Beneath Pipe			
Connection to Ballast			
Connection of Pipe Boot to Liner			

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RECYCLE POND - DECANT STRUCTURE

(continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Seepage Around or into Conduit			

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RECYCLE POND – WATER LEVEL GAGE STRUCTURE

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE

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APPENDIX E
HERBICIDES

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HERBICIDES

Site personnel should check with the Illinois Department of Natural Resources, Regional Fisheries Biologist and the Regional Wildlife Biologist before using any herbicide. Read the product label prior to use and follow the use directions and precautions accordingly.

On March 1, 1979 the U.S. Environmental Protection Agency (U.S.E.P.A.) halted the use of the herbicide 2, 4, 5-T in parks and recreation areas. The use of silvex (2, 4, 5-TP) around water has also been banned.

The Agronomy Department at the University of Illinois and the Aquatic Biology Section of the Department of Natural Resources, Office of Scientific Research and Analysis indicate that the herbicides containing the 2, 4-D or 2, 4-DP are legal for use in parks and recreation areas and effective for controlling brush and woody growth. Some examples of approved herbicides are:

1. Tordon RTU by DOW Chemical. (Can be obtained with blue dye.)
2. WEEDONE 170 by Union Carbide
3. WEEDONE, 2, 4-DP by Union Carbide
4. A 1% to 2% solution of ROUNDUP
5. Garlon by DOW Chemical
6. Banvel by Sandoz

Your distributor may carry brand name herbicides other than those listed above. Be certain that the product does not contain the ingredients 2, 4, 5-T or 2, 4, 5-TP. An example of an unacceptable product is ESTERON 2, 4, 5 by DOW Chemical.

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October 11, 2021

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, Illinois 61520

Subject: USEPA CCR Rule and IEPA Part 845 Rule Applicability Cross-Reference
2021 USEPA CCR Rule Periodic Certification Report
GMF Pond, Duck Creek Power Plant, Canton, Illinois

At the request of Illinois Power Resources Generating, LLC (IPRG), Geosyntec Consultants (Geosyntec) has prepared this letter to document how the attached 2021 United States Environmental Protection Agency (USEPA) CCR Rule Periodic Certification Report (Report) was prepared in accordance with both the Federal USEPA CCR Rule[1] and the state-specific Illinois Environmental Protection Agency (IEPA) Part 845 Rule[2]. Specific sections of the report and the applicable sections of the USEPA CCR Rule and Illinois Part 845 Rule are cross-referenced in **Table 1**. A certification from a Qualified Professional Engineer for each of the CCR Rule sections listed in **Table 1** is provided in Section 9 of the attached Report. This certification statement is also applicable to each section of the Part 845 Rule listed in **Table 1.**

Table 1 – USEPA CCR Rule and Illinois Part 845 Rule Cross-Reference

Report Section	USEPA CCR Rule		Illinois Part 845 Rule	
3	§257.73 (a)(2)	Hazard Potential Classification	845.440	Hazard Potential Classification Assessment[3]
4	§257.73 (c)(1)	History of Construction	845.220(a)	Design and Construction Plans (Construction History)
5	§257.73 (d)(1)	Structural Stability Assessment	845.450 (a) and (c)	Structural Stability Assessment
6	§257.73 (e)(1)	Safety Factor Assessment	845.460 (a-b)	Safety Factor Assessment
7	§257.82 (a)(1-3)	Adequacy of Inflow Design Control System Plan	845.510(a), (c)(1), (c)(3)	Hydrologic and Hydraulic Capacity Requirements / Inflow Design Flood Control System Plan
	§257.82 (b)	Discharge from CCR Unit	845.510(b)	Discharge from CCR Surface Impoundment

[1] United Stated Environmental Protection Agency, 2015. *40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule.*
[2] State of Illinois, Joint Committee on Administrative Rule, Administrative Code (2021). *Title 35: Environmental Protection, Subtitle G: Waste Disposal, Chapter I: Pollution Control Board, Subchapter j: Coal Combustion Waste Surface Impoundment, Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments.*
[3] "Significant" and "High" hazard, per the CCR Rule[1], are equivalent to Class II and Class I hazard potential, respectively, per Part 845[2].

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CLOSING

This letter has been prepared to demonstrate that the content and Qualified Professional Engineer Certification of the 2021 Periodic USEPA CCR Rule Certification Report fulfills the corresponding requirements of Part 845 of Illinois Administrative Code listed in **Table 1**.

Sincerely,





Lucas P. Carr, P.E.
Senior Engineer

John Seymour, P.E.
Senior Principal

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2021 USEPA CCR RULE PERIODIC CERTIFICATION REPORT §257.73(a)(2), (c), (d), (e) and §257.82 GMF POND Duck Creek Power Plant Fulton County, Illinois

Submitted to

Illinois Power Resources Generating, LLC

17751 North Cilco Road
Canton, Illinois 61520

Submitted by

Geosyntec consultants

engineers | scientists | innovators

1 McBride and Son Center Drive, Suite 202
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October 11, 2021

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Attachment D Periodic Structural Stability and Safety Factor Assessment Analyses

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EXECUTIVE SUMMARY

This Periodic United States Environmental Protection Agency (USEPA) Coal Combustion Residuals (CCR) Rule [1] certification report (Periodic Certification Report) for the GMF Pond[1] at the Duck Creek Power Plant (DCPP) has been prepared in accordance with Rule 40, Code of Federal Regulations (CFR) §257. herein referred to as the "CCR Rule" [1]. The CCR Rule requires that initial certifications for existing CCR surface impoundment, completed in 2016 and subsequently posted on the Illinois Power Resources Generating, LLC (IPRG) CCR Website ([2], [3], [4], [5], [6]) be updated on a five-year basis.

The initial certification reports developed in 2016 and 2017 ([2], [7], [3], [4], [5], [6], [8]) were independently reviewed by Geosyntec. Additionally, field observations, interviews with plant staff, and evaluations were performed to compare conditions in 2021 at the GMF Pond relative to the 2016 initial certifications. These tasks determined that updates are not required for the Initial Hazard Potential Classification or Inflow Design Flood Control Plan. However, due to changes at the site and technical review comments, updates were required and were performed for the:

- History of Construction Report,
- Initial Structural Stability Assessment, and
- Initial Safety Factor Assessment.

Geosyntec's evaluations of the initial certification reports and updated engineering evaluations determined that the GMF Pond meets all requirements for hazard potential classification, history of construction reporting, structural stability assessment, safety factor assessment, and hydrologic and hydraulic control. **Table 1** provides a summary of the initial 2016 certifications and the updated 2021 periodic certifications.

[1] The GMF Pond is also referred to as ID Number W05780100001-04, GMF Pond by the Illinois Environmental Protection Agency (IEPA); CCR unit ID 203 by IPRG, and IL50573 within the National Inventory of Dams (NID) maintained by the Illinois Department of Natural Resources (IDNR). Within this document it is referred to as the GMF Pond or the GMFP.

Table 1 – Periodic Certification Summary

	CCR Rule Reference	Requirement Summary	2016 Initial Certification		2021 Periodic Certification	
			Requirement Met?	Comments	Requirement Met?	Comments
Hazard Potential Classification						
3	§257.73(a)(2)	Document hazard potential classification	Yes	Impoundment was determined to have Significant hazard potential classification [2].	Yes	Updates were not determined to be necessary. Geosyntec recommends retaining the Significant hazard potential classification.
History of Construction						
4	§257.73(c)(1)	Compile a history of construction	Yes	A history of Construction report was prepared for the GMF Pond [3].	Yes	The Duck Creek Power Plant closed and CCR materials are no longer being placed in the GMF Pond. A letter listing updates to the History of Construction report is provided in **Attachment C.**
Structural Stability Assessment						
5	§257.73(d)(1)(i)	Stable foundations and abutments	Yes	Foundations and abutments were found to be stable [8].	Yes	Foundations and abutments were found to be stable after performing updated slope stability analyses.
	§257.73(d)(1)(ii)	Adequate slope protection	Yes	Slope protection was adequate [8].	Yes	No changes were identified that may affect this requirement.
	§257.73(d)(1)(iii)	Sufficiency of dike compaction	Yes	Dike compaction was sufficient for expected ranges in loading conditions [8].	Yes	Dike compaction found to be sufficient after performing updated slope stability analyses.
	§257.73(d)(1)(iv)	Presence and condition of slope vegetation	Yes	Vegetation was present on exterior slopes and is maintained. Interior slopes had alternate protection (geomembrane liner) [8].	Yes	No changes were identified that may affect this requirement.
	§257.73(d)(1)(v)(A) and (B)	Adequacy of spillway design and management	Yes	Spillways were adequately designed and constructed and were expected to adequately manage flow during 1,000-year flood [8].	Yes	No changes were identified that may affect this requirement.
	§257.73(d)(1)(vi)	Structural integrity of hydraulic structures	Not Applicable	Hydraulic structures penetrating the dikes or underlying the base of the GMF Pond were not present [8].	Not Applicable	No changes were identified that may affect this requirement.
	§257.73(d)(1)(vii)	Stability of downstream slopes inundated by water body.	Not Applicable	Inundation of exterior slopes was not expected; this requirement was not applicable [8].	Not Applicable	No changes were identified that may affect this requirement.
Safety Factor Assessment						
6	§257.73(e)(1)(i)	Maximum storage pool safety factor must be at least 1.50	Yes	Safety factors were calculated to be 4.27 and higher [8].	Yes	Safety factors from an updated slope stability analyses were calculated to be 3.47 and higher.
	§257.73(e)(1)(ii)	Maximum surcharge pool safety factor must be at least 1.40	Yes	Safety factors were calculated to be 4.26 and higher [8].	Yes	Safety factors from an updated slope stability analyses were calculated to be 3.47 and higher.
	§257.73(e)(1)(iii)	Seismic safety factor must be at least 1.00	Yes	Safety factors were calculated to be 2.37 and higher [8].	Yes	Safety factors from an updated slope stability analyses were calculated to be 1.88 and higher.
	§257.73(e)(1)(iv)	For dike construction of soils that have susceptible to liquefaction, safety factor must be at least 1.20	Not Applicable	Dike soils were not susceptible to liquefaction [8].	Not Applicable	No changes were identified that may affect this requirement.
Inflow Design Flood Control System Plan						
7	§257.82(a)(1), (2), (3)	Adequacy of inflow design control system plan.	Yes	Flood control system adequately managed inflow and peak discharge during the 1,000-year, 24-hour, Inflow Design Flood [8].	Yes	No changes were identified that may affect this requirement.
	§257.82(b)	Discharge from CCR Unit	Yes	Discharge into Waters of the United States is not expected during 1,000-year, 24-hour Inflow Design Flood conditions [8].	Yes	No changes were identified that may affect this requirement.

SECTION 1

INTRODUCTION AND BACKGROUND

This Periodic United States Environmental Protection Agency (USPA) Coal Combustion Residual (CCR) Rule [1] Certification Report was prepared by Geosyntec Consultants (Geosyntec) for Illinois Power Resources Generations, LLC (IPRG) to document the periodic certification of the GMF Pond at the Duck Creek Power Plant (DCPP) located at 17751 North Cilco Road in Canton, Illinois, 61520. The location of Duck Creek is provided in **Figure 1**, and a site plan showing the location of the GMF Pond, among other closed and open CCR units and non-CCR surface impoundments, is provided in **Figure 2**.

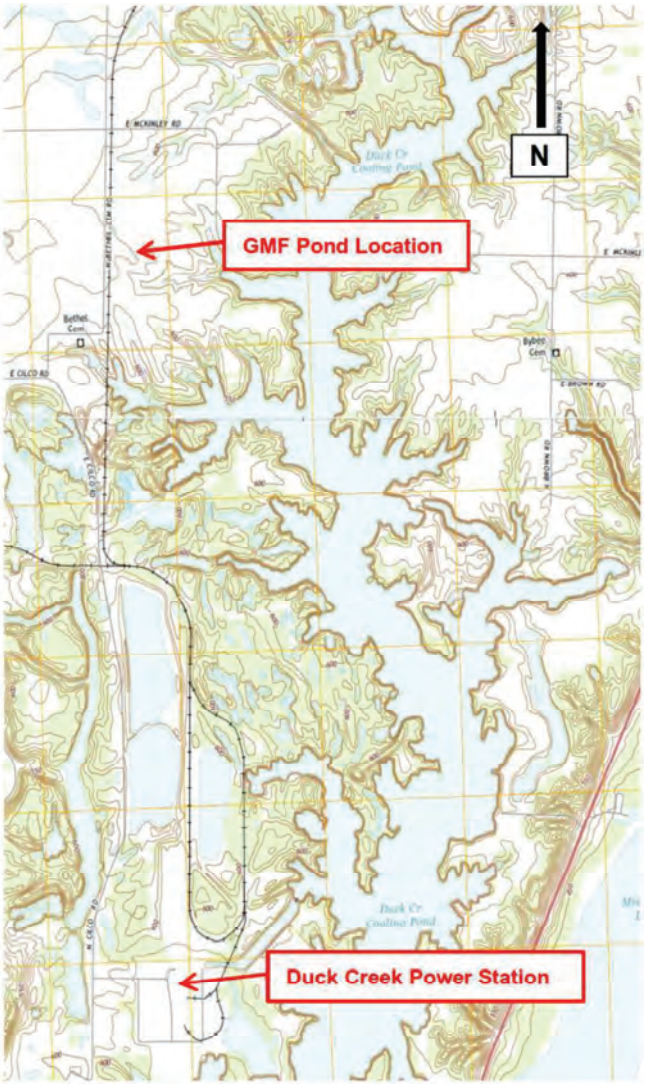

Figure 1 – Site Location Map (from AECOM, 2016)



Figure 2 – Site Plan

1.1 GMF Pond Description

DCPP was retired in 2019. Prior to retirement, two active CCR surface impoundments – the GMF Pond and the Bottom Ash Basin, and one CCR landfill, were used for managing CCRs generated at DCPP [8]. This certification report only pertains to the GMF Pond. The GMF Pond has a "Significant" hazard potential, based on the initial hazard potential classification assessment performed by Stantec in 2016 in accordance with §257.73(a)(2) ([2], [7]).

The GMF Pond served as the wet impoundment basin for gypsum proceeded by the emissions scrubbers at DCPP. The GMF Pond was constructed between 2008 and 2009 and received inflow from three pairs of 10-in diameter high-density polyethylene (HDPE) gypsum slurry pipes. Clear water discharge from the GMF Pond flows downstream into the approximately 8.5-acre GMF Recycle Pond, which is a non-CCR unit, via a lined channel (transfer channel). The transfer channel is approximately 150-ft long, trapezoidal in shape, lined with 60-mil HDPE, has 3H:1V (horizontal to vertical) side slopes, and a depth of 6 ft. Stoplogs are present within the transfer channel that would allow the pool level to be maintained as high as El. 616.0 ft[2]. The channel transitions from a 16-ft bottom width at an invert elevation of 614.0 ft at the upstream end to a 35-ft bottom width at an invert elevation of 609.0 ft at the downstream end. Outflow from the GMF Recycle Pond was formerly pumped back to DCPP to be recycled for use in the wet scrubber system [8]. Currently, the GMF Pond and GMF Recycle Pond are maintained in a zero-discharge configuration, where the only inflows are precipitation flowing directly into the impoundments and the only outflows are evaporation.

The GMF Pond has a composite liner system that is present underneath the entire footprint of the pond and extends up the interior slopes. The liner system includes, from bottom to top, a 3-ft thick layer of compacted clay that is overlain by a geosynthetic clay liner (GCL) and a 60-mil textured HDPE geomembrane, all of which serve as the lower liner. Above the lower liner, a 10-oz

[2] All elevations are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

geotextile is overlain by a 1-ft thick granular drainage layer and a 4-oz geotextile filter. The upper liner is comprised from bottom to top of a 1-ft thick soil cushion layer and a 60-mil textured HDPE geomembrane. The upper geomembrane liner is exposed at the pond bottom and side slopes [8].

As formerly operated, the normal pool of the GMF Pond was El. 615.0 ft, as controlled by the stoplog structure at the top of the transfer channel. The GMF Pond is approximately 31.6 acres in size and has a total perimeter embankment length of approximately 4,560 ft. The perimeter dike was constructed to include a crest width of approximately 30 ft and crest height ranging from approximately 5 to 10 ft along the eastern side of the pond. The interior of the ponds extends deeper than the exterior slopes; the maximum interior slope height is approximately 45 ft in the southwest corner of the pond. The design elevation of the embankment crest is 620 ft. Both interior and exterior slopes have an orientation of 3.5H:1V (horizontal to vertical).

Initial certifications for the GMF Pond for Hazard Potential Classification (§257.73(a)(2)), History of Construction (§257.73(c)), Structural Stability Assessment (§257.73(d)), Safety Factor Assessment (§257.73(e)(1)), and Inflow Design Flood Control System Plan (§257.82) were completed by Stantec and AECOM in 2016 and 2017 and subsequently posted to IPRG's CCR Website ([2], [3], [4], [5], [6]). Additional documentation for the initial certifications included a detailed operating record reports containing calculations and other information prepared for the hazard potential classification by Stantec [7] and for the structural stability assessment, safety factor assessment, and inflow design flood control system plan by AECOM [8]. These operating record reports were not posted to IPRG's CCR Website.

1.2 Report Objectives

The following objectives are associated with this report:

- Compare site conditions from 2015/2016, when the initial certifications were developed, to site conditions in 2020/2021, when data for the periodic certification was obtained, and evaluate if updates are required to the:
    - §257.73(a)(2) Hazard Potential Classification [2].
    - §257.73(c) History of Construction [3].
    - §257.73(d) Structural Stability Assessment [4].
    - §257.73(e) Safety Factor Assessment [5], and/or
    - §257.82 Inflow Design Flood Control System Plan [6].
- Independently review the Hazard Potential Classification ([2], [7]), Structural Stability Assessment ([4], [8]), Safety Factor Assessment ([5], [8]), and Inflow Design Flood

Control System Plan ([6], [8]) reports to determine if updates may be required based on technical considerations.

  - The History of Construction report [3] was not independently reviewed for technical considerations, as this report contained historical information primarily developed prior to promulgation of the CCR Rule [1] for the CCR units at DCPP, and did not include calculations or other information used to certify performance and/or integrity of the impoundments under §257.73(a)(2), §257.73(c)-(e), or §257.82.

- Confirm that the GMF Pond meets all of the requirements associated with §257.73(a)(2), (c), (d), (e), and §257.82, or, if the GMF Pond does not meet any of these requirements, provide recommendations for compliance with those sections of the CCR Rule [1].

SECTION 2

COMPARISION OF INITIAL AND PERIODIC SITE CONDITIONS

2.1 Overview

This section describes the comparison of conditions at the GMF Pond between the start of the initial CCR certification program in 2015 and 2016 (initial conditions) and subsequent collection of periodic certification site data in 2020 and 2021 (periodic conditions).

2.2 Review of Annual Inspection Reports

Annual onsite inspections for the GMF Pond were performed between 2016 and 2020 ([9], [10], [11], [12], [13]) were certified by a licensed professional engineer in accordance with §257.83(b). Each inspection report stated the following information, relative to the previous inspection:

- A statement that no changes in geometry of the impounding structure were observed since the previous inspection;
- A statement that no instrumentation was present;
- Approximate volumes of impounded water and CCR at the time of inspection;
- A statement that no appearances of actual or potential structural weakness or other disruptive conditions were observed; and
- A statement that no other changes which may have affected the stability or operation of the impounding structure were observed.

In summary, the reports did not indicate any significant changes to the GMF Pond between 2015 and 2020. No signs of instability, structural weakness, or changes which may have affected the operation or stability of the GMF Pond were noted in the inspection reports.

2.3 Review of Instrumentation Data

Multiple groundwater monitoring wells are present around the GMF Pond. Eight of the groundwater monitoring wells, G50S, G51S, G54C, G57C, G57S, G60S, G64S, and X301 have been monitored periodically since by IPRG. Water level readings were provided from December 2, 2015 through June 21, 2021 for most of the wells, with the exception of X301, for which water level readings were provided starting on March 2, 2015, and G54C, for which readings were provided starting on April 14, 2021. Geosyntec reviewed the water levels to evaluate if significant fluctuations, partially increases in phreatic levels, may have occurred between development of the

initial structural stability and factor of safety certifications ([4], [5], [8]) and June 21, 2021. Available monitoring well water levels are plotted in **Attachment A**.

In summary, only minor changes in phreatic conditions were observed in the available monitoring well level data. Phreatic levels typically exhibited consistent seasonal variations of 5 to 10 ft, with the exception of X301 and G54C, which varied by approximately 2 ft. These levels do not significantly differ from those utilized for the initial structural stability and factor of safety certifications ([4], [5], [8]).

2.4 Comparison of Initial to Periodic Surveys

The initial survey of the GMF Pond, conducted by Weaver Consultants (Weaver) in 2015 [14], was compared to the periodic survey of the GMF Pond, conducted by IngenAE, LLC (IngenAE) in 2020 [15], using AutoCAD Civil3D 2021 software. This comparison quantified changes in the volume of CCR placed within the GMF Pond and considered volumetric changes above and below the starting water surface elevation (SWSE) used for the 2016 §257.82 inflow design flood control plan hydraulic analysis [6]. Potential changes to embankment geometry were also evaluated. This comparison is presented in side-by-side comparison of the two surveys in **Drawing 1,** and a plan view isopach map denoting changes in ground surface elevation in **Drawing 2**. A summary of the water elevations and changes in CCR volumes is provided in **Table 2**.

Table 2 – Initial to Periodic Survey Comparison

Initial Surveyed Pool Elevation (ft)	614.2
Periodic Surveyed Pool Elevation (ft)	613.9
Initial §257.82 Starting Water Surface Elevation (SWSE) (ft)	616.0
Total Change in CCR Volume* (CY)	+ 8,000 (Fill)
Change in CCR Volume Above SWSE* (CY)	- 9,000 (Cut)
Change in CCR Volume Below SWSE* (CY)	+ 17,000 (Fill)

*All volumes rounded to the nearest 1,000 CY

The comparison indicated that approximately 8,000 CY of CCR was placed in the GMF Pond between the initial and periodic surveys. The CCR was placed entirely below the SWSE and a net cut occurred above the SWSE. CCR grades above the SWSE were generally similar to the initial survey (e.g., within +/- 2 ft). These changes are considered unlikely to result in increase in the peak water surface elevation (PWSE) during a flood event, as additional flood storage is present relative to conditions observed in 2015. No significant changes to embankment geometry appeared to have occurred between the initial and periodic surveys.

2.5 Comparison of Initial to Periodic Aerial Photography

Initial aerial photographs of the GMF Pond collected by Weaver in 2015 [14] were compared to periodic aerial photographs collected by IngenAE in 2020 [15] to visually evaluate if potential site changes (i.e., changes to the embankment, outlet structures, limits of CCR, other appurtenances)

may have occurred. A comparison of these aerial photographs is provided in **Drawing 3**. No significant changes were noted during this comparison.

2.6 Comparison of Initial to Periodic Site Visits

An initial site visit to the GMF Pond was conducted by AECOM in 2015 and documented with a Site Visit Summary and corresponding photographs [16]. A periodic site visit was conducted by Geosyntec on May 27, 2021, with Mr. Lucas P. Carr, P.E. conducting the site visit. The site visit was intended to evaluate potential changes at the site since the initial certifications were prepared (i.e., modification to the embankment, outlet structures or other appurtenances, limits of CCR, maintenance programs, repairs), in addition to performing visual observations of the GMF Pond to evaluate if the structural stability requirements (§257.73(d)) were still met. The stie visit included walking the perimeter of the GMF Pond, visually observing conditions, recording field notes, and collecting photographs. The site visit is documented in a photographic log provided in **Appendix A**. A summary of significant findings from the periodic site visit is provided below:

- Overall site maintenance appears to be similar to conditions observed in 2015.
- No signs or structural stability, erosion, or required maintenance items were observed during the stie visit.

2.7 Interview with Power Plant Staff

An interview with Mr. Daryl Johnson and Mr. Brandon Potter of the DCPP was conducted by Lucas P. Carr, P.E. of Geosyntec on May 27, 2021. Mr. Johnson, at the time of the interview, had been employed at the DCPP for 8 years and was responsible for environmental compliance and completed weekly CCR inspections on some years, including for the GMF Pond, in addition to managing vegetation maintenance. Mr. Potter, at the time of the interview, had been employed at DCPP for 10 years and assisted in the inspection and operation of the GMF Pond. The interview included a discussion of included a discussion of potential changes that that may have occurred at the GMF Pond since development of the initial certifications ([2], [7], [3], [4], [5], [6], [8]).

- Were any construction projects completed for the GMF Pond since 2015, and, if so, are design drawings and/or details available?
    - No.
- Were there any changes to the purpose of the GMF Pond since 2015?
    - The DCPP was closed in December of 2019. Sluicing into the GMF Pond and pumping of water from the GMF Recycle Pond was stopped at this time.
- Were there any changes to the to the instrumentation program and/or physical instruments for the GMF Pond since 2015?

- The GMF Pond does not have instrumentation, so no changes occurred.

- Have area-capacity curves for the GMF Pond been prepared since 2015?
  - No known area-capacity curves have been developed.
- Were there any changes to spillways and/or diversion features for the GMF Pond completed since 2015?
  - No.
- Were there any changes to construction specifications, surveillance, maintenance, and repair procedures for the GMF Pond since 2015?
  - No.
- Were there any instances of dike and/or structural instability for the GMF Pond since 2015?
  - No known instances occurred.

SECTION 3

HAZARD POTENTIAL CLASSIFICATION - §257.73(a)(2)

3.1 Overview of Initial HPC

The Initial Hazard Potential Classification (Initial HPC) was prepared by Stantec Consulting Services, Inc. (Stantec) in 2016 ([2], [7]), following the requirements of §257.73(a)(2). The Initial HPC included the following information:

- Visual analysis to evaluate potential hazards associated with a failure of the GMF Pond perimeter dike, along the north, south, east, and west embankments of the GMF Pond.
- Evaluation of potential breach flow paths using elevation data and aerial imagery to assess potential impacts to downstream structures, infrastructure, and waterways.
- While a breach map is not included within the Initial HPC, it included within the §257.73(a)(3) Initial Emergency Action Plan (Initial EmAP) [17].

The visual analysis indicated that only structures owned by DCPP were within the potential breach path, and that public impacts were limited to portions of North Bethel Cemetery Road and the railroad leading to the Power Plant. The reported noted that North Bethel Cemetery Road is intermittently used, and the at-risk population was considered transient. The Initial HPC concluded that breach of the GMF pond would be unlikely to result in a probable loss of human life, although the breach could cause CCR to be released into downstream waterways, thereby causing environmental damage. The Initial HPC therefore recommended a “Significant” hazard potential classification for the GMF Pond [2].

3.2 Review of Initial HPC

Geosyntec performed a review of the Initial HPC ([2], [7]), in terms of technical approach, assessment of the results, and applicable requirements of the CCR Rule [1]. No significant technical issues were noted within the technical review, although a detailed review (e.g., check) of the calculations was not performed as the initial HPC utilized a visual assessment.

3.3 Summary of Site Changes Affecting the Initial HPC

Geosyntec did not identify any changes at the site that may affect the HPC. No new structures, infrastructure, frequently occupied facilities/areas, or waterways were observed to be present in the probable breach area indicated in the Initial EmAP [17]. Additionally, no significant changes to the topography in the probable breach were identified.

3.4 Periodic HPC

Geosyntec recommends retaining the "Significant" hazard potential classification for the GMF Pond, per §257.73(A)(2), based on the lack of site changes potentially affecting the Initial HPC occurring since the initial HPC was developed, as described in **Section 3.3**, and the lack of significant review comments, as described in **Section 3.2**. Updates to the Initial HPC reports ([2], [7]) are not recommended at this time.

SECTION 4

HISTORY OF CONSTRUCTION REPORT - §257.73(c)

4.1 Overview of Initial HoC

The Initial History of Construction report (Initial HoC) was prepared by AECOM in 2016 [3] following the requirements of §257.73(c) and included information on all non-incised CCR surface impoundments at DCPP, including the GMF Pond, Ash Pond No. 1, and Ash Pond No. 2. This report only discusses the HoC as it pertains to the GMF Pond. The Initial HoC included the following information for the GMF Pond:

- The name and address of the owner/operator,
- Location maps,
- Statements of purpose,
- The names and size of the surrounding watershed,
- A description of the foundation and abutment materials,
- A description of the dike materials,
- Approximate dates and stages of construction,
- Available design and engineering drawings,
- A summary of instrumentation,
- Area-capacity curves for the GMF Pond,
- Information on spillway structures,
- Construction specifications,
- Inspection and surveillance plans,
- A statement that operations and maintenance plans are being generated or revised, and that the report will be updated when the new plans are available,
- A statement that no known historical structural instability has occurred at the CCR surface impoundments.

4.2 Summary of Site Affecting the Initial HoC

One significant change at the site that occurred after development of the initial HoC report [3] was identified and is described below:

- Electricity generation at the DCPP ceased in December of 2019 and the pumping of inflow and outflow into and from the GMF Recycle Pond ceased at this time.
    - An update to the HoC report was performed to state that the DCPP is no longer active and the GMF Pond is no lower receiving inflows and outflow is no longer pumped back to the DCPP. A letter documenting changes to the HoC report is provided in **Attachment C**.

SECTION 5

STRUCTURAL STABILITY ASSESSMENT - §257.73(d)

5.1 Overview of Initial SSA

The Initial Structural Stability Assessment (Initial SSA) was prepared by AECOM in 2016 ([4], [8]), following the requirements of §257.73(d)(1), and included the following evaluations:

- Stability of dike foundations, dike abutments, slope protection, dike compaction, and slope vegetation,
- Spillway stability including capacity, structural stability and integrity; and
- Downstream slope stability under sudden drawdown conditions for a downstream water body.

The Initial SSA ([4], [8]) concluded that the GMF Pond met all structural stability requirements for §257.73(d)(1)(i)-(vii). This included noting that the structural integrity of hydraulic structures (§257.73(d)(1)(vi)) was not applicable, due to no hydraulic structures penetrating or underlying the base of the GMF Pond. Additionally, it was noted that the stability of downstream slopes inundated by water bodies (§257.73(d)(1)(vii) was also not applicable, due to inundation of the downstream slopes not being expected.

5.2 Review of Initial SSA and Updated Periodic SSA

Geosyntec performed a review of the Initial SSA ([4], [8]) in terms of technical approach, calculation input parameters and methodology, recommendations, and completeness. The review included the following tasks:

- Reviewing photographs collected in 2015 and used to demonstrate compliance with §257.73(d)(1)(i)-(vii).
- Reviewing geotechnical calculations used to demonstrate the stability of foundations, per §257.73(d)(1)(i) and sufficiency of dike compaction, per §257.73(d)(1)(iii), in terms of supporting geotechnical investigation and testing data, input parameters, analysis methodology, selection of critical cross-sections, and loading conditions.
- Review of the methodology used to demonstrate that a downstream water body that could induce a sudden drawdown condition, per §257.73(d)(1)(vii), is not present.

One review comment and corresponding recommended technical update was identified during review of the geotechnical analyses supporting the sufficiency of dike compaction

(§257.73(d)(1)(i)) and foundation and abutment stability (§257.73(d)(1)(iii) portions of the Initial SSA. These analyses were performed for the Initial Safety Factor Assessment (SFA) but also utilized to support the initial SSA. The review comment and subsequent updates the Initial SFA, are discussed in **Section 6.**

5.3 Summary of Site Changes Affecting the Initial SSA

No changes since development of the Initial SSA were identified that would require updates to the Initial SSA ([4], [8]).

5.4 Periodic SSA

The updated Periodic SFA (**Section 7**) indicates that foundations and abutments are stable and dike compaction is sufficient for expected ranges in loading conditions, as slope stability factors of safety for slip surfaces passing through the dike and foundation were found to meet or exceed the requirements of §257.73(e)(1), including for static maximum storage pool conditions and post-earthquake (i.e., liquefaction) loading conditions considering seismically-induced strength loss in the foundation soils. Therefore, the requirements of §257.73(d)(1)(i) and §257.73(d)(1)(iii) are met for the Periodic SSA.

SECTION 6

SAFETY FACTOR ASSESSMENT - §257.73(e)(1)

6.1 Overview of Initial SFA

The Initial Safety Factor Assessment (Initial SFA) was prepared by AECOM in 2016 ([5], [8]) following the requirements of §257.73(e)(1). The Initial SFA included the following information:

- A geotechnical investigation program with in-situ and laboratory testing;
- An assessment of the potential for liquefaction in the dike and foundation soils;
- The development of a single slope stability cross-sections for limit equilibrium stability analysis utilizing GeoStudio SLOPE/W software; and
- The analysis of the cross-section for maximum storage pool, maximum surcharge pool, and seismic loading conditions.
    - Liquefaction loading conditions were not evaluated as liquefaction-susceptible soil layers were not identified in either the embankments or foundation soils.

The Initial SFA concluded that the GMF Pond met all safety factor requirements, per §257.73(e), as all calculated safety factors were equal to or higher than the minimum required values.

6.2 Review of Initial SFA

Geosyntec performed a review of the Initial SFA ([5], [8]) in terms of technical approach, calculation input parameters and methodology, recommendations, and completeness. The review included the following tasks:

- Reviewing geotechnical calculations used to demonstrate the acceptable safety factors, per §257.73(e)(1), in terms of:
    - Completeness and adequacy of supporting geotechnical investigation and testing data;
    - Completeness and approach of liquefaction triggering assessments; and
    - Input parameters, analysis methodology, selection of critical cross-sections, and loading conditions utilized for slope stability analyses.
    - Phreatic conditions based on piezometric data collected between March 2, 2015 June 21, 2021, as discussed in **Section 2.3**.

One review comment was identified during review of the Initial SFA. The comment and the is described below:

- The Initial SFA utilized a single cross-section (A-A') along the eastern embankment where the exterior slope is approximately 8 ft tall. However, the maximum height of the exterior slope is approximately 11 ft at the southwest corner of the embankment.

6.3 Summary of Site Changes Affecting the Initial SFA

No changes since development of the Initial SFA were identified that would require updates to the Initial SFA ([5], [8]).

6.4 Periodic SFA

Following review of the Initial SFA ([5], [8]), Geosyntec developed a new slope stability analysis cross-section (B-B') at the southwest corner of the GMF Pond embankment to account for the maximum embankment height of 11 ft. The model was developed utilizing the following approach and input data:

- Ground surface geometry was obtained from the 2020 survey of the GMF Pond [15].

- Subsurface stratigraphy was obtained from 2007 borings B-53 and B-67, as provided in the Initial SFA report [8]. Geosyntec reviewed the boring data and determined that subsurface conditions were similar to conditions at cross-section A-A'. Therefore, the soil properties (i.e., strength, unit weight) from the Initial SFA ([5], [8]) were utilized for cross-section B-B',

- Piezometric levels in the foundation soils were assumed to follow the ground surface past the embankment toe, per providing readings from monitoring wells G51S and G54C; and,

- All other analysis settings and input data from the Initial SFA ([5], [8]) was utilized, including, but not limited to, software package and version, slip surface search routines and methods, and pseudostatic seismic coefficients.

Factors of safety form the Periodic SFA (cross-section B-B') and Initial SFA (cross-section A-A') are summarized in **Table 3** and confirm that the GMF Pond meets the requirements of §257.73(e)(1). A location of the cross-section B-B' in plan and analysis output data for cross-section B-B' is provided in **Attachment D**.

Table 3 – Factors of Safety from Periodic SFA

	Structural Stability Assessment (§257.73(d)) and Safety Factor Assessment (§257.73(e))				Structural Stability Assessment (§257.73(d))
Cross-Section	**Maximum Storage Pool §257.73(e)(1)(i) Minimum Required = 1.50**	**Maximum Surcharge Pool §257.73(e)(1)(ii) Minimum Required = 1.40**	**Seismic §257.73(e)(1)(iii) Minimum Required = 1.00**	**Dike Liquefaction §257.73(e)(1)(iv) Minimum Required = 1.20**	**Foundation Liquefaction §257.73(d)(1)(i) Minimum Required = 1.20**
A-A'	4.27	4.26	2.37	N/A	N/A
B-B'	3.47*	3.47*	1.88*	N/A	N/A

Notes:
[1]Denotes cross-section where results from the Initial SFA are presented due to no observed changes relative to the Initial IDF.
[2]Denotes cross-section where changes are occurred, and results are presented from the updated Periodic SFA.
*Indicates critical cross-section (i.e., lowest calculated factor of safety out of the two cross-sections analyzed)
N/A – Loading condition is not applicable.

SECTION 7

INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN - §257.82

7.1 Overview of Initial IDF

The Initial Inflow Design Flood Control System Plan (Initial IDF) was prepared by AECOM in 2016 ([6], [8]) following the requirements of §257.82. The Initial IDF included the following information:

- A hydraulic and hydrologic analysis, performed for the 1,000-year design flood event because of the hazard potential classification of "significant", which corresponded to 9.37 inches of rainfall over a 24-hour period.
- The Initial IDF utilized a HydroCAD Version 8.5 model to evaluate spillway flows and pool level increases during the design flood, with a SWSE of 616.0 ft.

The Initial IDF ([6], [8]) concluded that the GMF Pond met the requirements of §257.82, as the peak water surface estimated by the HydroCAD model was El. 618.3 ft, relative to a minimum GMF Pond dike crest elevation of 620.0 ft. Therefore, overtopping was not expected. The Initial IDF also evaluated the potential for discharge from the CCR unit and determined that discharge into Waters of the United States and no overtopping was expected during the 1,000-year design flood.

7.2 Review of Initial IDF

Geosyntec performed a review of the Initial IDF ([6], [8]) in terms of technical approach, calculation input parameters and methodology, recommendations, and completeness. The review included the following tasks:

- Reviewing the return interval used vs. the hazard potential classification.
- Reviewing the rainfall depth and distribution for appropriateness.
- Performing a high-level review of the inputs to the hydrological modeling.
- Reviewing the hydrologic model parameters for spillway parameters, starting pool elevation, and storage vs. the reference data.
- Reviewing the overall Initial IDF vs. the applicable requirements of the CCR Rule [1].

No significant technical issues were noted within the technical review, although a detailed review (e.g., check) of the calculations was not performed.

7.3 Summary of Site Changes Affecting the Initial IDF

No changes since development of the Initial IDF were identified that would require updates to the Initial IDF ([6], [8]).

SECTION 8

CONCLUSIONS

The GMF Pond at DCPP was evaluated relative to the USEPA CCR Rule periodic assessment requirements for:

- Hazard potential classification (§257.73(a)(2)),
- History of Construction reporting (§257.73(d)),
- Structural stability assessment (§257.73(d)),
- Safety factor assessment (§257.73(e)), and
- Inflow design flood control system planning (§257.82).

Based on the evaluations presented herein, the referenced requirements are satisfied.

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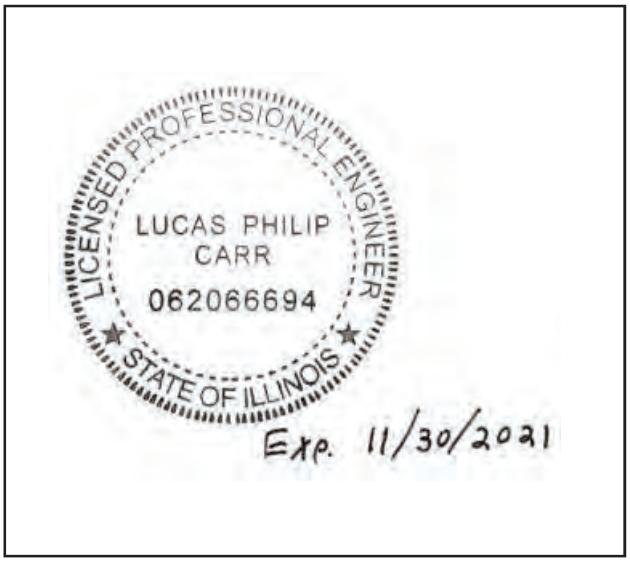
SECTION 9

CERTIFICATION STATEMENT

CCR Unit: Illinois Power Resources Generation, LLC; Duck Creek Power Plant, GMF Pond

I, Lucas P. Carr, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this 2021 USEPA CCR Rule Periodic Certification Report, has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the periodic assessment of the hazard potential classification, history of construction report, structural stability, emergency action plan, safety factors, and inflow design flood control system planning, dated October 2021, were conducted in accordance with the requirements of 40 CFR §257.73(a)(2), (c), (d), (e), and §257.82.



Lucas P. Carr

10/11/2021

Date

SECTION 10

REFERENCES

[1] United States Environmental Protection Agency, 40 CFR Parts 257 and 261; Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 2015.

[2] Stantec Consulting Services Inc., "Initial Hazard Potential Classification Assessment, EPA Final CCR Rule, GMF Pond, Duck Creek Power Station, Fulton County, Illinois," Fenton, MO, October 12, 2016.

[3] AECOM, "History of Construction, USEPA Final CFR Rule, 40 CFR §257.73(c), Duck Creek Power Station, Canton, Illinois," October 2016.

[4] AECOM, "CCR Rule Report: Initial Structural Stability Assessment for GMF Pond at Duck Creek Power Station," October 2016.

[5] AECOM, "CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station," St. Louis, MO, October 2016.

[6] AECOM, "CCR Rule Report: Initial Inflow Design Flood Control System Plan for GMF Pond at Duck Creek Power Station," October 2016.

[7] Stantec Consulting Services Inc., "Documentation of Initial Hazard Potential Classification Assessment, GMF Pond, Duck Creek Power Station, Fulton County, Illinois," October 12, 2016.

[8] AECOM, "CCR Certification Report: Initial Structural Stability Assessment, Initial Safety Factor Assessment, and Initial Inflow Design Flood Control System Plan for GMF Pond at Duck Creek Power Station," October 2016.

[9] J. Knutelski and J. Campbell, "Annual CCR Surface Impoundment Inspection Report (per 40 CFR 257.83(b)(2)), Duck Creek Power Station, GMF Pond," January 18, 2017.

[10] J. Knutelski and J. Campbell, "Annual CCR Surface Impoundment Inspection Report (per 40 CFR 257.83(b)(2)), Duck Creek Power Station, GMF Pond," February 7, 2018.

[11] J. Knutelski, "Annual Inspection by a Qualified Professional Engineer, 40 CFR §2357.83(b), Duck Creek Power Station, GMF Pond," January 10, 2019.

[12] J. Knutelski, "Annual Inspection by a Qualified Professional Engineer, 40 CFR §257.83(b), Duck Creek Power Station, GMF Pond," January 8, 2020.

[13] J. Knutelski, "Annual Inspection by a Qualified Professional Engineer, 40 CFR §257.83(b), Duck Creek Power Station, GMF Pond," January 6, 2021.

[14] Weaver Consultants Group, "Dynegy, Collinsville, Illinois, 2015 - Duck Creek Existing Topography," December 1, 2015.

[15] IngenAE, "Luminant, Illinois Power Resrouces Generating, LLC, Duck Creek Power Station, December 2020 Topography," February 9, 2021.

[16] AECOM, "Initial Site Visit CCR Unit Summary, Dynegy CCR Compliance Program - Duck Creek, Duck Creek GMF Primary Pond," June 23, 2015.

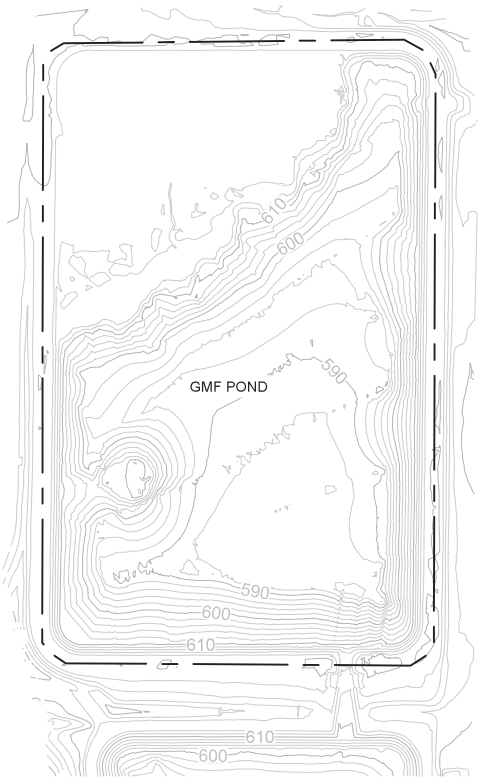
[17] Stantec Consulting Services Inc., "Duck Creek Power Station, Emergency Action Plan (EAP)," April 13, 2017.

Electronic Filing: Received, Clerk's Office 06/20/2024

DRAWINGS

Electronic Filing: Received, Clerk's Office 06/20/2024





INITIAL SURVEY
12-01-2015 TOPOGRAPHY



PERIODIC SURVEY
02-09-2021 TOPOGRAPHY



NOTES:

1. THE INITIAL SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "DYNEGY, COLLINSVILLE, ILLINOIS, 2015 - DUCK CREEK EXISTING TOPOGRAPHY", PREPARED BY WEAVER CONSULTANTS GROUP, DATED DECEMBER 1, 2015.
2. THE PERIODIC SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "LUMINANT, ILLINOIS POWER RESOURCES GENERATING, LLC, DUCK CREEK POWER STATION, DECEMBER 2020 TOPOGRAPHY", PREPARED BY INGENAE, DATED FEBRUARY 9, 2021.
3. ALL SURVEY DATA WAS COLLECTED IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) AND NORTH AMERICAN DATUM OF 1983 (NAD83) FOR VERTICAL AND HORIZONTAL COORDINATES, RESPECTIVELY.

INITIAL TO PERIODIC SURVEY COMPARISON
GMF POND
DUCK CREEK POWER STATION
CANTON, ILLINOIS

Geosyntec consultants

DRAWING 1

GLP8027.03 | MAY 2021

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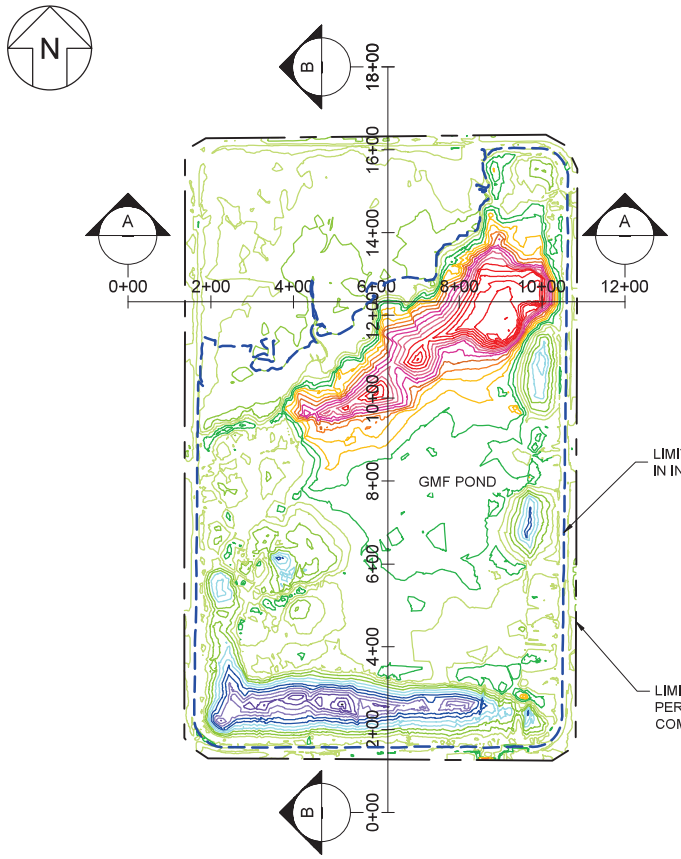

ISOPACH CONTOUR KEY		
COLOR	MIN ELEV	MAX ELEV
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	-10	-8
	-8	-6
	-6	-4
	-4	-2
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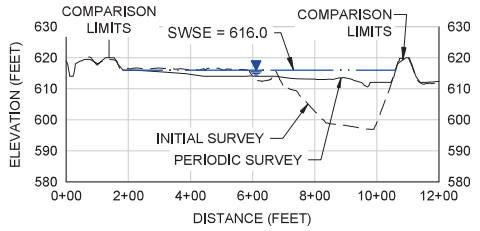
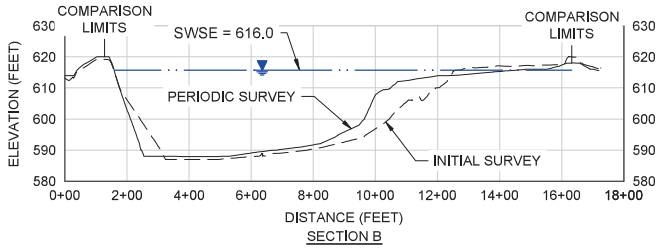
	6	8
	8	10
	10	17



SECTION A



SECTION B





INITIAL TO PERIODIC SURVEY COMPARISON SUMMARY			
SURFACE IMPOUNDMENT	CUT*	FILL*	NET (CU. YD.)*
GMF POND	54,000	62,000	8,000 (FILL)
ABOVE SWSE	10,000	1,000	9,000 (CUT)
BELOW SWSE	44,000	61,000	17,000 (FILL)

* ALL VOLUMES ROUNDED TO THE NEAREST 1,000 CY

NOTES:

1. THE INITIAL SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "DYNEGY, COLLINSVILLE, ILLINOIS, 2015 - DUCK CREEK EXISTING TOPOGRAPHY", PREPARED BY WEAVER CONSULTANTS GROUP, DATED DECEMBER 1, 2015.
2. THE PERIODIC SURVEY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "LUMINANT, ILLINOIS POWER RESOURCES GENERATING, LLC, DUCK CREEK POWER STATION, DECEMBER 2020 TOPOGRAPHY", PREPARED BY INGENAE, DATED FEBRUARY 9, 2021.
3. ALL SURVEY DATA WAS COLLECTED IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) AND NORTH AMERICAN DATUM OF 1983 (NAD83) FOR VERTICAL AND HORIZONTAL COORDINATES, RESPECTIVELY.
4. THE STARTING WATER SURFACE ELEVATION (SWSE) OF THE GMF POND IS EL. 616.0 FT, AS NOTED IN THE REPORT TITLED "CCR CERTIFICATION REPORT: INITIAL STRUCTURAL STABILITY ASSESSMENT, INITIAL SAFETY FACTOR ASSESSMENT, AND INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN FOR GMF POND AT DUCK CREEK POWER STATION", PREPARED BY AECOM, DATED OCTOBER, 2016.



GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

Geosyntec consultants

DRAWING 2

GLP8027.03 | AUGUST 2021

P:\CADD\PROJECTS\VISTRA PONDS\DUCK CREEK\FIGURES\ISOPACH-1 - Last Saved by: KHanavec on 8/3/21

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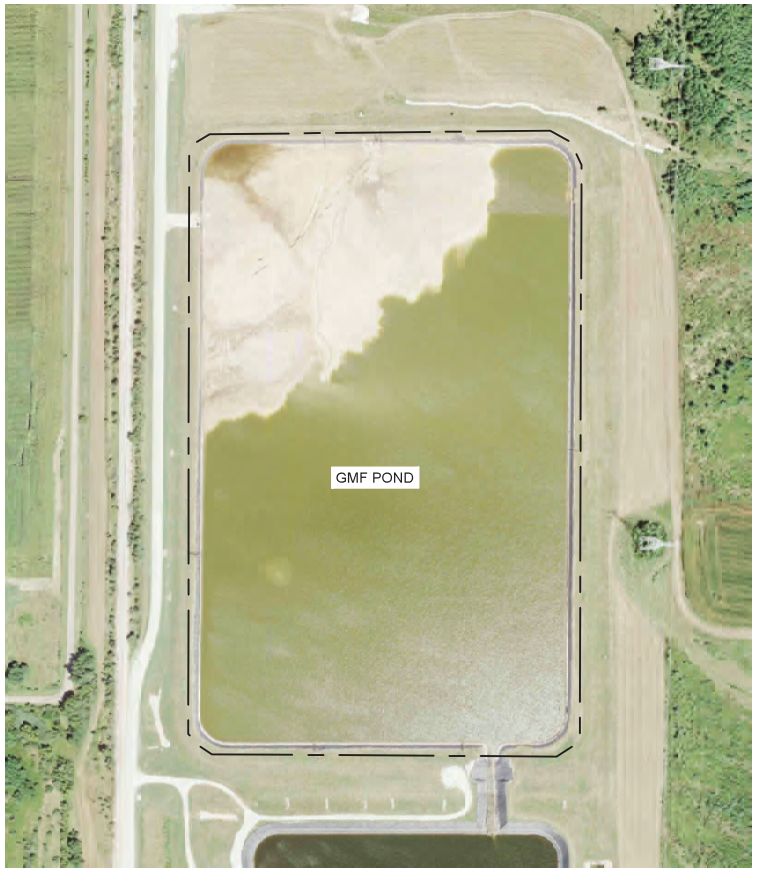

INITIAL AERIAL
12-01-2015 IMAGERY



PERIODIC AERIAL
02-09-2021 IMAGERY

0 300
SCALE IN FEET

NOTES:

1. THE INITIAL IMAGERY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "DYNEGY, COLLINSVILLE, ILLINOIS, 2015 - DUCK CREEK EXISTING TOPOGRAPHY", PREPARED BY WEAVER CONSULTANTS GROUP, DATED DECEMBER 1, 2015.
2. THE PERIODIC IMAGERY WAS TAKEN FROM THE DRAWING PACKAGE TITLED "LUMINANT, ILLINOIS POWER RESOURCES GENERATING, LLC, DUCK CREEK POWER STATION, DECEMBER 2020 TOPOGRAPHY", PREPARED BY INGENAE, DATED FEBRUARY 9, 2021.

INITIAL TO PERIODIC AERIAL IMAGERY
COMPARISON
GMF POND
DUCK CREEK POWER STATION
CANTON, ILLINOIS

Geosyntec consultants

DRAWING
3

GLP8027.03 | MAY 2021

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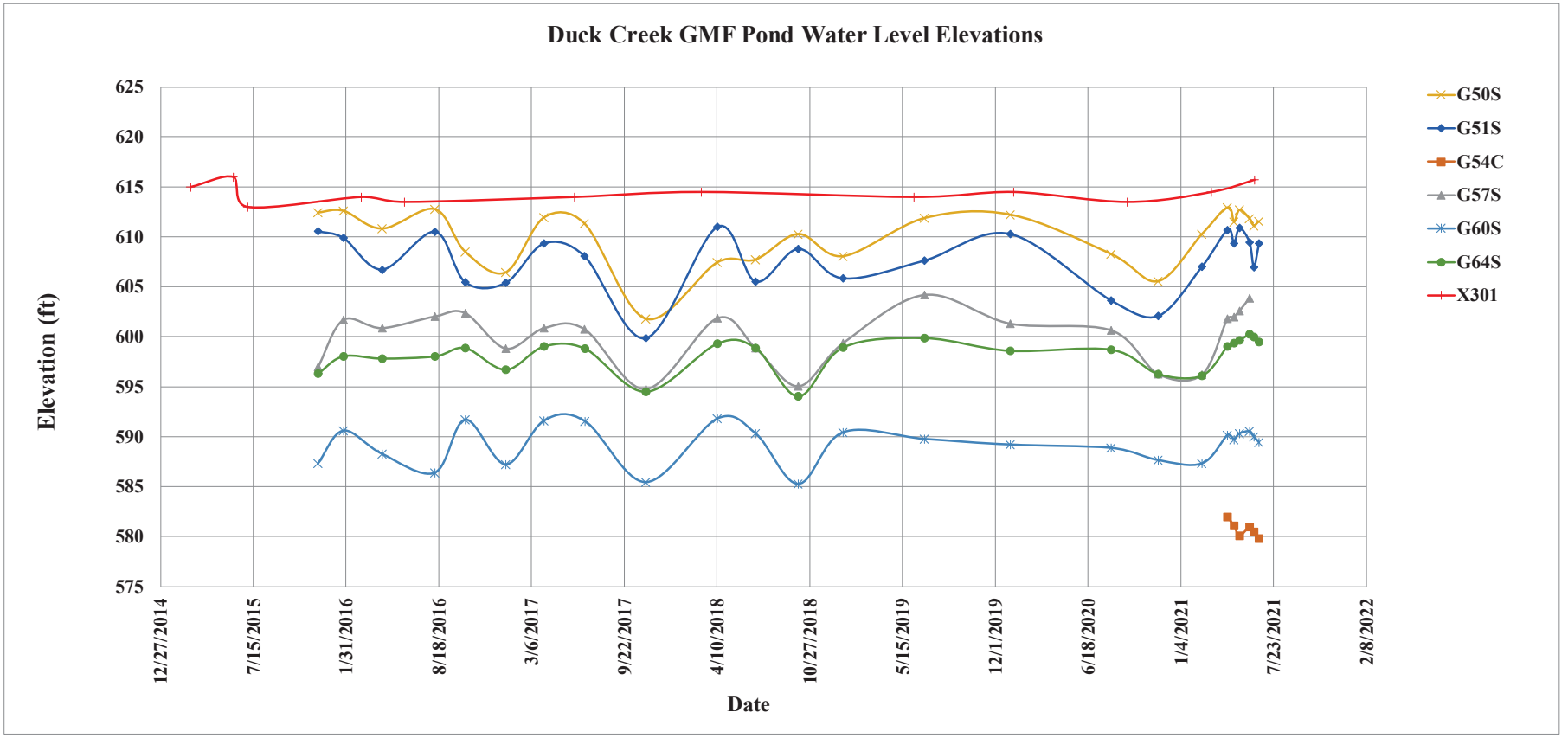
ATTACHMENTS

Electronic Filing: Received, Clerk's Office 06/20/2024

Attachment A

GMF Pond Piezometer Data Plots

Electronic Filing: Received, Clerk's Office 06/20/2024



NOTES:
1. Piezometeric data was taken from the spreadsheet titled "DC_GW_Elev_Export_Vistra_20210722", provided by the Duck Creek Power Plant.

PIEZOMETER DATA PERIODIC CERTIFICATION DUCK CREEK POWER PLANT- GMF POND FULTON, ILLINOIS		
Geosyntec consultants		Figure 1
GLP8027	7/23/2021	

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Attachment B

GMF Pond Site Visit Photolog

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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating | **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) | **Site:** Duck Creek Power Plant

Photo: 01 **Date:** 05/27/2021 **Direction Facing:** SE **Comments:** GMFP north overview	
Photo: 02 **Date:** 05/27/2021 **Direction Facing:** S **Comments:** GMFP north overview	

Electronic Filing: Received, Clerk's Office 06/20/2024

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating | **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) | **Site:** Duck Creek Power Plant

Photo: 03

Date: 05/27/2021

Direction Facing: E

Comments: GMFP north interior slope and crest.



Photo: 04

Date: 05/27/2021

Direction Facing: E

Comments: GMFP north exterior slope and crest.



Electronic Filing: Received, Clerk's Office 06/20/2024

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating | **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) | **Site:** Duck Creek Power Plant

Photo: 05

Date: 05/27/2021

Direction Facing: S

Comments: GMFP east exterior slope and crest.



Photo: 06

Date: 05/27/2021

Direction Facing: N

Comments: GMFP east exterior slope and crest.



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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating | **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) | **Site:** Duck Creek Power Plant

Photo: 07

Date: 05/27/2021

Direction Facing: S

Comments: GMFP east interior slope and crest.



Photo: 08

Date: 05/27/2021

Direction Facing: S

Comments: GMFP east slope crest.



Electronic Filing: Received, Clerk's Office 06/20/2024

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating | **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) | **Site:** Duck Creek Power Plant

Photo: 09

Date: 05/27/2021

Direction Facing: W

Comments: GMFP south crest and transfer channel.



Photo: 10

Date: 05/27/2021

Direction Facing: W

Comments: GMFP transfer channel and weir. All stoplogs were installed.



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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating	**Project Number:** GLP8027
CCR Unit: GMF Pond (GMFP)	**Site:** Duck Creek Power Plant

Photo: 11 **Date:** 05/27/2021 **Direction Facing:** W **Comments:** GMFP south dike interior slope.	
Photo: 12 **Date:** 05/27/2021 **Direction Facing:** NW **Comments:** GMFP southwest corner overview.	

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GEOSYNTEC CONSULTANTS Photographic Record	
Site Owner: Illinois Power Resources Generating	**Project Number:** GLP8027
CCR Unit: GMF Pond (GMFP)	**Site:** Duck Creek Power Plant

Photo: 13 **Date:** 05/27/2021 **Direction Facing:** W **Comments:** GMFP southwest corner exterior dike overview.	
Photo: 14 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GMFP west dike overview.	

Electronic Filing: Received, Clerk's Office 06/20/2024

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating | **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) | **Site:** Duck Creek Power Plant

Photo: 15

Date: 05/27/2021

Direction Facing: N

Comments: GMFP west interior dike overview.



Photo: 16

Date: 05/27/2021

Direction Facing: N

Comments: GMFP west exterior dike overview.



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GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating | **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) | **Site:** Duck Creek Power Plant

Photo: 17 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GFMP west interior dike overview.	
Photo: 18 **Date:** 05/27/2021 **Direction Facing:** N **Comments:** GMFP west exterior dike overview.	

Electronic Filing: Received, Clerk's Office 06/20/2024

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Site Owner: Illinois Power Resources Generating **Project Number:** GLP8027

CCR Unit: GMF Pond (GMFP) **Site:** Duck Creek Power Plant

Photo: 19 **Date:** 05/27/2021 **Direction Facing:** E **Comments:** GMFP northwest corner overview.	

Photo: 20 **Date:** 05/27/2021 **Direction Facing:** S **Comments:** GMFP west dike overview.	

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Attachment C

Periodic History of Construction Report Update Letter

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Geosyntec consultants

1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
PH 636-812-0800
www.geosyntec.com

October 11, 2021

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, Illinois 61520

Subject: Periodic History of Construction Report Update Letter
USEPA Final CCR Rule, 40 CFR §257.73(c)
Duck Creek Power Plant
Canton, Illinois

At the request of Illinois Power Resources Generating, LLC (IPRG), Geosyntec Consultants (Geosyntec) has prepared this Letter to documents updates to the Initial History of Construction (HoC) report for the Duck Creek Power Plant (DCPP), also known as the Duck Creek Power Station (DUC). The Initial HoC report was prepared by AECOM in October of 2016 [1] in accordance with 40 Code of Federal Regulations (CFR) §257.73(c) of the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals Rule, known as the CCR Rule [2]. This letter also includes information required by Section 845.220(a)(1)(B) (Design and Construction Plans) of the state-specific Illinois Environmental Protection Agency (IEPA) Part 845 CCR Rule [3] that is not expressly required by §257.73(c).

BACKGROUND

The CCR Rule required that, by October 17, 2016, Initial HoC reports to be compiled for existing CCR surface impoundments with: (1) a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) a height of 20 feet or more. The Initial HoC report was required to contain, to the extent feasible, the information specified in 40 CFR §257.73(c)(1)(i)-(xii). The Initial HoC report for DCPP, which included three existing CCR surface impoundments, the GMF Pond (GMFP), Ash Pond No. 1 (AP1), and Ash Pond No. 2 (AP2), was prepared and subsequently posted to IPRG's CCR Website prior to October 17, 2016.

The CCR Rule requires that Initial HoC to be updated if there is a significant change to any information complied in the Initial HoC report, as listed below:

§ 257.73(c)(2): If there is a significant change to any information complied under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(9).

IPRG retained Geosyntec to review the Initial HoC report, review reasonably and readily available information for the GMFP, AP1, and AP2 generated since the Initial HoC report was prepared, and perform a site visit to DCPP to evaluate if significant changes may have occurred since the Initial HoC report was prepared.

This Letter contains the results of Geosyntec's evaluation and documents significant changes that have occurred at the GMFP, AP1, and AP2 at DCPP, as they pertain the requirements of §257.73(c)(1)(i)-(xii)

UPDATES TO HISTORY OF CONSTRUCTION REPORT

Geosyntec's evaluation for the DCPP GMFP, AP1, and AP2 determined that no known significant changes requiring updates to the information in the Initial HoC report pertaining to §257.73(c)(1)(i)-(ii), §257.73(c)(1)(iv)-(vii), §257.73(c)(1)(ix), and §257.73(c)(1)(xi)-(xii) of the CCR Rule had occurred since the Initial HoC report was developed.

However, Geosyntec's evaluation determined that significant changes at the DCPP GMFP, AP1, and AP2 pertaining to §257.73(c)(1)(iii), §257.73(c)(1)(viii), §257.73(c)(1)(x) of the CCR Rule had occurred since the Initial HoC report had been developed. Additionally, information how long the CCR surface impoundments have been operating and the types of CCR in the surface impoundments, as required by Section 845.220(a)(1)(B) of the Part 845 Rule were not included in the Initial HoC report, as this information is not required by the CCR Rule. Each change and the subsequent updates to the Initial HoC report is described within this section.

Section 845.220(a)(1)(B): A statement of ... how long the CCR surface impoundment has been in operation, and the types of CCR that have been placed in the surface impoundment.

GMF Pond

GMFP is in operation since 2009. As of the date of this report, the GMFP has been present for approximately 12 years.

CCR placed in the GMFP is being used to store and dispose of gypsum and to clarify recycled process water for plant operations [4].

Ash Pond No. 1

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AP1 was in operation from 1976 until November 2015, for a total of approximately 39 years.

CCR placed in AP1 was used to store and dispose of fly ash and bottom ash [4].

Ash Pond No. 2

AP2 was in operation from 1986 until November 2015, for a total of approximately 35 years.

CCR placed in AP2 was used to store and dispose of fly ash and bottom ash and to clarify CCR contact stormwater prior to discharge.

§257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

The state identification numbers (ID) for the GMFP, AP1 and AP2 have been assigned by the Illinois Environmental Protection Agency (IEPA). The IDs are listed in **Table 1**.

Table 1 – IEPA ID Numbers

CCR Surface Impoundment		State ID
Ash Pond No. 1		W0578010001-01
Ash Pond No. 2		W0578010001-02
GMF Pond		W0578010001-04

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

AP1 and AP2 were closed in 2021, in substantial compliance with the written closure plans posted to IPRG's CCR Website ([5], [6]), and as documented by a certified Notification of Completion of Closure posted to IPRG's CCR Website [7]. Therefore, AP1 and AP2 are no longer capable of storing CCR or free liquids.

The DCPP was retired in December of 2019, with the generation of electricity ceased at that time. Therefore, the GMFP is no longer being used to storge and disposed of gypsum or to clarify recycled process water for use in plant operations, as gypsum is no longer being generated and process water is no longer required by the DCPP.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Instrumentation monitoring at AP1 and AP2 is no longer required as both CCR surface impoundments were closed in accordance with §257.102 [7], and the instrumentation

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network was modified at that time. Therefore, the instrumentation locations shown in Appendix C of the Initial HoC report are no longer applicable to AP1 and AP2.

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

AP1 and AP2 no longer retain free water as both CCR surface impoundments were closed in 2021 [7]. Therefore, spillways are no longer present the information regarding the spillways of these structures, as presented in the Initial HoC report, is no longer applicable to AP1 and AP2.

CLOSING

This letter has been prepared to document Geosyntec's evaluation of changes that have occurred at the GMFP, AP1, and AP2 at the DCPP since the Initial HoC was developed, based on reasonably and readily available information provided by IPRG, observed by Geosyntec during the site visit, or generated by Geosyntec as part of subsequent calculations.

Sincerely,

Lucas P. Carr, P.E.
Senior Engineer

John Seymour, P.E.
Senior Principal

engineers | scientists | innovators

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REFERENCES

[1] AECOM, "History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Duck Creek Power Station, Canton, Illinois," October 2016.

[2] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[3] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[4] AECOM, "History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Hennepin Power Station, Hennepin, Illinois," October 2016.

[5] V. Modeer, "Closure Plan for Existing CCR Sruface Impoundment, 40 CFR 257.102(b), Duck Creek Power Station, Illinois Power Resoruces Generation, LLC, Ash Pond No. 1," December 17, 2020.

[6] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Duck Creek Power Station, Illinois Power Resoruces Generating, LLC, Ash Pond No. 2," December 17, 2020.

[7] D. Tickner, "Duck Creek Power Station; Ash Pond No.1 and No. 2, Notificaiton of Completion of Closure," Luminant, Collinsville, Illinois, January 22, 2021.

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Attachment D

Periodic Structural Stability and Safety Factor Assessment Analyses

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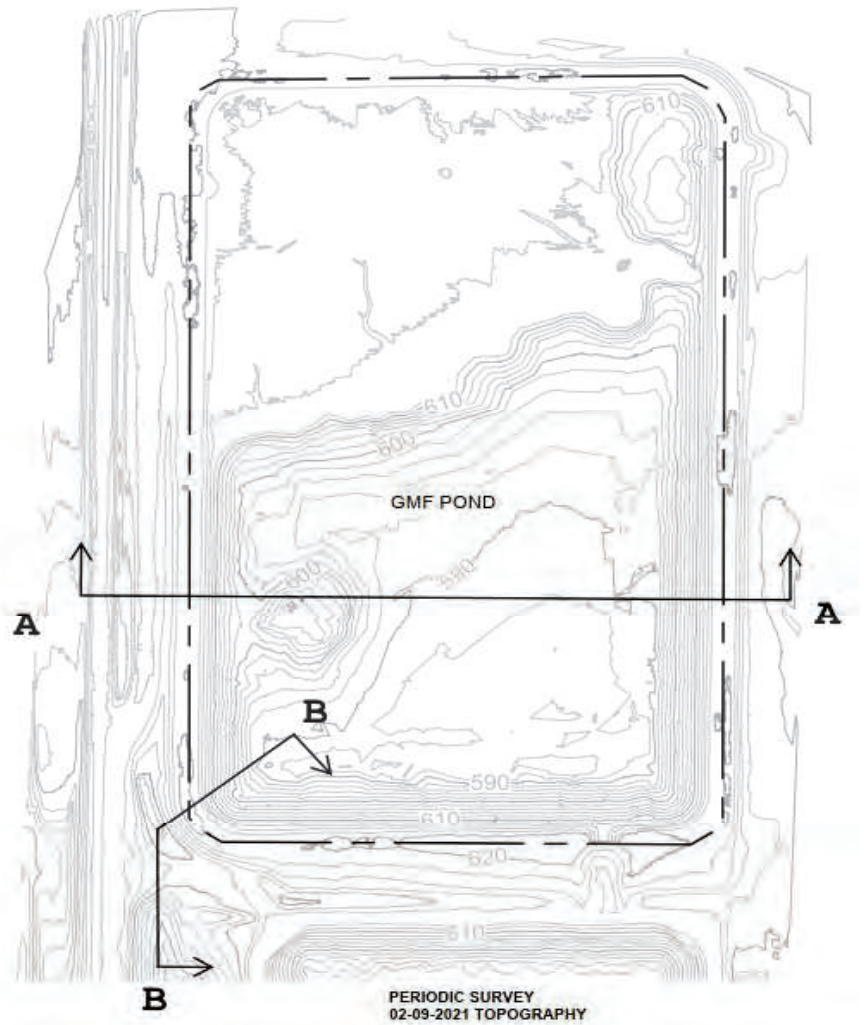


NOTES:

1. The cross-sections are shown on the periodic topography of GMF Pond, prepared by IngenAE, dated February 9, 2021.
2. A-A is the cross-section used in the 2016 AECOM initial SFA & SSA and cross-section B-B is the 2021 Geosyntec updated periodic SFA.

CROSS-SECTION LOCATIONS
PERIODIC CERTIFICATION
DUCK CREEK POWER PLANT- GMF POND
FULTON, ILLINOIS

Geosyntec consultants

Figure D-1

GLP8027 | 8/25/2021

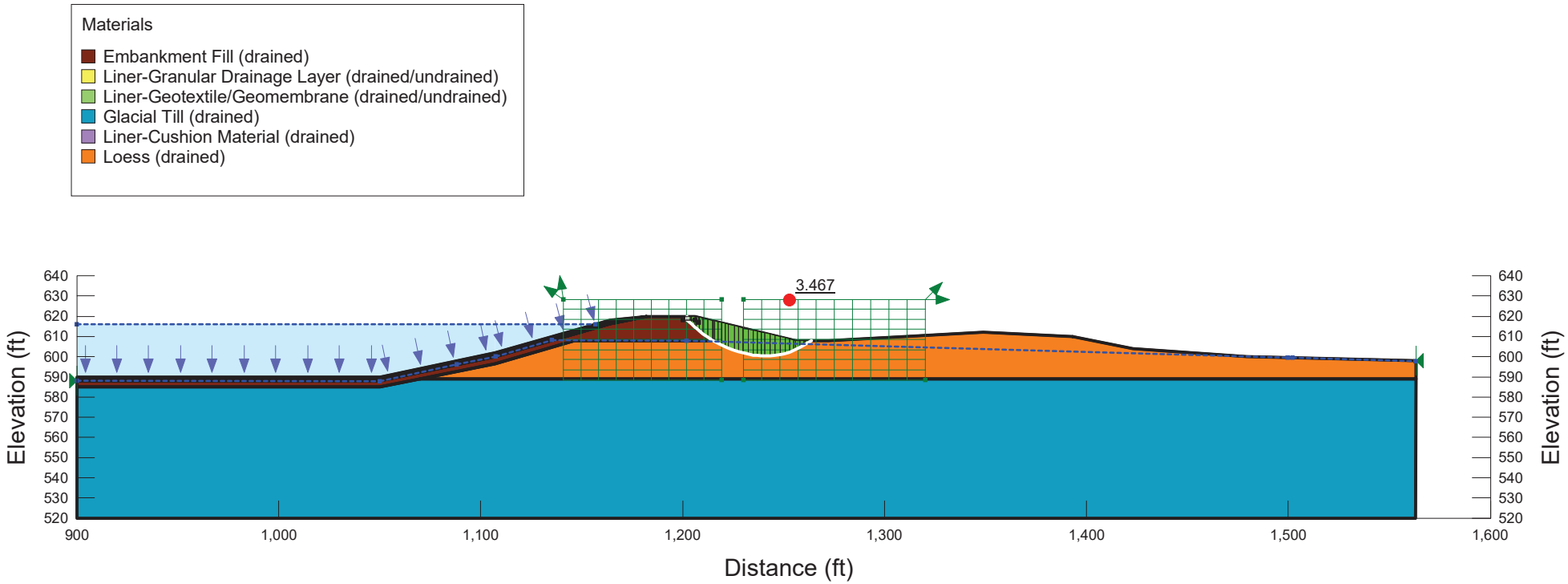
\\STLOUSMG01\Data\Company\Projects_post_2014\GLP8027_CCR_ReCert\300_Technical\303_DUC\303d_Periodic_Report\GMF\Revised SFA\New Section_2021\[DUC_GMF_New Section_20210824.xls]Plot12]

Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Long-Term, Block Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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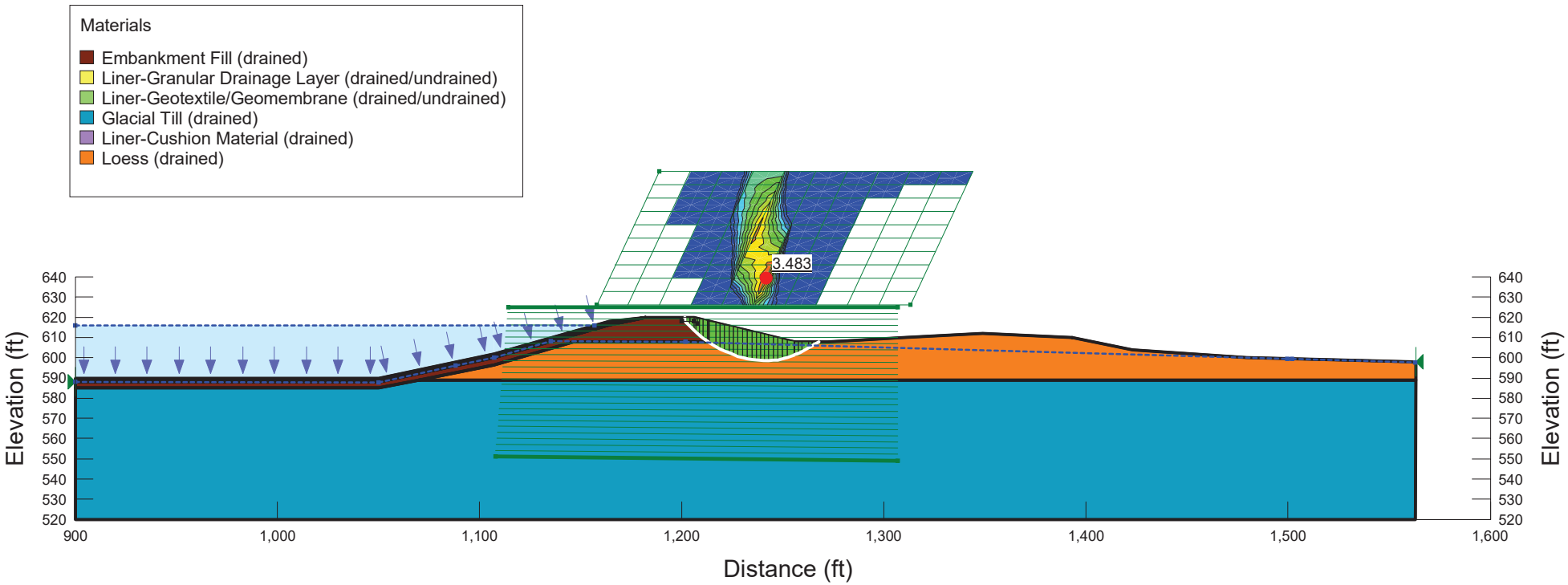
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Long-Term, Circular Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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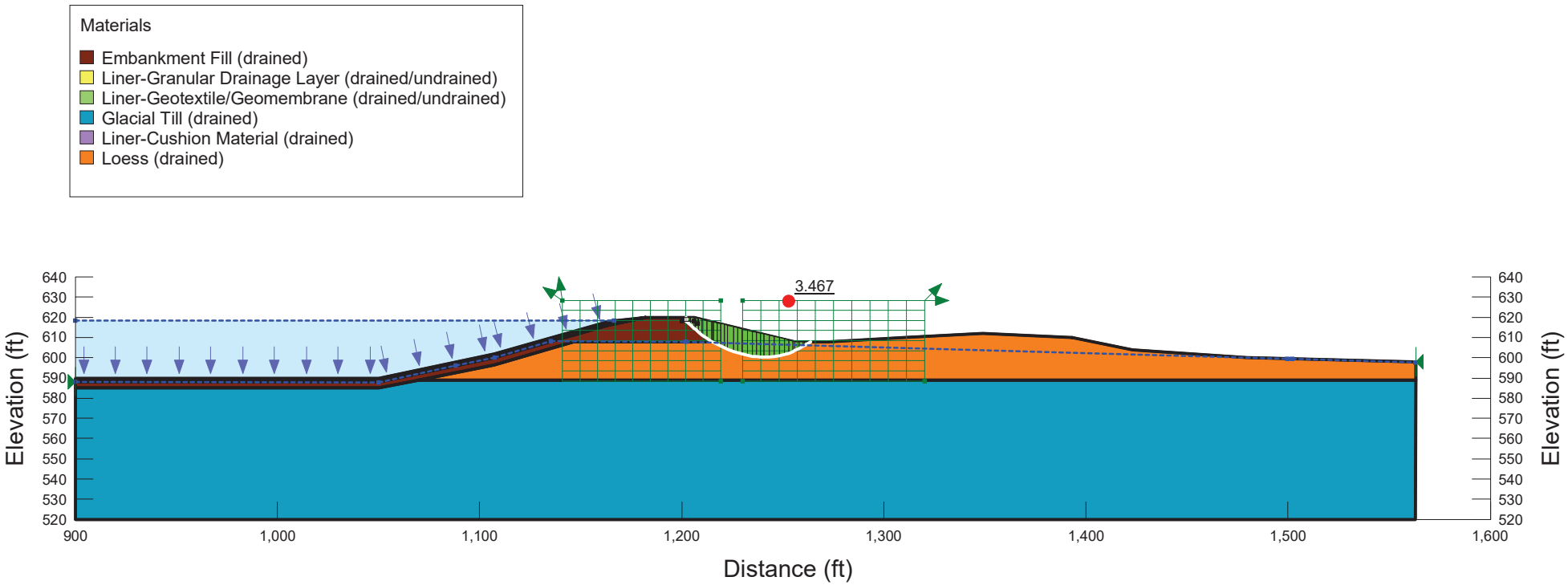
Electronic Filing: Received, Clerk's Office 06/20/2024

Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Surchage Pool, Block Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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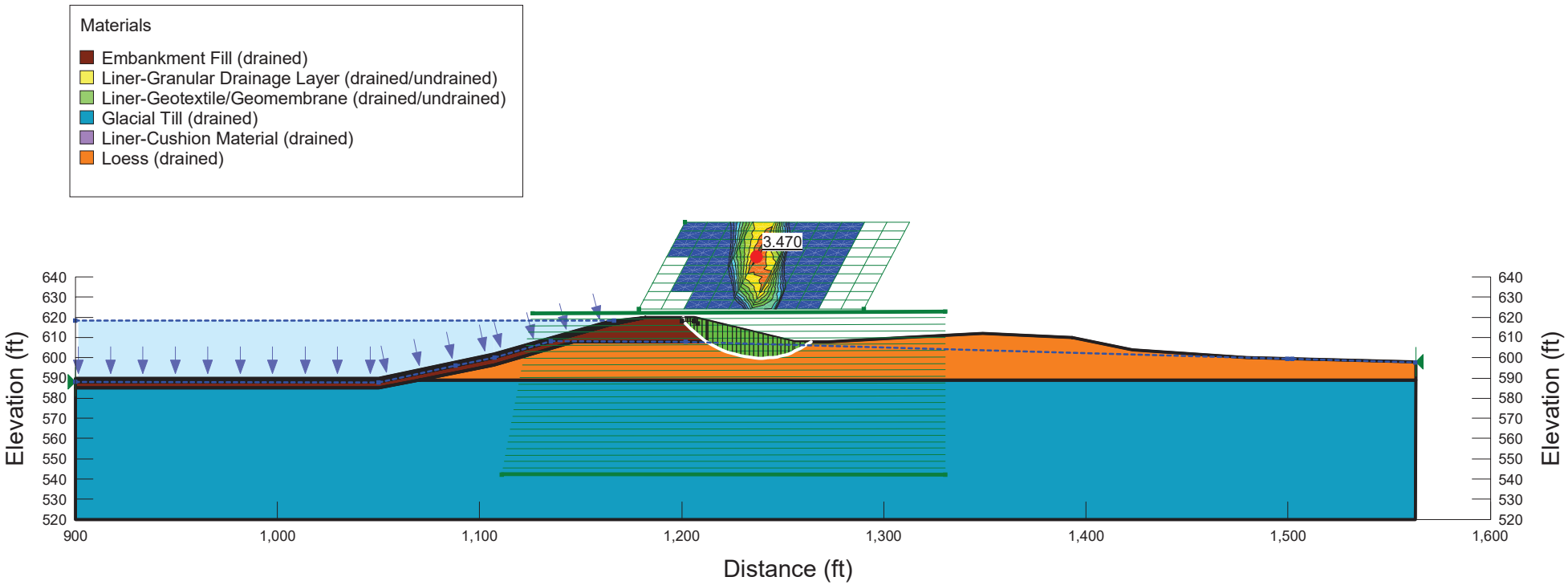
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Static, Surcharge Pool, Circular Failure Surface

Name: Embankment Fill (drained) Unit Weight: 116 pcf Cohesion': 150 psf Phi': 32 °
Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Glacial Till (drained) Unit Weight: 125 pcf Cohesion': 200 psf Phi': 30 °
Name: Liner-Cushion Material (drained) Unit Weight: 116 pcf Cohesion': 0 psf Phi': 38 °
Name: Loess (drained) Unit Weight: 116 pcf Cohesion': 100 psf Phi': 32 °



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Electronic Filing: Received, Clerk's Office 06/20/2024

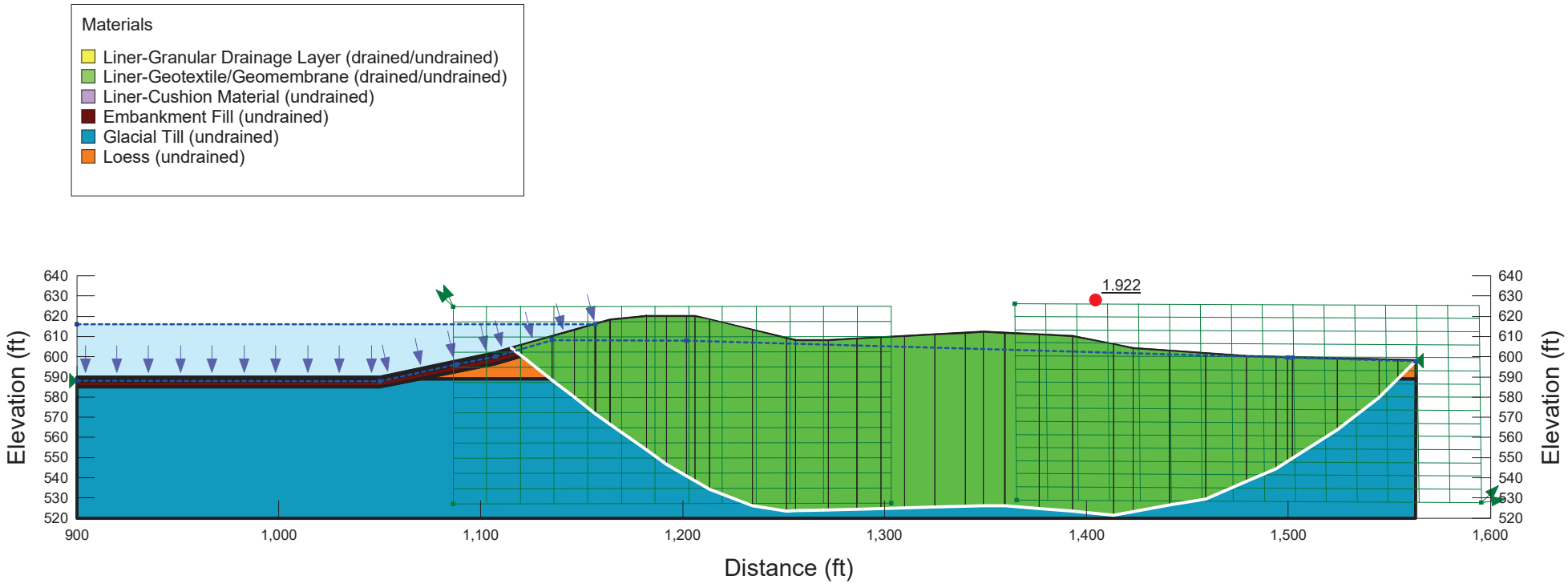
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Seismic, Block Failure Surface

Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Liner-Cushion Material (undrained) Unit Weight: 116 pcf Cohesion': 660 psf Phi': 0 °
Name: Embankment Fill (undrained) Unit Weight: 116 pcf Cohesion': 2,150 psf Phi': 0 °
Name: Glacial Till (undrained) Unit Weight: 125 pcf Cohesion': 1,900 psf Phi': 0 °
Name: Loess (undrained) Unit Weight: 116 pcf Cohesion': 1,250 psf Phi': 0 °

Horz Seismic Coef.: 0.116 g



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Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Seismic, Circular Failure Surface

Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Liner-Cushion Material (undrained) Unit Weight: 116 pcf Cohesion': 660 psf Phi': 0 °
Name: Embankment Fill (undrained) Unit Weight: 116 pcf Cohesion': 2,150 psf Phi': 0 °
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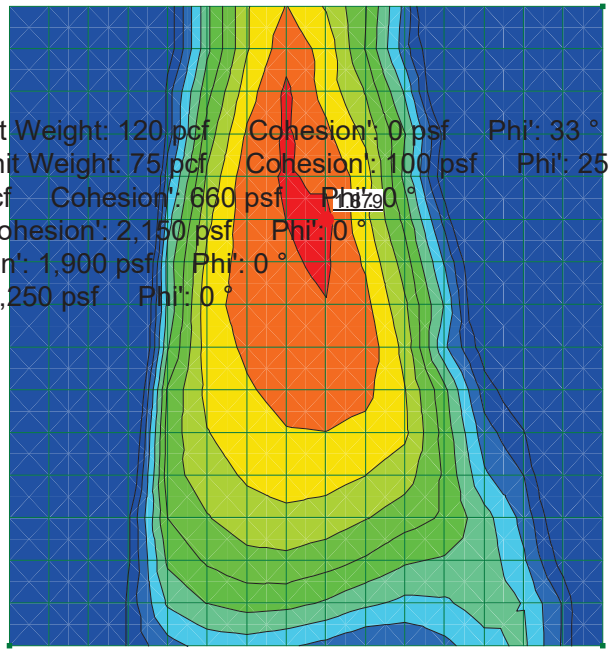
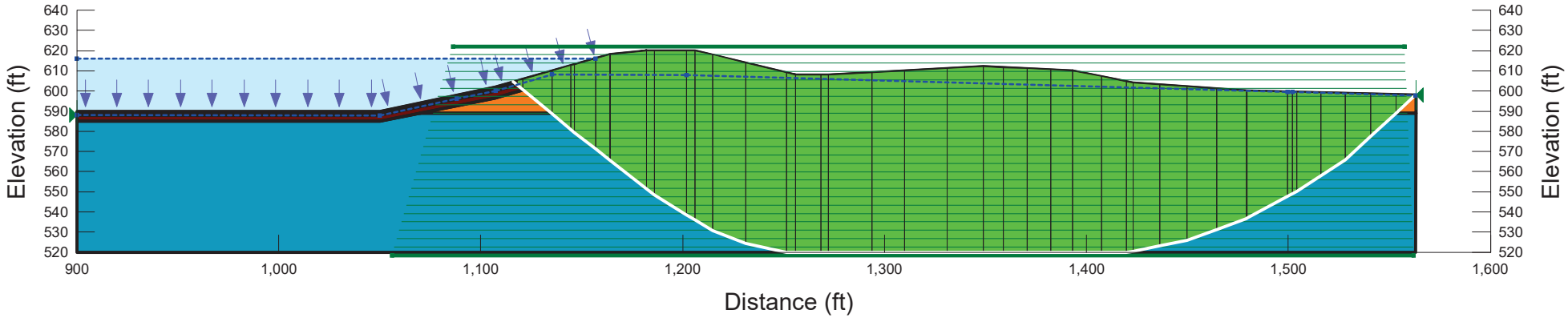
Name: Loess (undrained) Unit Weight: 116 pcf Cohesion': 1,250 psf Phi': 0 °

Horz Seismic Coef.: 0.116 g



Materials
- Liner-Granular Drainage Layer (drained/undrained)
- Liner-Geotextile/Geomembrane (drained/undrained)
- Liner-Cushion Material (undrained)
- Embankment Fill (undrained)
- Glacial Till (undrained)
- Loess (undrained)



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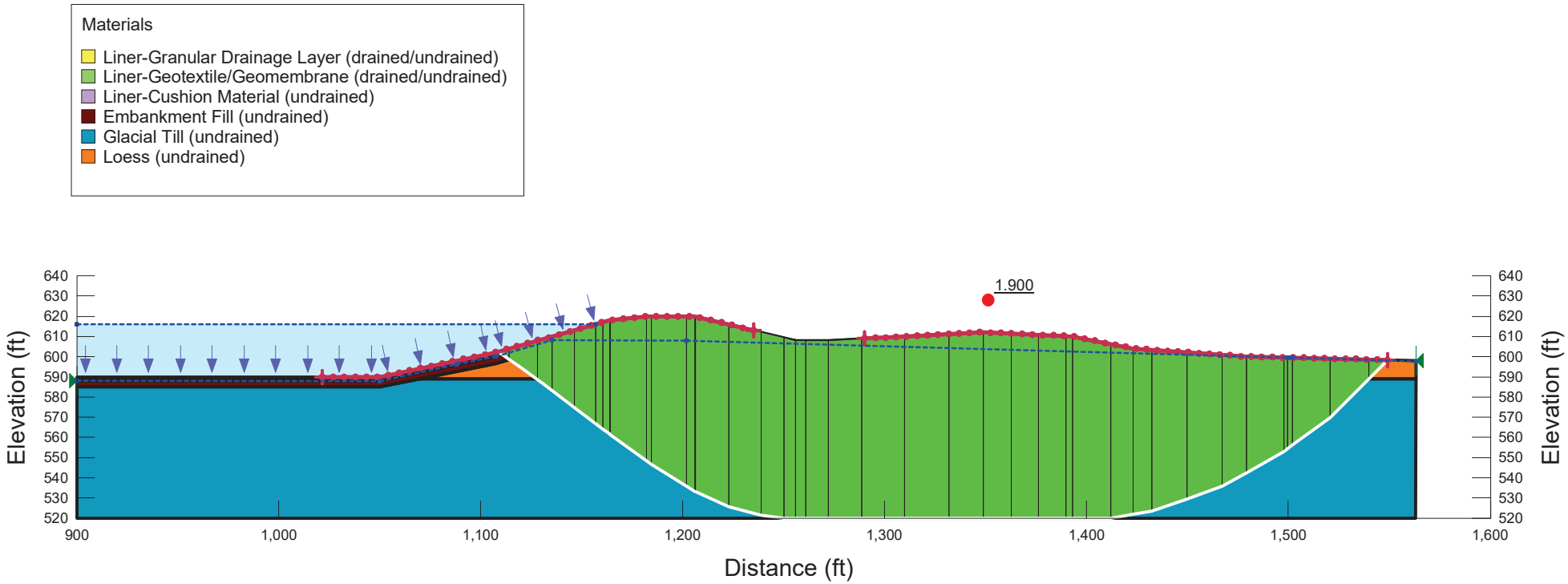
Dynegy CCR Program - Duck Creek Power Plant
GMF Pond Section B-B
Canton, Illinois

Drawn by: PK Date: 8/25/2021
Checked by: LPC Date: 8/25/2021

Name: Seismic, Entry-Exit Failure Surface

Name: Liner-Granular Drainage Layer (drained/undrained) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 33 °
Name: Liner-Geotextile/Geomembrane (drained/undrained) Unit Weight: 75 pcf Cohesion': 100 psf Phi': 25 °
Name: Liner-Cushion Material (undrained) Unit Weight: 116 pcf Cohesion': 660 psf Phi': 0 °
Name: Embankment Fill (undrained) Unit Weight: 116 pcf Cohesion': 2,150 psf Phi': 0 °
Name: Glacial Till (undrained) Unit Weight: 125 pcf Cohesion': 1,900 psf Phi': 0 °
Name: Loess (undrained) Unit Weight: 116 pcf Cohesion': 1,250 psf Phi': 0 °

Horz Seismic Coef.: 0.116 g



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APPENDIX B

Narrative Description

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MEMBER OF WSP

APPENDIX B

Narrative Description of the Gypsum Management Facility Pond

Duck Creek Power Plant

Submitted to:

Illinois Environmental Protection Agency

1021 North Grand Avenue East
P. O. Box 19276
Springfield, Illinois 62794-9276

Submitted by:

Illinois Power Resources Generating, LLC

1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Prepared by:

Golder Associates USA Inc.
701 Emerson Road, Suite 250
Creve Coeur, Missouri 63141

21454861-7-R-0

January 25, 2022

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1.0 FACILITY INFORMATION 1

1.1 Coal Combustion Residuals Material Received 1

1.1.1 Chemical Analysis 1

1.2 Facility Capacity 1

1.3 Facility Operation 1

1.4 Transportation Plan 1

ATTACHMENTS

Figure 1
Transportation Plan

ATTACHMENT 1
Chemical Analysis

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1.0 FACILITY INFORMATION

1.1 Coal Combustion Residuals Material Received

The Gypsum Management Facility (GMF) Pond is used to store gypsum (calcium sulfate), a byproduct of the wet scrubber system that was used for flue gas desulfurization at the Duck Creek Power Plant. The synthetic gypsum is generally of the same chemical makeup as natural gypsum.

1.1.1 Chemical Analysis

Available information regarding chemical analysis of the gypsum that is stored in the GMF Pond is provided in Attachment 1.

1.2 Facility Capacity

The GMF Pond capacity was estimated as 2,200,000 cubic yards in the closure plan prepared in 2016 for compliance with 40 CFR 257.102. However, the Duck Creek Power Plant was retired in December 2019, before the GMF Pond could be filled to its capacity. The amount of coal combustion residuals (CCR) currently contained in the GMF Pond was estimated by a volumetric analysis using Autodesk Civil 3D as approximately 400,000 cubic yards. No additional CCR will be placed in the GMF Pond.

1.3 Facility Operation

The GMF Pond is no longer receiving CCR or other waste streams. The GMF Pond received CCR from early 2009 until the Duck Creek Power Plant was retired in December 2019.

1.4 Transportation Plan

During operation, transport of CCR to the GMF Pond was by pipeline. Figure 1 shows the main route that is used for vehicle travel between the Duck Creek Power Plant and the GMF Pond. Figure 1 also shows the route that will be used to transport borrow materials from a soil stockpile to the GMF Pond for closure and to transport soils excavated during closure to the soil stockpile. These routes are all on site.

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Signature Page

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https://golderassociates.sharepoint.com/sites/141778/project files/5 technical work/duck creek/gypsum and gypsum recycle ponds/permit application/final/app b narr descr/appb-gmf_narrative_description.docx

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FIGURE 1

Transportation Plan

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LEGEND

- ROUTE BETWEEN GYPSUM MANAGEMENT FACILITY POND AND ON-SITE LANDFILL OR BORROW AREA
- ROUTE BETWEEN DUCK CREEK POWER PLANT AND GYPSUM MANAGEMENT FACILITY POND

REFERENCE(S)

AERIAL IMAGERY OBTAINED FROM ESRI-PROVIDED BASEMAP SURVEY. IMAGERY COLLECTED 5/14/2017, 10/21/2017, AND 4/1/2019.

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-01-24
DESIGNED	DVS
PREPARED	DVS
REVIEWED	JJS
APPROVED	JEO

PROJECT
GYPSUM MANAGEMENT FACILITY POND
PART 845 CONSTRUCTION PERMIT APPLICATION

TITLE
TRANSPORTATION PLAN

PROJECT NO.	REV.	FIGURE
21454861	A	1

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ATTACHMENT 1

Chemical Analysis

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DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	FGD Gypsum
Synonyms:	Gypsum, calcium sulfate dihydrate, calcium sulphate dihydrate, gesso, alabaster, plaster of Paris.
Formula:	UVCB Substance

1.2 Relevant Identified Uses of the Substance or Mixture and Uses Advices Against

Relevant Identified Uses:	Component of wallboard, concrete, roofing material, bricks, cement kiln feed, agricultural amendment.
Uses Advised Against:	None known.

1.3 Details of the Supplier of the SDS

Manufacturer/Supplier:	Dynegy, Inc.
Street Address:	601 Travis Street, Suite 1400
City, State and Zip Code:	Houston, TX 77002
Customer Service Telephone:	800-633-4704

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Section 2
Hazards Identification

2.1 Classification of the Substance

GHS Classification(s) according to OSHA Hazard Communication Standard (29 CFR 1910.1200):

- STOT-SE Category 3 (Respiratory Irritation)
- STOT-RE Category 1 (Lungs)
- Carcinogen Category 1A

2.2 Label Elements

Labelling according to 29 CFR 1910.1200 Appendices A, B and C*	
Hazard Pictogram(s):	
Signal word:	**DANGER**
Hazard Statement(s):	*May cause respiratory irritation.* *Causes damage to lungs after repeated/prolonged exposure via inhalation.* *May cause cancer of the lungs.*
Precautionary Statement(s):	*Obtain special instructions before use.* *Do not handle until all safety precautions have been read and understood.* *Do not breathe dust.* *Wash hands thoroughly after handling.* *Do not eat, drink or smoke when using this product.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Do not eat drink or smoke when using this product.* *Use outdoors or in a well-ventilated area.* *If inhaled: Remove to fresh air and keep comfortable for breathing.* *Get medical advice/attention if you feel unwell.* *Store in a secure area.* *Dispose of product in accordance with local/national regulations.*

The following elements may be present in trace amounts as oxides: aluminum, calcium, iron, magnesium, nickel, phosphorus, potassium, silicon, sulfur, titanium, and vanadium. The exact composition of the gypsum will be dependent on the fuel source and flue additives composed of many constituents.

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2.3 Other Hazards

Listed Carcinogens:

-Respirable Crystalline Silica

IARC: [Yes] **NTP:** [Yes] **OSHA:** [Yes] **Other:** **(ACGIH)** [Yes]

Section 3
Composition/Information on Ingredients

Substance	***CAS No.***	***Percentage (%)***	***GHS Classification***
Calcium sulfate, dihydrate	*10104-14-1*	*90 - 99%*	*STOT – Single Exposure Category 3 (Respiratory Irritation)*
Crystalline Silica	*14808-60-7*	*≥0.1 - 3%*	*STOT – Repeated Exposure Category 1 (Lung)* *Carcinogen, Category 1A*
Silica, crystalline respirable (RCS)	*14808-60-7*	***See Footnote 1***	*STOT – Repeated Exposure Category 1 (Lungs)* *Carcinogen Category 1A*
Fly Ash	*68131-74-8*	*<2%*	*STOT – Single Exposure Category 3 (Respiratory Irritation)*

Footnote 1: *The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen, Category 1A has been assigned.*

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Section 4
First Aid Measures

4.1 Description of First Aid Measures

Inhalation:	If product is inhaled and irritation of the nose or coughing occurs, remove person to fresh air. Get medical advice/attention if respiratory symptoms persist.
Skin Contact:	If skin exposure occurs, wash with soap and water.
Eye Contact:	If product gets into the eye, rinse copiously with water for several minutes. Remove contact lenses, if present and easy to do. Seek medical attention/advice if irritation occurs or persists.
Ingestion:	No specific first aid measures are required.

4.2 Most Important Health Effects, Both Acute and Delayed

Acute Effects: Short-term airborne exposure to FGD gypsum dust may cause respiratory irritation. Direct exposure can dry and irritate the skin and cause dermatitis or eye irritation through mechanical abrasion.

Chronic Effects: Chronic (long-term) exposure to FGD gypsum may cause lung damage from repeated exposure. Prolonged inhalation of dusts containing respirable crystalline silica above certain concentrations may cause lung disease (silicosis) and lung cancer.

4.3 Indication of Any Immediate Medical Attention and Special Treatment Needed

Seek first aid or call a doctor or Poison Control Center if contact with eyes occurs and irritation remains after rinsing. Get medical advice if inhalation occurs and respiratory symptoms persist.

Section 5
Firefighting Measures

5.1 Extinguishing Media

Suitable Extinguishing Media:	Product is not flammable. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Not applicable, the product is not flammable.

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5.2 Special Hazards Arising from the Substance or Mixture

Hazardous Combustion Products:	Above 1450°C (~2600°F), gypsum decomposes to calcium oxide and sulfur dioxide.

5.3 Advice for Firefighters

Special Protective Equipment and Precautions for Firefighters:	As with any fire, wear self-contained breathing apparatus (NIOSH approved or equivalent) and full protective gear.

Section 6
Accidental Release Measures

6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Personal precautions/Protective Equipment:	See Section 8.2.2 Individual Protective Measures. For concentrations exceeding Occupational Exposure Levels (OELs), use a self-contained breathing apparatus (SCBA).
Emergency procedures:	Use scooping, water spraying/flushing/misting or ventilated vacuum cleaning systems to clean up spills. Do not use pressurized air.

6.2 Environmental Precautions

Environmental precautions:	Prevent contamination of drains or waterways and dispose according to local and national regulations.

6.3 Methods and Material for Containment and Cleaning Up

Methods and materials for containment and cleaning up:	Do not use brooms or compressed air to clean surfaces. Use dust collection vacuum and extraction systems. Large spills of dry product should be removed by a vacuum system. Dampened material should be removed by mechanical means and recycled or disposed of according to local and national regulations.

See Sections 8 and 13 for additional information on exposure controls and disposal.

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Section 7
Handling and Storage

7.1 Precautions for Safe Handling

Practice good housekeeping. Use adequate exhaust ventilation, dust collection and/or water mist to maintain airborne dust concentrations below permissible exposure limits (note: respirable crystalline silica dust may be in the air without a visible dust cloud).

Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain and test ventilation and dust collection equipment. In cases of insufficient ventilation, wear a NIOSH approved respirator for silica dust when handling or disposing dust from this product. Avoid contact with skin and eyes. Wash or vacuum clothing that has become dusty. Avoid eating, smoking, or drinking while handling the material.

7.2 Conditions for Safe Storage, Including any Incompatibilities

Minimize dust produced during loading and unloading.

Section 8
Exposure Controls/Personal Protection

8.1 Control Parameters

OCCUPATIONAL EXPOSURE LIMITS					
SUBSTANCE		**OSHA PEL TWA (mg/m^3)**	**NIOSH REL TWA (mg/m^3)**	**ACGIH TLV TWA (mg/m^3)**	**CA - OSHA PEL (mg/m^3)**
Particulates Not Otherwise Regulated	Total	15	15	10	10
	Respirable	5	5	3	5
Respirable Crystalline Silica	Total Respirable	0.05-	0.05	0.025	0.05
Calcium Sulfate, anhydrous (CAS# 7778-18-9)	Total Dust	*	10	10	*
	Respirable	*	5	-	*
Note: In the absence of a CA-PEL, the value for Particulates Not Otherwise Regulated (PNOR) is applied.					

8.2 Exposure Controls

8.2.1 Engineering Controls

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Provide ventilation to maintain the ambient workplace atmosphere below the occupational exposure limit(s). Use general and local exhaust ventilation and dust collection systems as necessary to minimize exposure.

8.2.2 Personal Protective Equipment (PPE)

Respiratory protection:	Wear a NIOSH approved particulate respirator if exposure to airborne particulates is unavoidable and where occupational exposure limits may be exceeded. If airborne exposures are anticipated to exceed applicable PELs or TLVs, a self-contained breathing apparatus or airline respirator is recommended.
Eye and face protection:	If eye contact is possible, wear protective glasses with side shields. Avoid contact lenses.
Hand and skin protection:	Wear gloves and protective clothing. Wash hands with soap and water after contact with material.

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Section 9
Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Property: Value	Property: Value
Appearance (physical state, color, etc.): White or gray cake-like material	**Upper/lower flammability or explosive limits:** Not applicable
Odor: Odorless	**Vapor Pressure (Pa):** Not applicable
Odor threshold: Not applicable	**Vapor Density:** Not applicable
pH (25 °C) (in water): 6 - 8	**Specific gravity or relative density:** 2.0 – 2.9
Melting point/freezing point (°C): 128	**Water Solubility:** 0.1 – 0.3%
Initial boiling point and boiling range (°C): >163	**Partition coefficient: n-octane/water:** Not determined
Flash point (°C): Not determined	**Auto ignition temperature (°C):** Not applicable
Evaporation rate: Not applicable	**Decomposition temperature (°C):** 1450
Flammability (solid, gas): Nonflammable/non-combustible	**Viscosity:** Not applicable

Section 10
Stability and Reactivity

10.1 Reactivity:	Avoid contact with strong acids or oxidizers and diazomethane.
10.2 Chemical stability:	The material is stable under normal use conditions.
10.3 Possibility of hazardous reactions:	The material is a relatively stable, inert material; polymerization will not occur.
10.4 Conditions to avoid:	Product can become airborne in moderate winds. Dry material should be stored in silos. Materials stored out of doors should be covered or maintained in a damp condition.
10.5 Incompatible materials:	Acids, ammonium salts, diazomethane, phosphorus and aluminum metal.
10. 6 Hazardous decomposition products:	None known.

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Section 11
Toxicological Information

11.1 Information on Toxicological Effects

Endpoint	Data
Acute oral toxicity	Oral LD50 > 2000 mg/kg
Acute dermal toxicity	No data.
Acute inhalation toxicity	Inhalation LC50: > 3.26 mg/L
Skin corrosion/irritation	Not irritating or corrosive to skin based on 4-hour, semi-occlusive exposure to rabbits.
Eye damage/irritation	No positive responses in rabbits based upon 24-, 48-, and 72-hour mean scores for corneal opacity, iritis, conjunctival redness/edema.
Respiratory/skin sensitization	Not a respiratory or dermal sensitizer.
Germ cell mutagenicity	Several in vitro and in vivo mutagenicity assays determined that calcium sulfate, dihydrate was non-mutagenic, with and without metabolic activation.
Carcinogenicity	No data on calcium sulfate, dihydrate. Carcinogenic studies were not conducted based on the non-neoplastic effects noted in the oral and inhalation repeated dose studies as well as the negative mutagenicity assays. Respirable crystalline silica has been identified as a carcinogen by NTP, IARC, ACGIH and OSHA.
Reproductive toxicity	No significant developmental or reproductive toxicity were identified in rabbits after exposure to either calcium sulfate, dehydrate or calcium sulfate, dihydrate.
STOT-SE	Acute toxicity testing did not result in direct organ toxicity after a single exposure to calcium sulfate, dihydrate. However, as the form tested was not indicated, FGD gypsum dust may result in mechanical respiratory irritation.
STOT-RE	A repeat dose oral toxicity study (35-45 days) with calcium sulfate, dihydrate conducted using rats reported a NOAEL for males of 100 mg/kg/day on the basis of decreased total protein, albumin, blood urea nitrogen, and creatinine levels observed at the 300 and 1,000 mg/kg/day dose groups. No effects were observed in females. Repeated inhalation exposures to high levels of respirable crystalline silica may result in lung damage (silicosis) and lung cancer.
Aspiration Hazard	Not applicable based on product form.

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Section 12
Ecological Information

12.1 Toxicity

Calcium sulfate (CAS# 7778-18-9) [1]	
Toxicity to Fish	Fathead Minnow (*Pimephales promelas*): Acute, 7-day LC50 > 1,970 mg/L Acute, 96-hour NOEC = 1,470 mg/L
	Rainbow trout (*Oncorhynchus mykiss*): Chronic, 30-day NOEC (survival, growth, reproduction) = 732 mg/L
	Bluegill (*Lepomis macrochirus*): Acute, 96-hour LC50 = 2,890 mg/L
Toxicity to Aquatic Invertebrates	Water Flea (*Ceriodaphnia dubia*): Acute, 96-hour NOEC = 1447.4 mg/L
	Water Flea (*Daphnia magna*): Acute, 48-hour LC50 = 1,970 mg/L Chronic, 21-day NOEC (and 42-day post-hatch): 1,600 mg/L
Toxicity to Aquatic Algae and Plants	Algae (*Navicula seminulum; Nitzschia linearis*): Chronic, 96-hour LC50 and EC50 (growth) = 3,200 mg/L

[1]The aquatic toxicity of sulfate has been shown to be dependent on water hardness, generally decreasing as hardness increases.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

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Section 13
Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

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Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status
  - FGD gypsum as well as listed impurities are on the TSCA Inventory.
- California Proposition 65

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:
  - Respirable crystalline silica
- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Gypsum; calcium sulfate; calcium sulfate dihydrate	7778-18-9 or 10101-41-4	Yes	Yes	Yes	No
Calcium carbonate	1317-65-3	Yes	Yes	Yes	No
Silica-crystalline (SiO2), quartz	14808-60-7	Yes	Yes	Yes	No

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 27, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency
- FGD: Flue Gas Desulfurization
- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration estimated to result in the mortality of 50% of an animal population
- LD50: Dose estimated to result in the mortality of 50% of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey

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- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	1*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
*** Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

DISCLAIMER:

This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

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APPENDIX C

Map Package

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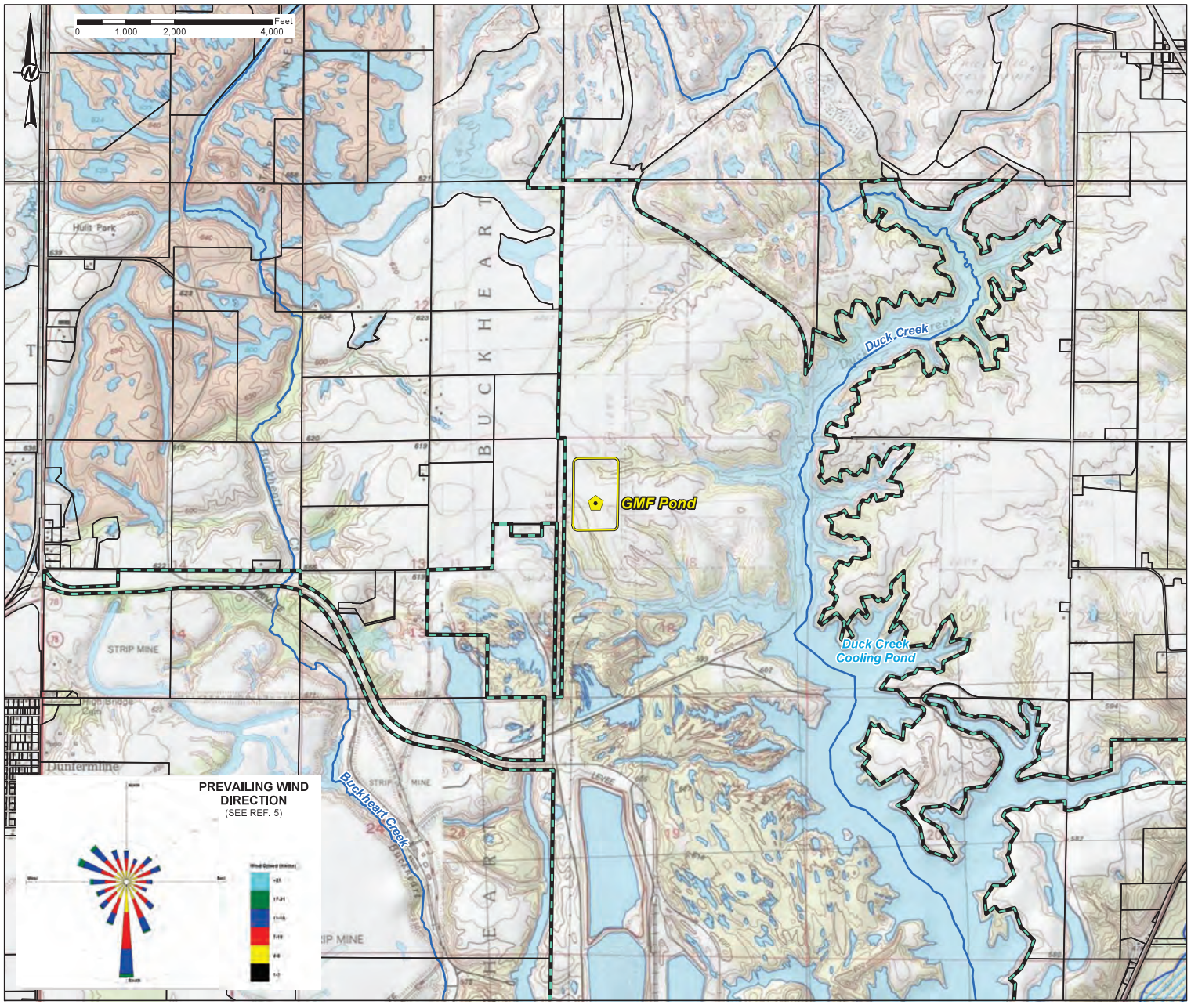

LEGEND

- SITE LOCATION
- SURFACE WATER - LINEAR FEATURE
- SURFACE WATER BODY
- FEMA 100-YEAR FLOODPLAIN
- IPRG BOUNDARY
- NEIGHBORING PROPERTY BOUNDARIES
- GMF BOUNDARY



NOTES

1. A SEARCH OF THE ILLINOIS DEPARTMENT OF NATURAL RESOURCES (IDNR) NATURAL HERITAGE DATABASE FOR NATURAL AREAS AND PROTECTED AREAS WITHIN 1,000 METERS OF THE GMF POND WAS PERFORMED, ACCORDING TO THE IDNR NATURAL HERITAGE DATABASE, THERE ARE 15 NATURAL AREAS IN FULTON COUNTY, INCLUDING TWO CATEGORY III - NATURE PRESERVES (HARPER-RECTOR WOODS NATURE PRESERVE [34.67 ACRES] AND KEDZIOR WOODLANDS LAND AND WATER RESERVE [163.64 ACRES]). NO NATURAL AREAS WERE IDENTIFIED WITHIN 1,000 METERS OF THE GMF POND.
2. THE IDNR NATURAL HERITAGE DATABASE THREATENED AND ENDANGERED SPECIES BY COUNTY LISTS 11 STATE THREATENED AND 12 STATE ENDANGERED SPECIES IN FULTON COUNTY. THE USFWS ENVIRONMENTAL CONSERVATION ONLINE SYSTEM LISTS THREE FEDERALLY THREATENED AND ONE FEDERALLY ENDANGERED SPECIES IN FULTON COUNTY.

REFERENCES

1. TOPOGRAPHIC BASEMAP: UNITED STATES GEOLOGICAL SURVEY 7.5-MINUTE TOPOGRAPHIC QUADRANGLES SHOWN: CANTON, BANNER, SAINT DAVID, AND DUCK ISLAND.
2. PROPERTY BOUNDARIES: FULTON COUNTY ASSESSOR'S OFFICE, APRIL 2021.
3. FLOODPLAIN DATA: FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA). PANEL 17057C0250E, EFFECTIVE ON FEBRUARY 4, 2011.
4. SURFACE WATER FEATURES: NATIONAL HYDROGRAPHY DATASET (NHD), USGS.
5. PREVAILING WIND DIRECTION GRAPHIC: ILLINOIS STATE CLIMATOLOGIST OFFICE. 1961-1990 ANNUAL AVERAGE WIND SPEEDS AND DIRECTIONS, AS MEASURED AT STATION #14842 -PEORIA/GREATER PEORIA ARPT, IL.

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC

PROJECT
DUCK CREEK POWER PLANT
GMF POND

TITLE
SITE LOCATION MAP

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	JS
PREPARED	KJC/RHG
REVIEWED	-
APPROVED	-

PROJECT NO.
21454861

FIGURE
1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

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LEGEND

- IPRG BOUNDARY
- GMF BOUNDARY
- ROUTE BETWEEN GMF AND ON-SITE BORROW AREA
- ROUTE BETWEEN GMF AND ON-SITE LANDFILL
- WELL LOCATION

KEY MAP



REFERENCES

1. AERIAL BASEMAP: ESRI PROVIDED BASEMAP SERVICE. VIVID. MAXAR. IMAGERY COLLECTED 10/21/2017.
2. PROPERTY BOUNDARIES: FULTON COUNTY ASSESSOR'S OFFICE, APRIL 2021.

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC

PROJECT
DUCK CREEK POWER PLANT
GMF POND

TITLE
SITE PLAN MAP

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	JS
PREPARED	KJC/RHG
REVIEWED	-
APPROVED	-

PROJECT NO.
21454861

FIGURE
1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

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APPENDIX D

Hydrogeologic Site Characterization

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Intended for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

GYPSUM MANAGEMENT FACILITY POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

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HYDROGEOLOGIC SITE CHARACTERIZATION REPORT DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND

Project Name	**Duck Creek Power Plant Gypsum Management Facility Pond**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Hydrogeologic Site Characterization Report**
Revision	**FINAL**
Date	**October 25, 2021**

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
CSM	conceptual site model
CQA	Construction Quality Assurance
DCPP	Duck Creek Power Plant
DWW	Illinois Drinking Water Watch
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
ft/day	feet per day
ft/ft	feet per feet
GMF	Gypsum Management Facility
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standard
Hanson	Hanson Professional Services, Inc.
HCR	Hydrogeologic Site Characterization Report
HDPE	high density polyethylene
HMP	Hydrogeologic Monitoring Plan
HUC	Hydrologic Unit Code
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ILWATER	Illinois Water and Related Wells
IPRG	Illinois Power Resources Generating, LLC
ISAS	Illinois State Archaeological Survey
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
mg/L	milligrams per liter
mil	millimeter
msl	above mean sea level
NAVD88	North American Vertical Datum of 1988
NGWMN	National Groundwater Monitoring Network
NID	National Inventory of Dams
No.	Number
NRCS	Natural Resources Conservation Service
NRT	Natural Resource Technology, Inc.
NRT/OBG	Natural Resource Technology, Inc., an OBG Company
oz/yd^2	ounce per square yard

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Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
pCi/L	picocuries per liter
pcf	Pound per cubic foot
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RCRA	Resource Conservation and Recovery Act
RQD	rock quality designation
SDWIS	Safe Drinking Water Information System
SI	Surface Impoundment
SSURGO	Soil Survey Geographic
SU	standard unit
TDS	total dissolved solids
USCS	Unified Soil Classification System
USFWS	United States Fish and Wildfire Service
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

This Hydrogeologic Site Characterization Report (HCR) for the Gypsum Management Facility (GMF) Pond at Duck Creek Power Plant (DCPP) expands upon the hydrogeology, groundwater quality data, and conceptual site model (CSM) presented in previous hydrogeologic investigation reports prepared for the GMF Pond. This report has been assembled to satisfy the information and analysis requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845.620 as summarized in **Table ES-1**. The CSM includes hydrogeologic and groundwater quality data specific to the GMF Pond, which has been collected from 2015 to 2021. The GMF Pond (Vistra identification [ID] number [No.] 203, Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04, and National Inventory of Dams [NID] No. IL50573) is located at the DCPP southwest of Canton, Illinois (**Figure 1-1**).

The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP. Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development.

The GMF Pond is a 1500-foot by 900-foot earthen berm double-lined coal combustion residuals (CCR) Surface Impoundment (SI) located north of the former power plant. The GMF Pond decant water discharges to the lined GMF Recycle Pond. Several other CCR units are located on the DCPP property, including the Landfill located due north of the GMF Pond; the closed units, Ash Pond No. 1 and Ash Pond No. 2, located south of the GMF Pond; and the Bottom Ash Basin located between the former power plant and the closed Ash Pond Nos. 1 and 2.

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) coal unit at some portions of the DCPP property. Previous investigations completed outside of the GMF Pond indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to and downgradient of several former large surface mining areas.

In addition to the CCR within the lined GMF Pond, there are five layers of unlithified material present above the Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). These materials have been categorized into three hydrostratigraphic units presented below in descending order:

- **Uppermost Aquifer:** At the GMF Pond this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sands. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (Natural Resource Technology, an OBG Company [NRT/OBG], 2017a). The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally located at an elevation of 570 to 590 feet above mean sea level (msl). The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the

northeast corner and southwest corner of the pond), putting the base of liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.

- **Lower Radnor Till/Lower Confining Unit:** Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick.
- **Bedrock Confining Unit:** The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet.

The Peoria/Roxanna Loess within the uppermost aquifer has also been identified as a potential migration pathway (PMP) for contaminant migration. While the primary migration pathway is the shallow sand of the uppermost aquifer, the groundwater within the overlying Peoria/Roxanna Loess has the potential to be impacted and is considered a PMP.

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow in the sands is generally in a northwest to southeast direction. Seasonal variation of groundwater levels at the GMF Pond are present and may fluctuate approximately 1 to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond associated with the elevation changes. Groundwater flows toward the Duck Creek Cooling Pond located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Cooling Pond is estimated from 562.5 to 565 feet North American Vertical Datum of 1988 (NAVD88). Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond.

Part 845 parameters were monitored in uppermost aquifer and PMP monitoring wells as part of groundwater quality evaluations performed from 2015 to 2021. These data were supplemented with installation and sampling of additional locations in 2021. The results indicate that the following parameters were detected at concentrations greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs) and are considered potential exceedances:

- Antimony, arsenic, cobalt, lead, pH, sulfate, and thallium were detected at least once at concentrations greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). Lead, mercury, pH, and thallium were detected at concentrations greater than the GWPS in upgradient uppermost aquifer wells. Radium 226 and 228 combined was detected once at concentrations greater than the GWPS in the bedrock confining unit well.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPS to determine potential exceedances. Potential exceedances include results reported during the background groundwater monitoring or prior period that are greater than the GWPS. The results are considered potential exceedances because the results were compared directly to the standard and did not include an evaluation of background groundwater quality or the statistical methodologies proposed in the groundwater monitoring plan (GMP) provided in the Operating Permit application. Exceedances will be determined following IEPA approval of the GMP.

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TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)	**The hydrogeologic site characterization shall include but not be limited to the following:**	--
845.620(b)(1)	Geologic well logs/boring logs;	Table 3-1 Figure 3-1 Appendix B
845.620(b)(2)	Climatic aspects of the site, including seasonal and temporal fluctuations in groundwater flow;	Sections 3.2.4 & 3.3.1 Figures 3-2 to 3-5
845.620(b)(3)	Identification of nearby surface water bodies and drinking water intakes;	Sections 3.3.2 & 5.2 Appendix A
845.620(b)(4)	Identification of nearby pumping wells and associated uses of the groundwater;	Section 5.1 Appendix A
845.620(b)(5)	Identification of nearby dedicated nature preserves;	Section 5.3 Appendix A
845.620(b)(6)	Geologic setting;	Section 2 Figures 2-1 to 2-4
845.620(b)(7)	Structural characteristics;	Section 2.4.3 Figure 2-5
845.620(b)(8)	Geologic cross-sections;	Figures 2-7 and 2-8
845.620(b)(9)	Soil characteristics;	Section 2.3 Figure 2-2 Tables 2-1 & 2-4

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TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(10)	Identification of confining layers;	Section 3.2.1
845.620(b)(11)	Identification of potential migration pathways;	Section 3.2.1 & 3.2.3
845.620(b)(12)	Groundwater quality data;	Section 4.2 Table 4-1 & 4-2
845.620(b)(13)	Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy;	Section 2.5 Figures 2-7 through 2-9 Appendix B
845.620(b)(14)	A map displaying any known underground mines beneath a CCR surface impoundment;	Section 2.4.5 Appendix A
845.620(b)(15)	Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface;	Section 2.5 Tables 2-1, 2-2, & 2-4 Appendices B & C
845.620(b)(16)	Hydraulic characteristics of the geologic layers identified as migration pathways and geologic layers that limit migration, including:	Sections 3.2.4.1, 3.2.5, & 3.2.6 Tables 3-2 to 3-4 Appendices C & E
845.620(b)(16)(A)	water table depth;	Section 3.2.4 Figures 3-3 to 3-5
845.620(b)(16)(B)	hydraulic conductivities;	Section 3.2.5 Tables 2-1 & 3-3 Appendix E
845.620(b)(16)(C)	effective and total porosities;	Sections 2.5.1 Table 2-1

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TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(16)(D)	direction and velocity of groundwater flow; and	Sections 3.2.4 & 3.2.6 Tables 3-2, 3-4, & 4-2 Figures 3-3 to 3-5 Appendix D
845.620(b)(16)(E)	map of the potentiometric surface;	Figures 3-2 through 3-5
845.620(b)(17)	Groundwater classification pursuant to 35 I.A.C. § 620	Section 3.2.7

[O: EDP 08/24/21, C: LDC 09/16/21]

Notes:
35 I.A.C. § 620 = Title 35 of the Illinois Administrative Code, Part 620
HCR = Hydrogeologic Characterization Report
-- = reference to main regulation

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: 35 I.A.C. § 845 (Part 845) (IEPA, April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this HCR on behalf of DCPP (**Figure 1-1**), operated by Illinois Power Resources Generating, LLC (IPRG). This report will apply specifically to the CCR Unit referred to as the GMF Pond. However, information gathered to evaluate other CCR units in the vicinity regarding geology, hydrogeology, and groundwater quality is included, where appropriate. The GMF Pond consists of a 1,500-foot by 900-foot earthen berm with 3.5:1 side slopes, a maximum elevation of 620 feet, a double geomembrane liner consisting of a 60-millimeter (mil) high-density polyethylene (HDPE) geomembrane liner, 12-inch clay cushion, 4 ounce per square yard (oz/yd^2) non-woven geotextile filter fabric, 12-inch highly permeable granular drainage (sand), 10 oz/yd^2 non-woven geotextile filter fabric, 60-mil HDPE geomembrane liner, reinforced bentonite mat, 36-inch compacted clay, all installed over in-situ foundation soil, and all pipes, pumps, and appurtenances necessary for the storage of approximately 3.6 million tons of gypsum at a maximum elevation of 715 feet with discharge to the GMF Recycle Pond. This HCR includes Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the GMF Pond at the DCPP.

1.2 Part 845 Description

CCR is commonly referred to as coal ash, and CCR SIs are commonly referred to as coal ash ponds. Part 845 contains comprehensive rules for the design, construction, operation, corrective action, closure, and post closure care of these SIs. This rule includes GWPSs applicable at the waste boundary at each CCR SI and requires each owner or operator to monitor groundwater. IEPA's rule includes a permitting program as well as all federal standards for CCR SIs promulgated by the United States Environmental Protection Agency (USEPA). In addition, the rules include procedures for public participation, closure alternatives analyses, and closure prioritization, and provides access to records via public website. The rules also include financial assurance requirements for CCR SIs.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.620 is included in **Table ES-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.620.

1.3 Previous Investigations and Reports

Numerous hydrogeologic investigations have been performed concerning the CCR Units at the DCPP. The information presented in this HCR includes data collected in support of the monitoring well network established for development of the GMP and supplements comprehensive data collection and evaluations from prior hydrogeologic investigation reports (recent to oldest), including, but not limited to, the following:

- ***Hanson Professional Services, Inc. (Hanson), March 25, 2021. First Quarter 2021 Groundwater Report, Duck Creek Power Station, Gypsum Stack and Recycle Pond, WPC Permit No. 2017-EO-62640, Fulton County.***
  Quarterly comparison of groundwater monitoring results to the relevant groundwater standard and submittal of the quarterly sample results.

- ***Natural Resource Technology, an OBG Company (NRT/OBG), October 17, 2017. Hydrogeologic Monitoring Plan, Duck Creek GMF Pond – CCR Unit ID 203, Duck Creek Landfill – CCR Unit ID 204, Duck Creek Power Station, Canton, Illinois.***
  Hydrogeologic Monitoring Plan (HMP) prepared to provide background information necessary to support the groundwater monitoring system established to comply with Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257.91 to regulate the disposal of CCR as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA) [40 C.F.R. § 257 Subpart D; published in 80 FR 21302-21501, April 17, 2015] for the DCPP located in Canton, Illinois.
- ***AECOM, October 2016. History of Construction, USEPA Final CCR Rule, 40 C.F.R. § 257.739(c), Duck Creek Power Station, Canton, Illinois.***
  History of construction for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the DCPP in accordance with 40 C.F.R. § 257.73(c).
- ***Hanson, March 2016. Clay Liner Evaluation Report, Illinois Power Resources Generating LLC, Duck Creek Power Station, Fulton County, Illinois.***
  Evaluation prepared to show that the existing liner in the GMF Pond meets the minimum requirements of the 40 C.F.R. § 257 regulations. Conclusion indicated that the as built liner exceeds the performance standard set by 40 C.F.R. § 257.70(b). Construction Quality Assurance (CQA) documents are presented to verify the integrity of the liner components.
- ***Natural Resource Technology, Inc. (NRT), March 31, 2016. Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan, Duck Creek Ash Ponds 1 and 2, Duck Creek Energy Center, Canton, Illinois.***
  This Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan was prepared to develop hydrogeologic information in support of a Closure Plan for the Duck Creek Energy Center Ash Ponds 1 and 2.
- ***Hanson, February 29, 2016. Ash Pond 1 and Ash Pond 2, Aquifer Evaluation in the Surface (Strip) Mining Area, Duck Creek Power Station, Illinois Power Resources Generating, LLC, Fulton County, IL.***
  Characterization of strip mining areas adjacent to Ash Ponds 1 and 2 at the DCPP.
- ***Hanson, March 2010. Hydrogeologic Report, Ameren Duck Creek Power Generating Station Solid Waste Disposal System (Ash Pond 1, Ash Pond 2, and Recycle Pond).***
  Hydrogeologic site characterization report for multiple ponds at the DCPP.
- ***Hanson, 2009. Section 3 – Hydrogeologic Report, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Springfield, Fulton County, Illinois.***
  An overview prepared to illustrate regional climate, geology, and hydrogeology and site-specific information related to geotechnical, hydrogeological, and geochemical characteristics found at the site.

A GMP is being prepared for the GMF Pond in conjunction with this report and is included in the Operating Permit to which this Report is attached.

1.4 Site Location and Background

The DCPP is located in Fulton County, Illinois and approximately 6 miles southeast of the town of Canton. The GMF Pond is located north of the power plant in Section 18 of Township 6 North,

Range 5 East (**Figure 1-1**). The GMF Recycle Pond is located just south of the GMF Pond (**Figure 1-2**). The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. The Landfill is located due north of the GMF Pond and the closed units, Ash Pond No. 1 and Ash Pond No 2, are located south of the GMF Recycle Pond. Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP (**Figure 1-1**). Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development.

1.5 Site History and Unit Description

Surface preparation for the GMF Pond began in 2007 and construction took place from 2008 to 2009. The GMF Recycle Pond was constructed at the same time.

The GMF Pond, also referred to as the gypsum stack/management system, operates under an IEPA permit (#2017-E0-62640) issued in December 2017. It consists of a 1,500-foot by 900-foot earthen berm with 3.5:1 side slopes, a maximum elevation of 620 feet, a double geomembrane liner consisting of a 60-mil HDPE geomembrane liner, 12-inch clay cushion, 4 oz/yd^2 non-woven geotextile filter fabric, 12-inch highly permeable granular drainage (sand), 10 oz/yd^2 non-woven geotextile filter fabric, 60-mil HDPE geomembrane liner, reinforced bentonite mat, 36-inch compacted clay, all installed over in-situ foundation soil, and all pipes, pumps, and appurtenances necessary for the storage of approximately 3.6 million tons of gypsum at a maximum elevation of 715 feet with discharge to the GMF Recycle Pond.

The GMF Pond decant water discharges to the GMF Recycle Pond, which has a capacity of 32.6 million gallons. The GMF Recycle Pond is lined with a 60-mil HDPE geomembrane liner, reinforced bentonite mat and 36 inches of compacted clay.

2. REGIONAL AND LOCAL GEOLOGY

2.1 Topography

Topography within the DCPP property (**Figure 1-1**) is significantly influenced by the history of mining in the area. Strip mining has occurred in this area since the 1930s prior to mine reclamation laws; and, where present, has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit. The strip mining activity has produced rough topography from soil piles and depressions, often ponded with water (Hanson, 2009). As discussed later in this document, soils in the immediate vicinity of the GMF Pond and GMF Recycle Pond do not appear to have been disturbed by surface mining activities; however, areas surrounding these ponds have been disturbed. Topography adjacent to the GMF Pond is provided in **Figure 2-1**.

2.2 Regional Geomorphology

The DCPP lies near the east edge of Fulton County in north central Illinois. The study area lies along the southeast edge of the Galesburg Plain Division of the Central Lowland Physiographic Province. The area consists of flat to gently rolling uplands that are dissected by many, deeply incised streams that are tributaries to major river systems. The erosional landforms have developed primarily within deposits of glacial drift that blanket Pennsylvanian-aged bedrock. The Pennsylvanian bedrock generally controls the landforms, particularly drainage ways and rivers in the area (Hanson, 2009).

The Illinois River delineates the southeast border of the Galesburg Plain and is the main drainage for the region. The physiography of many areas in the Galesburg Plain has been affected by strip mining of coal. Strip mines have altered the natural landforms and drainage systems. Unreclaimed strip mine areas are usually very hummocky with mine spoils and are pocked with ponds and depressions (Hanson, 2009).

2.3 Soils

Surficial soils at the Site and vicinity are shown on **Figure 2-2**, based on the soil survey performed in Fulton County in 1994 available in the Soil Survey Geographic database (SSURGO) by the United States Department of Agriculture Natural Resources Conservation Service (NRCS) provided by the Environmental Systems Research Institute (ESRI) web-hosted layer (NRCS, 1997).

Former soils underlying the Site are identified as Fayette Silt Loam (#280E2 and #280gD2), Keomah Silt Loam (#17A), and Rozetta Silt Loam (#279B and #279C2). The Fayette series consists of well drained loess on sideslopes along upland drainageways. This soil is well suited for and used as habitat for openland and woodland wildlife. These soils are moderately suitable for cultivated crops due to crusting and water erosion and unsuitable for dwellings due to flooding. The Keomah series consists of somewhat poorly drained loess in interfluvial areas. This soil is well suited for and used as habitat for openland wildlife. These soils are moderately suitable for cultivated crops due to crusting and flooding and only moderately suitable to unsuitable for dwellings due to slope. The Rozetta series consists of well drained loess in interfluvial areas, head slopes, and sideslopes along upland drainageways. This soil is well suited for and used as habitat for openland and woodland wildlife. These soils are moderately suitable for cultivated crops due to crusting and water erosion and only moderately suitable for dwellings due to flooding.

Areas surrounding the GMF Pond are classified as Hickory Silt Loam (#8cF), Elco Silt Loam (#119E2), and Clarksdale Silt Loam (#257A). The Hickory series consists of well-drained till. These soils formed on sideslopes along upland drainageways. Most areas of this association are moderately unsuitable for cultivated crops due to frost heave, low pH, and water erosion. The Elco series consists of moderately well drained loess and underlying paleosol. These soils formed in loess and till on sideslopes along upland drainageways. Most areas of this association are moderately suitable for cultivated crops due to frost heave, low pH, and water erosion. The Clarksdale series consists of somewhat poorly drained loess. These soils formed in interfluvial areas. Most areas of this association are moderately suitable for cultivated crops due to frost heave, low pH, and wetness.

2.4 Regional Geology

Regionally, the DCPP is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province.

2.4.1 Regional Unlithified Geology

Upper unlithified materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems. The erosional landforms have developed primarily within deposits of glacial drift that blanket Pennsylvanian-aged bedrock (NRT/OBG, 2017a).

Areas near the GMF Pond are part of several large surface coal mines (**Figure 2-3**) where unlithified materials are present in the excavated strip mine spoils, but have been mixed due to the surface mining activities. Mining operations in the area have ceased (NRT/OBG, 2017a).

The Radnor Till is the only surficial Quaternary geologic deposit regionally mapped in the vicinity of the GMF Pond and is shown on **Figure 2-4**.

2.4.2 Regional Bedrock Geology

The uppermost bedrock stratum in the area is the Carbondale Formation of the Kewanee Group of the Pennsylvanian System. The Carbondale Formation consists of interbedded sequences of shale, sandstone, limestone, and coal with associated underclay. These sediments were deposited in shallow marine, deltaic, and swamp environments. Some of the shales are fossiliferous (containing either plant or marine fossils), and some contain sideritic nodules and bands. The sandstones are mostly subgraywackes and occur in elongated channel facies. The limestones are generally gray to dark gray, argillaceous, and normally fossiliferous. Thin black fissile shales are commonly associated with the limestones. The Carbondale Formation includes the principle Illinois economic coals: the Herrin (No. 6), the Springfield (No. 5), the Colchester (No. 2), and the Danville (No. 7). Underclays occur at the base of the coal seams. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) coal seam (Hanson, 2009).

2.4.3 Structure

The bedrock surface in the site area has been mapped at about elevation 560 feet NAVD88. The bedrock mapping indicates the beds dip to the east-southeast at about 60 feet per mile. The St. Davis anticline occurs within the Pennsylvanian sequence and passes through the landfill area which explains the lack of strip mining activity in this portion of the DCPP (Hanson, 2005).

2.4.4 Seismic Setting

The major geologic structural features within Illinois are depicted on **Figure 2-5**. Fulton County is not located in a seismic impact zone. The nearest areas of present-day fault-related, seismic activity are the Northern Illinois Seismic Source Zone and the Wabash Valley Fault Zone near southwestern Indiana and the New Madrid Fault Zone along the Ohio and Mississippi River Valleys in southeastern Illinois. Records dating from 1811 indicate that earthquakes greater than a Richter Scale Magnitude 6.0 occurred in or near the New Madrid Fault line. Away from the fault, all earthquakes have been a 5.9 magnitude or less. The earthquake epicenters appear to be the result of modern regional stress fields and are not related to the nearby inactive faults (Hanson, 2009).

2.4.5 Mining Activities

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. As indicated above, strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit at some portions of the Site. Previous investigations completed outside of the GMF Pond at the Site also indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet (as observed at monitoring well OM24D and OM15 near the ash ponds). The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to several former large surface mining areas (**Figure 2-3** and **Appendix A**).

2.5 Site Geology

A field investigation was performed in 2021 to collect additional data for the discussion of vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet below ground surface (bgs) as specified in 35 I.A.C. § 845.620(b). Field investigation locations from 2021 are shown on **Figure 2-6**. The major geomorphic features occurring within and nearby the GMF Pond include Peoria/Roxanna Loess overlying Glasford Formation clayey diamictons (till).

2.5.1 Site-Specific Unlithified Geology

The unlithified stratigraphy within and immediately surrounding the GMF Pond consists of the following in descending order: fill material and CCR; silt and clayey silt loess (Peoria/Roxanna Loess); weathered till (upper Radnor Till); shallow, medium-grained sand to silt zone within the Radnor Till; and till (lower Radnor Till). The unlithified units overlay Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). Boring logs and monitoring well and piezometer construction forms obtained from investigations at the GMF Pond are provided in **Appendix B**. Cross-sections showing the subsurface materials encountered at the GMF Pond are included in **Figures 2-7 and 2-8**. Samples for geotechnical analysis were collected from interpreted geologic units and composited to obtain a representative sample of the entire geologic unit prior to submittal (**Table 2-1**).

2.5.1.1 Fill and CCR

Gypsum is present within the GMF Pond at a maximum thickness of approximately 22 feet, as estimated from topography and the elevation of the base of the liner from available construction details (**Figure 2-9**). The range of gypsum thickness is estimated from less than 1 to 22 feet.

The thickest areas of gypsum are to the north and west within the GMF Pond and thin toward the south end of the GMF Pond. The base of the liner rests on top of the lower Radnor Till.

Geotechnical analysis results from two grab samples (sample IDs Gypsum and LSN-3781/Gypsum) collected from the GMF Pond near XTPW01 are summarized in **Table 2-1**. Sample locations are shown on **Figure 2-6**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results from grab samples near XTPW01 indicated the following:

- Average moisture content of 30.7 percent, with a range of 28.8 to 32.5 percent.
- Total porosity (calculated) of 56.1 percent.
- Dry density of 73.9 pounds per cubic foot (pcf).
- Average specific gravity of 2.51, with a range of 2.310 to 2.700.
- Grain size composition of 0 percent gravel, 4 percent sand, and 96 percent fines (silt and clay).
- Vertical hydraulic conductivity of 6.7×10^{-4} centimeters per second (cm/s).

Solid samples were collected from grab samples near XTPW01 in 2021 for chemical analysis. The results of solid samples collected from within the gypsum are summarized in **Table 2-2**.

To sample porewater, a piezometer (pre-pack well, XTPW02) was installed by Golder Associates, Inc. 5.5 feet into the gypsum on June 23, 2021. XTPW02 is located approximately 132 feet east of the western edge of the GMF Pond and is shown on **Figure 2-6**. The piezometer was installed using hand tools (no drilling log). A porewater sample was collected from XTPW02 on June 23, 2021. The results of porewater sample are summarized in **Table 2-3.**

2.5.1.2 Peoria/Roxanna Loess

The Wisconsinan Stage Peoria/Roxanna Loess extends from beneath the topsoil developed in the loess to depths ranging from 11 to 21 feet. The loess consists predominantly of silt and clayey silt with minor amounts of sand. The loess exhibits iron staining, concretions, and some fracturing. The Loess Unit is saturated below depths varying from approximately 3.5 to 11 feet.

Geotechnical analysis results from samples collected from Peoria/Roxanna Loess yielded Unified Soil Classification System (USCS) soil classifications of lean clay. Sample locations are shown on **Figure 2-6,** the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 22.0 percent, with a range of 18.6 to 25.9 percent.
- Average total porosity (calculated) of 37 percent, with a range of 32.4 to 41.8 percent.
- Average dry density of 103.8 pcf, with a range of 97.3 to 113.1 pcf.
- Average specific gravity of 2.67, with a range of 2.650 to 2.680.
- Average grain size composition of 0.1 percent gravel, 8.6 percent sand, and 91.4 percent fines (silt and clay). The fines content ranged from 88.2 to 97.4 percent, with a median value of 88.5 percent.

- Geometric mean vertical hydraulic conductivity of 2.1 x 10^{-7} cm/s and ranged from 7.1 x 10^{-8} to 6.3 x 10^{-7} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the loess are summarized in **Table 2-4**.

2.5.1.3 Upper Radnor Till

The loess is generally underlain by a relatively thin till sequence consisting of the Berry Clay (where present) and the Illinoian Stage upper Radnor Till. The till sequence ranges in thickness from 9 to 21 feet in the area of the GMF Pond. This shallow till is generally weathered and exhibits signs of oxidation and fracturing. The till is primarily clayey silt with minor amounts of sand and gravel.

Geotechnical analysis results from samples collected from the upper Radnor Till yielded USCS soil classifications of lean clay. Sample locations are shown on **Figure 2-6,** the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 22.4 percent, with a range of 21.1 to 24.6 percent.
- Average total porosity (calculated) of 36.8 percent, with a range of 30.7 to 41.4 percent.
- Average dry density of 106.1 pcf, with a range of 98.0 to 116.7 pcf.
- Average specific gravity of 2.69, with a range of 2.680 to 2.700.
- Average grain size composition of 1.5 percent gravel, 22.6 percent sand, and 75.9 percent fines (silt and clay). The fines content ranged from 77 to 80.6 percent, with a median value of 75.4 percent.
- Geometric mean vertical hydraulic conductivity of 7.7 x 10^{-7} cm/s and ranged from 2.6 x 10^{-7} to 2.3 x 10^{-6} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the upper Radnor Till are summarized in **Table 2-4**.

2.5.1.4 Shallow Sand Zone

The Shallow Sand Zone is laterally extensive within the Radnor Till across the site and varies in thickness from less than 1 to 18 feet near the GMF Pond. The top of the Shallow Sand Zone is generally located at an elevation of 570 to 590 feet msl. The Shallow Sand Zone exhibits lateral facies changes across the site and varies from a medium-grained sand to a silt and often contains intercalated till seams, as shown in the hydrogeologic cross sections (**Figures 2-7 and 2-8**). The Shallow Sand Zone is saturated. The Shallow Sand Zone is the most laterally extensive at the GMF Pond, with other zones having either an unsaturated component, intermittent presence, or entirely absent.

During construction, shallow sand was encountered and completely removed from underneath the northeast corner and southwest corner of the GMF Pond, putting the liner in contact with clay of the lower Radnor Till (**Figures 2-7 and 2-8**). Sand outside the GMF Pond footprint remains.

Geotechnical analysis results from samples collected from the Shallow Sand Zone yielded USCS soil classifications of silty lean clay and lean clay. These USCS classifications contain more fines

than expected, and are likely a result of difficulty targeting a thin sand zone within largely fine-grained materials. Sample locations are shown on **Figure 2-6**, the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 17.5 percent, with a range of 14.5 to 21.9 percent.
- Average total porosity (calculated) of 29.5 percent, with a range of 27.4 to 31.4 percent.
- Average dry density of 115.0 pcf, with a range of 105.1 to 122.3 pcf.
- Average specific gravity of 2.663, with a range of 2.640 to 2.700.
- Average grain size composition of 5.7 percent gravel, 27.1 percent sand, and 67.2 percent fines (silt and clay). The fines content ranged from 63.6 to 73.7 percent, with a median value of 64.4 percent.
- Geometric mean vertical hydraulic conductivity of 9.0×10^{-7} cm/s and ranged from 7.5×10^{-7} to 1.1×10^{-6} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the Shallow Sand Zone are summarized in **Table 2-4**.

2.5.1.5 Lower Radnor Till

Till sequences underlying the Shallow Sand Zone consist of clay, silt, and sand of the Illinoian Stage lower Radnor Till. The till ranges in thickness from 42 to 58 feet. In some areas of the site, including the area near the GMF Pond, the till sequences typically extend from the base of the shallow sand to the bedrock surface. In other areas of the site, the till sequences extend to intermediate or deep sands. The till sequences are typically high in silt content with varying amounts of clay, sand, and gravel, and are often calcareous.

Geotechnical analysis results from samples collected from the lower Radnor Till at soil borings yielded USCS soil classifications of silty clayey sand, silty lean clay, and lean clay. Sample locations are shown on **Figure 2-6**, the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 10.5 percent, with a range of 7.7 to 12.6 percent.
- Average total porosity (calculated) of 22.3 percent, with a range of 20.6 to 23.5 percent.
- Average dry density of 127.5 pcf, with a range of 123.2 to 133.8 pcf.
- Average specific gravity of 2.670, with a range of 2.640 to 2.700.
- Average grain size composition of 7.7 percent gravel, 38.2 percent sand, and 54 percent fines (silt and clay). The fines content ranged from 49.3 to 56.5 percent, with a median value of 64.4 percent.
- Geometric mean vertical hydraulic conductivity of 4.7×10^{-7} cm/s and ranged from 4.1×10^{-8} to 5.4×10^{-6} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the lower Radnor Till are summarized in **Table 2-4**.

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2.5.2 Site Specific Bedrock Geology

Pennsylvanian bedrock was encountered at greatly varying depths across the site. Bedrock depths ranged from a minimum of 52 feet to a maximum of 108 feet. Bedrock was encountered at boring locations B-54, B-60, and G54C at 84 feet bgs, 88 feet bgs, and 90 feet bgs, respectively, in the vicinity of the GMF Pond (**Appendix D** for boring locations). The bedrock shows little compositional variation across the site and consists primarily of shaley siltstone and silty shale. The shale bedrock unit is typically weathered near the surface, has low hydraulic conductivity, and underlies the glacial till sequences. These units often contain thin dolomite ledges and nodules and some fractures.

3. REGIONAL AND LOCAL HYDROGEOLOGY

3.1 Regional Hydrogeology

As discussed in **Section 2**, unlithified materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits overlying Pennsylvanian-aged bedrock. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems in areas that have not been disturbed by strip mining activity.

Available records of wells within one mile of the site indicate potable water may be obtained from unconsolidated materials or from deep bedrock. Estimated specific capacity (used to approximate the transmissivity of a formation) indicated shallow sands near the GMF Pond provide a very modest specific capacity and groundwater yield (Hanson, 2009).

3.2 Site Hydrogeology

Wells used for groundwater monitoring at the GMF Pond have been constructed in phases since 2008. Prior to 2021, there were more than 30 wells used to monitor the GMF Pond. In 2021, one additional well (G54C) was installed in bedrock to provide information to meet the requirements of Part 845. Construction details for monitoring wells and piezometers associated with the GMF Pond are provided in **Table 3-1** and depicted in **Figure 3-1**. Boring logs, monitoring well and piezometer construction forms are provided in **Appendix B**.

3.2.1 Hydrostratigraphic Units

Three distinct water-bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics which are summarized and discussed in subsequent sections:

- **The Uppermost Aquifer**: At the GMF Pond this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sands described in detail in **Section 2.5.1**. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (NRT/OBG, 2017a). The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally located at an elevation of 570 to 590 feet msl. The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the northeast corner and southwest corner of the pond), putting the base of liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.
- **Lower Radnor Till/Lower Confining Unit**: Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick. Previous hydrogeologic studies indicate discontinuous sand lenses observed within the till are not hydraulically connected to the shallow sand unit (NRT/OBG, 2017a).
- **Bedrock Confining Unit**: The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet. The boring for monitoring well G54C extends 11.5 feet into the bedrock. Additional bedrock detail is provided in **Section 2.5.2**.

3.2.2 Uppermost Aquifer

As stated above, this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sand zone. The shallow sand zone is the primary migration pathway within these hydraulically connected formations. In places where the shallow sand unit is absent (such as beneath the GMF Pond Liner) the uppermost aquifer may be functionally absent, as the liner is in contact with clay till. Groundwater monitoring is focused in the shallow sand unit because it is the most permeable and laterally continuous unit at the Site. The top of the uppermost aquifer is presented in **Figure 3-2.** The base of the uppermost aquifer is the lower confining unit (the lower Radnor Till).

3.2.3 Potential Migration Pathway

The Peoria/Roxanna Loess within the uppermost aquifer has also been identified as a PMP. While the primary migration pathway is the shallow sand of the uppermost aquifer, impacts have the potential to migrate within groundwater in the overlying Peoria/Roxanna Loess. The PMP is saturated at depths of 3.5 to 11 feet bgs. While the PMP and uppermost aquifer are hydraulically connected, groundwater flow in the PMP is expected to be primarily vertical, with the majority of the horizontal migration expected to occur within the uppermost aquifer. Monitoring wells with the suffix "L" are screened within the loess and provide representative data on the hydraulic properties and groundwater quality of the PMP.

3.2.4 Water Table Elevation and Groundwater Flow Direction

Groundwater flow across the GMF Pond within the uppermost aquifer is consistently in a southeast direction toward the Duck Creek Cooling Pond (**Figures 3-3 and 3-4**). Groundwater elevations of the uppermost aquifer vary seasonally although flow directions are generally consistent (additional contour maps are included in **Appendix D**).

Groundwater elevations in the PMP wells are generally higher than those in the uppermost aquifer and reflect the groundwater flow in the underlying uppermost aquifer wells. Surface water elevations within the GMF Pond are higher than the groundwater.

3.2.4.1 Vertical Hydraulic Gradients

Vertical hydraulic gradients were calculated using available groundwater elevation data from April to August 2021 at wells screened in the PMP, uppermost aquifer, and bedrock (**Table 3-2**). The results of the vertical hydraulic gradient calculations between these hydrostratigraphic units are summarized below:

- Uppermost aquifer to PMP:
  - Vertical hydraulic gradients between wells G51L (PMP) and G51S (uppermost aquifer) ranged from -0.01 to -0.03 feet per feet (ft/ft), upward, averaging 0.02 ft/ft upward
  - G54L (PMP) and G54S (uppermost aquifer) ranged from 0.01 to 0.09 ft/ft downward, averaging 0.04 ft/ft downward
  - G57L (PMP) and G57S (uppermost aquifer) ranged from -0.04 ft/ft upward to 0.12 ft/ft downward, averaging 0.02 ft/ft downward
  - G60L (PMP) and G60S (uppermost aquifer) ranged from 1.2 to 1.6 ft/ft downward, averaging 1.3 ft/ft downward

- Bedrock confining unit to uppermost aquifer:
  - Vertical hydraulic gradients between wells G54C (bedrock confining unit) and G54S (uppermost aquifer) ranged from 0.17 to 0.27 ft/ft, downward, averaging a downward vertical gradient of 0.20 ft/ft

The downward gradients observed between downgradient wells G54L and G54S, and G60L and G60S, are consistent with vertical gradients reported by Hanson in 2009. The slightly upward gradient between upgradient wells G51L and G51S, and the variable gradients between downgradient wells G57L and G57S did not have a comparable measurement from previous studies.

3.2.4.2 Impact of Existing Ponds and Ash Saturation

The GMF Pond is lined, as described in **Section 1.5,** and the shallow sands of the uppermost aquifer were removed from within the footprint of the pond. The phreatic surface measured from a transducer at location X301 within the GMF Pond ranges from approximately 613 to 617 feet NAVD88 with an average around 614 feet (**Appendix D**), whereas groundwater elevations measured in monitoring wells located around the GMF Pond and screened within the uppermost aquifer range from approximately 590 to 578 feet NAVD88. Groundwater elevation contours indicate groundwater generally flow to the southeast, with no indication of radial flow. The elevation difference between the phreatic surface and groundwater elevations, in addition to no observations of radial flow, provide evidence that the GMF Pond does not impact groundwater flow directions via recharge to groundwater. Given the low permeability of the liner system, it is more likely that the GMF Pond is a barrier to groundwater flow within the uppermost aquifer, deflecting flow from upgradient areas around the perimeter of the pond toward the downgradient areas.

With the relatively stable phreatic surface elevation within the pond around 614 feet, the thickness of saturated CCR (gypsum) in the pond will correspond with the thickness of gypsum in the pond. Thicker accumulations of gypsum are present in the north end of the pond and thin to the south.

3.2.4.3 Impact of Surface Water Bodies

The nearest surface water body to the GMF Pond is the Duck Creek Cooling Pond, which is located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Cooling Pond is estimated to be from 562.5 to 565 feet NAVD88. Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond, indicating that groundwater in the vicinity of the GMF Pond is flowing toward the Cooling Pond. The shoreline of the Cooling Pond is very irregular (**Figure 1-1**) as it occupies the former surface water drainage features associated with Duck Creek (which was impounded to create the Cooling Pond).

3.2.5 Hydraulic Conductivities

3.2.5.1 Field Hydraulic Conductivities

Field hydraulic conductivity tests were performed in the uppermost aquifer by Hanson in 2021. Hydraulic conductivity test analyses and results are summarized in **Table 3-3** and provided in **Appendix E**. Field hydraulic conductivity tests from monitoring wells G50L, G51L, G53L, G54L, G60L, G50S, G51S, G53S, G54S, G57S, G60S, and G63S indicated hydraulic conductivities from 3.0×10^{-5} to 3.9×10^{-3} cm/s with a geometric mean of 3.6×10^{-4} cm/s.

Results of field hydraulic conductivity tests conducted in 2021 in the bedrock confining unit by Hanson at monitoring well G54C ranged from 1.4 x 10^{-4} to 1.6 x10^{-4} cm/s, with a geometric mean of 1.5 x 10^{-4} cm/s. This is higher in comparison to the horizontal hydraulic conductivity range of 1.3 x 10^{-6} cm/s to 1.3 x 10^{-9} cm/s, established by Hanson in 2015, which used pressure testing on borehole OM32. The higher values observed at G54C are attributed to the highly weathered nature of the bedrock in the screen interval which is supported by the low rock quality designation (RQD) N values ranging from 14-22 (lower numbers indicating lower percentage of intact rock core recovered).

3.2.5.2 Laboratory Hydraulic Conductivities

Falling head permeability tests (ASTM D5084 Method F) were performed in the laboratory on samples collected during the 2021 investigations. Sample locations are shown on **Figure 2-6**. The geotechnical laboratory report from the most recent investigation and previous investigations (AECOM, 2016) are provided in **Appendix C**. The results are summarized in **Table 2-1** and discussed below.

- One CCR sample (LSN-3781) was collected from gypsum boring XTPW01. Laboratory falling head permeability test results in the CCR indicated a vertical hydraulic conductivity of 6.7 x 10^{-4} cm/s.
- Two samples were collected from the lower Radnor Till from soil boring G54C. Laboratory falling head permeability test results in the lower Radnor Till indicated a vertical hydraulic conductivity ranging from 4.1 x 10^{-8} to 5.4 x 10^{-6} cm/s.
- Seven samples were collected from the uppermost aquifer from soil borings G54C, SB50, and SB62. Laboratory falling head permeability test results in the uppermost aquifer indicated vertical hydraulic conductivities ranging from 7.1 x 10^{-8} to 1.1 x 10^{-6} cm/s, and a geometric mean vertical hydraulic conductivity of 4.6 x 10^{-7} cm/s.

3.2.6 Horizontal Groundwater Gradients and Flow Velocities

Groundwater flow around the GMF is generally in a southeast direction (**Figures 3-3 through 3-4**). Seasonal variation of groundwater levels at the GMF Pond are indicated in the series of 2015 to 2020 groundwater elevation contour maps and groundwater elevation table (**Appendix D**). Observed groundwater elevations may fluctuate seasonally by 1 to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond.

Horizontal hydraulic gradients and groundwater velocities for the uppermost aquifer were calculated based upon groundwater elevation measurements from April through August 2021 between G50S and G60S, G51S and G54S, and G50S and G64S (**Table 3-4**). Horizontal hydraulic gradients are slight across the GMF Pond and ranged from 0.0111 ft/ft between G50S and G64S in August 2021 to 0.0225 ft/ft between G51S and G54S in May 2021. The hydraulic gradients are consistent with previous calculations of horizontal gradients at upgradient locations (NRT/OBG, 2017a).

Horizontal hydraulic gradients calculated to the north of the GMF Pond, between G50S and G64S, were on average 0.0121 ft/ft with an average groundwater velocity of 0.045 feet per day (ft/day). Horizontal hydraulic gradients calculated through the center of the GMF Pond, between G50S and G60S, were on average 0.0172 ft/ft with an average groundwater velocity of 0.625 ft/day. Horizontal hydraulic gradients calculated to the south of the GMF Pond, between G51S

and G54S, were on average 0.0199 ft/ft, with an average groundwater velocity of 0.041 ft/day. From April to June 2021, average groundwater flow velocities at the GMF Pond were 0.024 ft/day and from July to August 2021, groundwater flow velocities at the GMF Pond were on average 0.023 ft/day. Horizontal hydraulic gradients and groundwater flow velocities are presented in **Table 3-4**.

3.2.7 Groundwater Classification

Per 35 I.A.C. § 620.210, groundwater within the uppermost aquifer at the GMF Pond meets the definition of a Class I – Potable Resource Groundwater based on the following criteria:

- Groundwater in the uppermost aquifer extends 10 feet or more below the land surface.
- Hydraulic conductivity exceeds the 1 x 10^{-4} cm/s criterion (**Table 3-3**).

Field hydraulic conductivity tests performed on the unlithified geologic materials that include loess, shallow sand, and intermediate sand at the GMF Pond had geometric mean hydraulic conductivities exceeding 1 x 10^{-4} cm/s. Based on this information groundwater is classified as Class I – Potable Resource Groundwater.

However, background (upgradient) groundwater originates from areas north and west of the GMF Pond that have been surface mined and present a significant alternative source for groundwater impacts.

3.3 Surface Water Hydrology

Surface water drainage over much of the site flows east or southeast into the Duck Creek Cooling Pond. The Duck Creek Cooling Pond was formed by damming a portion of Duck Creek, a minor tributary of the Illinois River, and was used for thermal treatment of cooling water discharged from the DCPP.

3.3.1 Climate

The climate in Canton is humid and annual precipitation generally exceeds evapotranspiration. Illinois State Water Survey (ISWS) records from 1989 through 2020 at Peoria, Illinois, which is located approximately 35 miles northeast of the DCPP, indicates precipitation averages 35.3 inches per year. Monthly precipitation averages higher than 3 inches from April through August, and 1 to 3 inches in September through March. On average 16 inches of precipitation occur as snowfall.

As shown in **Table A** below, ISWS temperature records show average maximum daily temperatures for 1989 to 2020 ranging from above 70 degrees Fahrenheit (°F) in May through September and minimum average daily temperatures that are below freezing December through March.

Table A. Average Monthly Temperature Extremes and Precipitation for Peoria, Illinois

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum Temperature (ºF)	33.3	37.6	49.9	62.5	72.6	81.3	84.4	82.5	76.9	64.5	50.1	37.2	61.2
Minimum Temperature (ºF)	18.3	21.5	31.6	41.8	52.2	61.7	65.4	63.2	55.4	44.1	33.3	22.7	42.7
Precipitation (inches)	1.71	1.60	2.08	3.42	3.93	3.18	3.02	3.10	2.97	2.64	2.35	1.84	35.3
https://www.isws.illinois.edu/warm/stationmeta.asp?site=ICC&from=wx													

3.3.2 Surface Waters

Duck Creek formerly bordered the east perimeter of the DCPP. In this area, Duck Creek has been dammed for use for thermal treatment of cooling water discharge from the DCPP and is now the predominant surface water body in the vicinity of the GMF Pond. Surface water elevations of the Cooling Pond are from 562.5 to 565 feet NAVD88. Other surface waters in the vicinity include Buckheart Creek to the west, and Rice Lake, Miserable Lake, Big Lake, and Goose Lake to the east, all of which are backwater lakes located between Duck Creek and the Illinois River. The distance between the GMF Pond and the Illinois River is sufficient to eliminate influence on local flow conditions at the site; therefore, site-specific flow conditions are not subject to surface water conditions of the Illinois River. Other surface waters in the vicinity of the GMF Pond include freshwater emergent wetland to the east, and various freshwater ponds to the northeast, south, southeast, and southwest.

4. GROUNDWATER QUALITY

4.1 Summary of Groundwater Monitoring Activities

Groundwater monitoring programs are currently being conducted at the GMF Pond as required by USEPA and IEPA. Additional monitoring was completed in 2021 for development of the Part 845 monitoring program. These programs are summarized below.

4.1.1 40 C.F.R. § 257 Program Monitoring and Well Network

The 40 C.F.R. § 257 Well Network consists of seven monitoring wells screened in the uppermost aquifer nearby and adjacent to the GMF Pond including: three background monitoring wells (G02S, G50S, and G51S) and four compliance monitoring wells (G54S, G57S, G60S, and G64S). The boring logs, well construction forms, and other related monitoring well forms for the GMF Pond 40 C.F.R. § 257 Well Network are included in **Appendix B** of this HCR. The well locations are shown on **Figure 3-1**.

Groundwater is being monitored at the GMF Pond in accordance with the Detection Monitoring Program requirements specified in 40 C.F.R. § 257.94. Details of the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the Sampling and Analysis Plan for the GMF Pond (NRT/OBG, 2017b). Results are discussed in **Section 4.2**.

The 40 C.F.R. § 257 groundwater samples are collected semi-annually and analyzed for the field and laboratory parameters from Appendix III of 40 C.F.R. § 257, summarized in **Table B** below.

Table B. 40 C.F.R. § 257 Groundwater Monitoring Program Parameters

Field Parameters[1]		
pH	Groundwater Elevation	
Appendix III Parameters (Total, except total dissolved solids [TDS])		
Boron	Chloride	Sulfate
Calcium	Fluoride	TDS

[1]Dissolved oxygen, temperature, specific conductance, oxidation/reduction potential, and turbidity were recorded during sample collection.

4.1.2 IEPA Groundwater Monitoring

Routine quarterly groundwater monitoring is completed at GMF Pond wells G50L/S, G51L/S, G52L/S, G53L/S, G54L/S, G55L/S, G56L/S, G57L/S, G58L/S, G59L/S, G60L/S, R61L/G61S, G62L, G63L/S, and G64L/S at the GMF Pond, in accordance with Water Pollution Control Permit No. 2017-E0-62640. This permit also requires sampling G65L/S, G66L/S, G67L/S, G70L, G71L/S, and G72L/S at the GMF Recycle Pond. The boring logs, well construction forms, and other related monitoring well forms for the GMF Pond well network are included in **Appendix B** of this HCR. The GMF Pond well locations are shown on **Figure 3-1**. Quarterly and annual samples are analyzed for the following field and laboratory parameters listed in **Table C** below.

Table C. IEPA Groundwater Monitoring Program Parameters

Field Parameters			
pH	Temperature	Specific Conductance	
Groundwater Elevation	Depth to Water (bmp)	Bottom of Well Elevation	
Quarterly Parameters (Dissolved)			
Arsenic	Cadmium	Lead	Sulfate
Boron	Chloride	Manganese	TDS
Annual Parameters (Dissolved)			
Alkalinity, bicarbonate	Chromium	Mercury	Selenium
Alkalinity, carbonate	Cobalt	Nickel	Sodium
Ammonia as Nitrogen	Iron	Nitrate nitrogen	Zinc
Calcium	Magnesium	Potassium	

4.1.3 Part 845 Well Installation and Groundwater Monitoring

In 2021, one additional monitoring well (G54C) was installed between the GMF Pond and the Gypsum Recycling Pond to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b). Additionally, a porewater sample was collected from temporary leachate monitoring location (XTPW02) installed within the GMF Pond to characterize the CCR materials.

Prospective Part 845 monitoring wells were sampled for eight rounds from February to August 2021 and the results were assessed for selection of the GMF Pond Part 845 monitoring well network presented in the groundwater monitoring plan. Samples were collected from the new monitoring points and analyzed for 35 I.A.C. § 845.600 parameters summarized in **Table D** below. Part 845 groundwater monitoring results are included below in **Section 4.2**.

Table D. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
pH	Turbidity	Groundwater Elevation	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1]Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

4.2 Groundwater Monitoring Results and Analysis

Groundwater data collected from the GMF Pond 40 C.F.R. § 257 network monitoring wells from 2015 to 2021 were supplemented with sampling of additional locations in 2021 and evaluated with respect to standards included in 35 I.A.C. § 845.600(a)(1). This data set was selected because it includes parameters (total metals) consistent with the parameter list in 35 I.A.C. § 845.600(a)(1). The groundwater analytical results are summarized in **Table 4-1** and discussed in the subsections below. Field parameters are included in **Table 4-2**. Results indicate that the parameters discussed in the following sections were detected at concentrations greater than the applicable 35 I.A.C. § 845.600(a)(1) standards and are considered potential exceedances[1].

4.2.1 Total Antimony

Total antimony was detected greater than the GWPS (0.006 milligrams per liter [mg/L]) in one of eight samples collected from downgradient well G57S. The other seven samples were non-detect. No other exceedances for total antimony were observed.

4.2.2 Total Arsenic

Total arsenic was detected greater than the GWPS (0.01 mg/L) in eleven downgradient wells G52S, G35S, G54L, G56S, G57L, G58L, G59L, G59S, G60S, G64S and P60. Total arsenic concentrations ranged from 0.001 to 0.051 mg/L. G52S is commonly in a side-gradient or upgradient position.

4.2.3 Total Cobalt

Total cobalt was detected greater than the GWPS (0.006 mg/L) in one of eight samples collected from downgradient well 60L. The other seven samples ranged from non-detect to 0.0052 mg/L. No other exceedances of total cobalt were observed.

4.2.4 Total Lead

Total lead was detected greater than the GWPS (0.0075 mg/L) in nine downgradient wells (G52S, G55S, G56S, G58L, G58S, G59L, G59S, G60S, G63L, and P60); and one background well G51S. Total lead concentrations in downgradient wells ranged from non-detect to 0.041 mg/L. Total lead concentrations in the upgradient well ranged from non-detect to 0.015 mg/L. G52S is commonly in a side-gradient or upgradient position.

4.2.5 Total Mercury

Total mercury was detected greater than the GWPS (0.002 mg/L) in one of 16 samples collected from upgradient well G02S. The other 15 samples were non-detect. No other exceedances for total mercury were observed.

[1] Potential exceedances include results reported during the eight rounds of baseline groundwater monitoring that are greater than the applicable 35 I.A.C. § 845.600(a)(1) standards. The results are considered potential exceedances because they were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the Groundwater Monitoring Plan (GMP). For simplicity, "GWPS" will be used hereafter in discussing potential exceedances. Exceedances will be determined following IEPA approval of the GMP.

4.2.6 pH (Lower Limit)

The GWPS lower standard for pH (6.5 standard units [SU]) was exceeded at four downgradient wells (G52L, G54L, G60L, and P60); and one background well G02S. Measurements of pH ranged from 6 to 7.1 SU in downgradient wells. Measurements ranged from 6.4 to 7.1 SU in the background well. G52L is commonly in a side-gradient or upgradient position.

4.2.7 Radium 226 and 228 Combined

Radium 226 and 228 combined was detected greater than the GWPS (5 picocuries per liter [pCi/L]) in one of five samples collected from bedrock well G54C. Observations ranged from non-detect to 5.38 pCi/L. No other exceedances for radium 226 and 228 combined were observed.

4.2.8 Total Sulfate

Sulfate can be a primary indicator parameter of CCR leachate impacts on groundwater quality. Total sulfate has been detected greater than the GWPS (400 mg/L) at downgradient well G58S in two of four samples. Total sulfate concentrations ranged from 250 to 540 mg/L. No other exceedances of total sulfate were observed.

4.2.9 Total Thallium

Total thallium was detected greater than the GWPS (0.002 mg/L) in one downgradient well (G57S); and one background well G51S. One of eight samples collected for total thallium from downgradient well G57S exceeded the GWPS; the other seven samples were non-detect. One of 16 samples collected for total thallium from background well G51S exceeded the GWPS; the other 15 samples were non-detect. No other exceedances for total thallium were observed.

5. EVALUATION OF POTENTIAL RECEPTORS

5.1 Water Well Survey

A water well survey was conducted for a 1,000 meter radius of the GMF Pond (Hanson, 2021; Ramboll, 2021). Additionally, a potable water well inventory was completed in 2021 utilizing federal and state databases to assess nearby pumping wells, drinking water receptors, and other uses of water in the vicinity of the GMF Pond. The following sources of information were queried to identify well locations, drinking water receptors, and other uses of water within 1,000 meters of the GMF Pond boundary:

- United States Geological Survey (USGS) National Groundwater Monitoring Network (NGWMN)[1]
- Illinois State Geological Survey (ISGS) Illinois Water and Related Wells (ILWATER) Map[2]
- USEPA Safe Drinking Water Information System (SDWIS)[3]
- IEPA Illinois Drinking Water Watch (DWW)[4]

According to the ISGS ILWATER Map, USEPA SDWIS, and IEPA DWW available records, there is one private well located southwest of the GMF Pond and within 1,000-meters of the GMF Pond. There is no data for Fulton County available from USGS NGWMN.

5.2 Surface Water

A search was performed utilizing the United States Fish and Wildlife Service (USFWS) Wetlands Mapper[5] and the USGS National Map[6] for surface water bodies within 1,000 meters of the GMF Pond.

As indicated on the USFWS Wetlands Mapper and USGS National Map, various surface water features were identified within a 1,000-meter radius of the GMF Pond. Surface waters in the vicinity of the GMF Pond include freshwater emergent wetland to the east, and various freshwater ponds to the northeast, south, southeast, and southwest (**Appendix A**).

The predominant surface water body in the region is the Illinois River and associated lowland backwater lakes. Duck Creek, a minor tributary of the Illinois River, formerly bordered the east perimeter of the DCPP. In this area, Duck Creek has been dammed for use for thermal treatment of cooling water discharge from the DCPP and is now the predominant surface water body in the vicinity of the GMF Pond. The distance between the GMF Pond and the Illinois River is sufficient to eliminate influence on local flow conditions at the site; therefore, site-specific flow conditions are not subject to surface water conditions of the Illinois River. Other surface waters in the vicinity of the GMF Pond include freshwater emergent wetland to the east, and various freshwater ponds to the northeast, south, southeast, and southwest. The USGS National Map places the DCPP within the lower Illinois-Lake Chautauqua watershed subbasin (Hydrologic Unit Code [HUC] 07130003) (**Appendix A**).

[1] USGS NGWMN: https://cida.usgs.gov/ngwmn/index.jsp
[2] ISGS ILWATER Map: https://prairieresearch.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87
[3] USEPA SDWIS: https://www.epa.gov/enviro/sdwis-search
[4] IEPA Illinois DWW: http://water.epa.state.il.us/dww/index.jsp
[5] USFWS Wetlands Mapper: https://www.fws.gov/wetlands/data/mapper.html
[6] USGS National Map: https://apps.nationalmap.gov/viewer/

A Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map for Fulton County Unincorporated Areas, Illinois (Map No. 17057C0375E, effective on 02/04/2011) is attached in **Appendix F**. The flood hazard areas to the east of the DCPP are defined as those areas subject to inundation by the 1 percent annual chance flood (*i.e.,* 100-year flood), also known as the base flood, that has a 1 percent chance of being equaled or exceeded in any given year.

5.3 Nature Preserves, Historic Sites, Endangered/Threatened Species

A search of the Illinois Department of Natural Resources (IDNR) Natural Heritage Database[7] for natural areas and protected areas within 1,000 meters of the GMF Pond was performed. According to the IDNR Natural Heritage Database, there are 15 Natural Areas in Fulton County, including two Category III - Nature Preserves (Harper-Rector Woods Nature Preserve [34.67 acres] and Kedzior Woodlands Land and Water Reserve [163.64 acres]). No natural areas were identified within 1,000 meters of the GMF Pond.

The IDNR Natural Heritage Database Threatened and Endangered Species by County[8] lists 11 state threatened and 12 state endangered species in Fulton County. The USFWS Environmental Conservation Online System[9] lists three federally threatened and one federally endangered species in Fulton County (**Appendix A**).

Additionally, a search of the IDNR Historic Preservation Division[10] database for historic sites in the vicinity of the Site yielded no results within 1,000 meters of the GMF Pond. The Illinois State Archaeological Survey (ISAS)[11] databases that do not require credentials to access were also searched and yielded no results within 1,000 meters of the GMF Pond.

[7] IDNR Natural Heritage Database: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Pages/NaturalHeritageDatabase.aspx
[8] Illinois Threatened and Endangered Species by County: https://www2.illinois.gov/dnr/ESPB/Documents/ET_by_County.pdf
[9] Illinois Threatened and Endangered Species by County: https://www2.illinois.gov/dnr/ESPB/Documents/ET_by_County.pdf
[10] IDNR Historic Preservation Division: https://www2.illinois.gov/dnrhistoric/Pages/default.aspx
[11] ISAS: https://www.isas.illinois.edu/

6. CONCLUSIONS

Hydrogeologic characterization of the GMF Pond was originally developed as part of the *Hydrogeologic Report, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Fulton County, Illinois* (Hanson, 2009) and most recently updated for this HCR. Results of these hydrogeologic studies were reintroduced in this HCR and updated to include geologic, hydrogeologic, and groundwater quality data collected with a focus on the GMF Pond (Part 845 regulated) CCR Unit.

The data were summarized and evaluated for changes in groundwater conditions since the previous investigations; available groundwater quality data for the GMF Pond was compared to the Part 845 Standards.

The results of the hydrogeologic and groundwater quality evaluation are:

- The unlithified stratigraphy within and immediately surrounding the GMF Pond consists of the following in descending order: fill material and CCR (gypsum); silt and clayey silt loess (Peoria/Roxanna Loess); weathered till (upper Radnor Till); shallow, medium-grained sand to silt zone; and till (lower Radnor Till).
- The unlithified units overlay Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). Bedrock was encountered approximately 90 feet bgs at the GMF Pond.
- Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit at some portions of the DCPP property. Previous investigations completed outside of the GMF Pond indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to and downgradient of several former large surface mining areas.
- Three distinct water-bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics:
  - **Uppermost Aquifer:** At the GMF Pond this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the Shallow Sand Zone. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (NRT/OBG, 2017a). The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally located at an elevation of 570 to 590 feet msl. The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the northeast corner and southwest corner of the pond), putting the base of the liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.
  - **Lower Radnor Till/Lower Confining Unit:** Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick.

  - **Bedrock Confining Unit:** The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet.

- Groundwater flow around the GMF Pond is generally in a southeast direction. Seasonal variation of groundwater levels at the GMF Pond are present and may fluctuate approximately 1 to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond associated with the elevation changes.
- Surface water drainage over much of the site flows east or southeast into the Duck Creek Cooling Pond. The Duck Creek Cooling Pond was formed by damming a portion of Duck Creek, a minor tributary of the Illinois River.
- The nearest surface water body to the GMF Pond is the Duck Creek Cooling Pond, which is located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Cooling Pond is estimated from 562.5 to 565 feet NAVD88. Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond, indicating that groundwater in the vicinity of the GMF Pond is flowing toward the Cooling Pond.
- Groundwater flow velocities in the uppermost aquifer are estimated from 3.1×10^{-2} to 6.5×10^{-1} ft/day.
- The GMF Pond is lined and the shallow sands of the uppermost aquifer were removed from within the footprint of the pond during construction. The GMF Pond does not appear to impact groundwater flow directions via recharge to groundwater. Given the low permeability of the liner system and the removal of sand below the unit, it is more likely that the GMF Pond is a barrier to groundwater flow within the uppermost aquifer deflecting flow from upgradient areas around the perimeter of the pond toward the downgradient areas south and east of the pond toward the Cooling Pond.
- Based on the detailed geologic information provided, and the hydrogeologic and groundwater quality data, groundwater within the uppermost aquifer at the GMF Pond is classified as Class I – Potable Resource Groundwater. However, background (upgradient) groundwater originates from areas north and west of the GMF Pond that have been extensively surface mined and present a significant alternative source for groundwater impacts.
- Antimony, arsenic, cobalt, lead, pH, sulfate, and thallium were detected at least once at concentrations greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). Lead, mercury, pH, and thallium were detected at concentrations greater than the GWPS in upgradient uppermost aquifer wells. Radium 226 and 228 combined was detected once at concentrations greater than the GWPS in the bedrock confining unit well.

Groundwater results are considered potential exceedances because they were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the GMP.

This HCR satisfies Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the GMF Pond at the DCPP.

7. REFERENCES

Federal Emergency Management Agency (FEMA), 2021. Flood Insurance Rate Map for Fulton County Unincorporated Areas, Illinois (Map No. 17057C0375E, effective on 02/04/2011). Accessed on August 27, 2021 from URL: https://msc.fema.gov/portal/search?AddressQuery=17751%20North%20Cilco%20Rd%2C%20Canton%2C%20IL#searchresultsanchor

Hanson Professional Services, Inc. (Hanson), 2005. *Geology and Hydrogeology Report* in Illinois EPA Bureau of Land Permit Application – Log No. 2005-121-LF. Hanson Professional Services Inc., Springfield, IL, 115 pp + App.

Hanson Professional Services, Inc. (Hanson), 2009. Section 3 – *Hydrogeologic Report*, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Springfield, Fulton County, Illinois.

Hanson Professional Services, Inc. (Hanson), 2015. *Aquifer Evaluation in the Surface Strip Mining Area (Ash Ponds 1 and 2).* December 22, 2015.

Hanson Professional Services, Inc. (Hanson), 2021. *First Quarter 2021 Groundwater Report, Duck Creek Power Station, Gypsum Stack and Recycle Pond*, WPC Permit No. 2017-EO-62640, Fulton County. March 25, 2021.

Illinois Department of Natural Resources (IDNR), 2021. Natural Heritage Database. Accessed from URL: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Pages/NaturalHeritageDatabase.aspx

Illinois Environmental Protection Agency (IEPA), 2021. Illinois Drinking Water Watch (DWW). Accessed from URL: http://water.epa.state.il.us/dww/index.jsp

Illinois Environmental Protection Agency (IEPA), 2021. *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New Title 35 Illinois Administration Code 845, Addendum*. April 15, 2021.

Illinois State Geological Survey (ISGS), 2021. Fulton County Coal Data, including Mine Map and Mine Directory. Accessed on August 27, 2021 from URL: https://isgs.illinois.edu/research/coal/maps/county/fulton

Illinois State Geological Survey (ISGS), 2021. Fulton County Coal Data, including Mine Map and Mine Directory. Accessed on August 27, 2021 from URL: https://isgs.illinois.edu/research/coal/maps/county/fulton

Illinois State Geological Survey (ISGS), 2021. *Illinois Water & Related Wells Map (ILWATER) for 17751 North Cilco Rd Canton, IL 61520*. Accessed from URL: https://prairie-research.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87

Illinois State Geological Survey (ISGS), 2021. ILMINES Interactive Map. Accessed from URL: https://isgs.illinois.edu/illinois-coal-mines-ilmines

Illinois State Water Survey (ISWS), 2021. *Official Climate Network: Station Data: Peoria. 1989-2020.* Accessed from URL: https://www.isws.illinois.edu/warm/stationmeta.asp?site=ICC&from=wx

NRCS, 1997. *Soil Survey of Fulton County, Illinois, Part 1*. Natural Resources Conversation Service. 1997.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017a. *Hydrogeologic Monitoring Plan, Duck Creek GMF Pond – CCR Unit ID 203 and Duck Creek Landfill – CCR Unit ID 204.* October 17, 2017.

Natural Resource Technology, an OBG Company. (NRT/OBG), 2017b. *Sampling and Analysis Plan, Final, Duck Creek GMF Pond, Duck Creek Power Station, Canton, Illinois, Project No. 2285, Revision 0.* October 17, 2017.

United States Environmental Protection Agency (USEPA), 2021. Safe Drinking Water Information System (SDWIS). Accessed from URL: https://www.epa.gov/enviro/sdwis-search

United States Fish and Wildlife Service (USFWS), 2021. Environmental Conservation Online System. Listed species believed to or known to occur in Fulton County, Illinois. Accessed from URL: https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=17057

United States Fish and Wildlife Service (USFWS), 2021. Wetlands Mapper, National Wetlands Inventory, surface waters and wetlands. Accessed from URL: https://www.fws.gov/wetlands/data/mapper.html

United States Geological Survey (USGS), 2021. Daily Gauge Height January 1, 2018 to May 31, 2021 for USGS Gaging Station 05568615 at the Illinois River at Copperas Creek, Illinois. Accessed from URL: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=05568615

United States Geological Survey (USGS), 2021. National Groundwater Monitoring Network (NGWMN). Accessed from URL: https://cida.usgs.gov/ngwmn/index.jsp

United States Geological Survey (USGS), 2021. National Map Viewer. Accessed from URL: https://apps.nationalmap.gov/viewer/

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TABLES

TABLE 2-1. GEOTECHNICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample ID	Field Location ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Moisture Content (%)	Dry Density (pcf)	Specific Gravity	Total Porosity[1] (%)	Vertical Hydraulic Conductivity (cm/s)	LL	PL	PI	Laboratory USCS	Gravel (%)	Sand (%)	Fines (%)
Peoria/Roxana Loess															
G54C-Comp 1	G54C	7	19	18.6	113.1	2.680	32.4	--	35	22	13	CL	0.2	11.6	88.2
G54C-ST14-16	G54C	14	16	22.2	104.0	--	--	7.10E-08	--	--	--	--	--	--	--
SB50/ST10-12	SB50	10	12	25.9	98.0	--	--	6.30E-07	--	--	--	--	--	--	--
SB50-Comp 1	SB50	5	19	24.9	97.3	2.680	41.8	--	32	23	9	CL	0.0	2.6	97.4
SB62/ST12-14	SB62	12	14	21.1	105.5	--	--	1.90E-07	--	--	--	--	--	--	--
SB62-Comp 1	SB62	7	19	19.3	104.7	2.650	36.7	--	35	22	13	CL	0.0	11.5	88.5
Upper Radnor Till															
G54C-Comp 2	G54C	25	33	24.6	98.0	2.680	41.4	--	40	18	22	CL	1.0	18.4	80.6
SB50/ST22-24	SB50	22	24	21.8	106.3	--	--	2.60E-07	--	--	--	--	--	--	--
SB50-Comp 2	SB50	21	31	21.1	116.7	2.700	30.7	--	28	18	10	CL	3.4	26.5	70.1
SB62/ST26-28	SB62	26	28	23.2	105.3	--	--	2.30E-06	--	--	--	--	--	--	--
SB62-Comp 2	SB62	23	33	21.5	104.1	2.700	38.2	--	29	17	12	CL	0.0	23	77
Shallow Sand Zone															
G54C-Comp 3	G54C	35	41	18.2	113.0	2.640	31.4	--	24	19	5	CL-ML	10.6	25.8	63.6
G54C-ST32-34	G54C	32	34	21.9	105.1	--	--	7.50E-07	--	--	--	--	--	--	--
SB50-Comp 3	SB50	31	39	17.1	122.3	2.700	27.4	--	27	18	9	CL	3.6	32	64.4
SB62/ST38-40	SB62	38	40	15.6	118.4	--	--	1.10E-06	--	--	--	--	--	--	--
SB62-Comp 3	SB62	33	39	14.5	116.1	2.650	29.8	--	26	19	7	CL-ML	2.9	23.4	73.7
Lower Radnor Till															
G54C-Comp 4	G54C	47	73	9.8	128.4	2.670	22.9	--	21	13	8	CL	7.4	36.3	56.3
G54C-ST44-46	G54C	44	46	12.2	126.1	--	--	5.40E-06	--	--	--	--	--	--	--
G54C-ST76-78	G54C	76	78	12.6	123.2	--	--	4.10E-08	--	--	--	--	--	--	--
SB50-Comp 4	SB50	41	51	7.7	133.8	2.700	20.6	--	21	15	6	SC-SM	12.9	37.8	49.3
SB62-Comp 4	SB62	41	51	10.0	126.1	2.640	23.5	--	21	15	6	CL-ML	2.8	40.7	56.5
CCR															
Gypsum	XTPW01[2]	grab	grab	32.5	--	2.310	--	--	--	--	--	Gypsum	0.0	4	96
LSN-3781/Gypsum	XTPW01[2]	grab	grab	28.8	73.9	2.700	56.1	6.70E-04	--	--	--	--	--	--	--

[O:FPO 7/13/21, U: EDP 8/25/21, C:LDC 09/07/21, C:SSW 09/16/21]

Notes:
[1] Porosity calculated as relationship of bulk density (p_b) to particle density (p_d) (n = 100[1- (p_b/p_d)])
[2] Gypsum grab samples were collected near location XTPW01
-- = Not Analyzed
% = Percent
bgs = below ground surface
CCR = coal combustion residuals
cm/s = centimeters per second
ft = foot/feet
GMF = Gypsum Management Facilty
LL = Liquid limit
pcf = pounds per cubic foot
PI = Plasticity Index
PL = Plastic Limit

USCS = Unified Soil Classification System
CL = lean clay
CL-ML = silty lean clay
SC-SM = Silty Clayey Sand

HSU = Hydrostratigraphic Unit
LCU = lower confining unit
UA = uppermost aquifer

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TABLE 2-2. CCR ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Plant	Sample Location	Sample Depth (ft)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chloride (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Fluoride (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Sulfate (mg/kg)	Thallium (mg/kg)
DC	GMF Gypsum	0-0	03/08/2021	<3	<1	6	<1	16	<1	100000	64	<4	<2	20	<1	<5	2.9	2.3	14000	<1

Notes:
-- = data not available
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
ft = feet
mg/kg = milligrams per kilogram

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TABLE 2-3. POREWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)
XTPW02	06/23/2021	<0.003	0.0026	0.059	<0.001	63	0.0066	750	3900	<0.004	0.0064	22.6	<0.001	0.26	0.00054	1.4	6.6	2.65	2.1	4300	0.0015

Notes:
Field readings are reported with as many significant figures as provided by analytical laboratory.
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units

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TABLE 2-4. SOIL ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Geologic Unit	Sample Depth (ft BGS)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Chloride (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Fluoride (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Sulfate (mg/kg)	Thallium (mg/kg)
SB-50	Peoria/Roxana Loess	4-18	02/02/2021	<2.8	<0.95	75	<0.95	<9.5	<0.95	<1	18	4	<0.25	6.7	6.7	<0.19	<0.95	<0.95	3	<0.95
SB-50	Upper Radnor Till	20-30	02/02/2021	<2.7	1.6	36	<0.91	<9.1	<0.91	<1	12	6.3	<0.25	10	12	<0.18	<0.91	<0.91	<1	<0.91
SB-50	Shallow Sand Zone	30-38	02/02/2021	<3	8.1	29	<1	<10	<1	<1	8.8	5.4	<0.25	7	11	<0.2	1.8	<1	<1	<1
SB-50	Lower Radnor Till	40-50	02/02/2021	<3	3.1	17	<1	<10	<1	<10	6.1	3.5	<2.5	4.3	14	<0.2	<1	<1	270	<1
SB-62	Peoria/Roxana Loess	6-18	02/03/2021	<3	4.6	87	<1	<10	<1	<10	16	3.5	<2.5	7.2	6.4	<0.2	<1	<1	27	<1
SB-62	Upper Radnor Till	22-32	02/03/2021	<3	3.2	30	<1	<10	<1	<10	8.3	4.3	<2.5	6.6	9.5	<0.2	<1	<1	12	<1
SB-62	Shallow Sand Zone	32-38	02/03/2021	<3	3.2	26	<1	<10	<1	<10	8.1	5.4	<2.5	7.2	9.3	<0.2	<1	<1	11	<1
SB-62	Lower Radnor Till	40-50	02/03/2021	<3.3	2.3	20	<1.1	12	<1.1	<11	6	2.7	<2.7	5	20	<0.22	<1.1	<1.1	130	<1.1
G54C	Peoria/Roxana Loess	6-18	02/03/2021	<2.8	2.5	100	<0.93	<9.3	<0.93	10	17	4.1	3	6.6	9.4	<0.19	<0.93	<1.9	37	<0.93
G54C	Upper Radnor Till	24-32	02/03/2021	<3	1.7	21	<1	<10	<1	<10	9.1	5.6	3.7	9.5	8.5	<0.2	<1	<1	11	<1
G54C	Shallow Sand Zone	34-40	02/04/2021	<2.4	3	33	<0.79	<7.9	<0.79	<10	9	5	<2.5	6	11	<0.16	1.7	<0.79	13	<0.79
G54C	Lower Radnor Till	46-80	02/04/2021	<2.1	9.4	86	0.87	<7.2	<0.72	<10	13	7	5.7	11	7	<0.14	<0.72	<0.72	<10	<0.72

Notes:
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
BGS = below ground surface
ft = foot or feet
mg/kg = milligrams per kilogram

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TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G02L	--	12/10/2003	--	621.94	Top of Disk	619.50	10.00	15.00	609.50	604.50	15.00	603.50	5	2	40.512901	-89.991114
G02S	UA	09/29/2003	--	621.66	Top of Disk	619.18	23.00	28.00	596.18	591.18	28.00	589.20	5	2	40.512879	-89.991105
G50L	UA/PMP	03/13/2007	623.52	623.52	Top of Riser	620.85	11.61	16.32	609.24	604.53	16.70	604.10	4.7	2	40.508688	-89.990606
G50S	UA	03/13/2007	623.65	623.65	Top of Riser	620.83	29.17	33.98	591.66	586.85	34.30	586.50	4.8	2	40.508672	-89.990607
G51L	UA/PMP	01/28/2008	619.74	619.74	Top of Riser	616.84	12.04	16.83	604.80	600.01	17.21	599.10	4.8	2	40.506573	-89.990864
G51S	UA	01/28/2008	619.66	619.66	Top of Riser	616.83	24.01	28.79	592.82	588.04	29.16	587.70	4.8	2	40.50656	-89.990864
G52L	UA/PMP	01/22/2008	619.55	619.55	Top of Riser	616.70	29.21	33.80	587.49	582.90	34.17	582.50	4.6	2	40.504515	-89.990871
G52S	UA	01/22/2008	619.62	619.62	Top of Riser	616.56	39.15	43.93	577.41	572.63	44.20	570.60	4.8	2	40.504502	-89.990869
G53L	UA/PMP	02/05/2009	623.24	623.24	Top of Riser	620.34	16.97	26.32	603.37	594.02	26.79	593.60	9.4	2	40.508739	-89.988768
G53S	UA	02/05/2009	623.05	623.05	Top of Riser	620.36	30.64	35.13	589.72	585.23	35.56	584.30	4.5	2	40.508739	-89.988753
G54C	BR	02/05/2021	622.72	622.72	Top of PVC	619.59	91.59	101.50	528.00	518.09	102.00	517.59	9.07	2	40.504533	-89.988975
G54L	UA/PMP	02/12/2009	622.95	622.95	Top of Riser	620.18	27.32	36.75	592.86	583.43	37.22	583.00	9.4	2	40.504524	-89.988927
G54S	UA	02/12/2009	622.98	622.98	Top of Riser	620.25	43.50	47.97	576.75	572.28	48.41	571.80	4.5	2	40.504525	-89.98894
G55L	UA/PMP	02/19/2009	623.20	623.20	Top of Riser	620.45	36.12	36.60	584.33	583.85	36.60	583.90	0.5	2	40.504532	-89.988061
G55S	UA	02/19/2009	622.89	622.89	Top of Riser	620.11	41.04	45.49	579.07	574.62	45.96	574.20	4.5	2	40.504522	-89.988062
G56L	UA/PMP	02/16/2009	622.42	622.42	Top of Riser	619.96	13.77	22.11	606.19	597.85	22.89	597.10	8.3	2	40.504643	-89.987075
G56S	UA	02/16/2009	622.71	622.71	Top of Riser	619.84	33.17	37.66	586.67	582.18	38.29	579.80	4.5	2	40.504633	-89.987076
G57L	UA/PMP	01/30/2009	622.90	622.90	Top of Riser	620.22	16.17	25.62	604.05	594.60	26.00	594.20	9.5	2	40.50562	-89.987044
G57S	UA	01/30/2009	622.76	622.76	Top of Riser	620.20	29.65	34.18	590.55	586.02	34.62	582.20	4.5	2	40.505608	-89.987043
G58L	UA/PMP	01/26/2009	622.95	622.95	Top of Riser	620.17	20.69	30.10	599.48	590.07	30.56	589.60	9.4	2	40.506004	-89.987036
G58S	UA	01/26/2009	622.93	622.93	Top of Riser	620.06	31.32	35.80	588.74	584.26	36.43	583.60	4.5	2	40.505993	-89.987033
G59L	UA/PMP	01/23/2009	622.35	622.35	Top of Riser	620.11	22.91	32.33	597.20	587.78	33.03	587.10	9.4	2	40.506386	-89.987023
G59S	UA	01/23/2009	622.79	622.79	Top of Riser	620.11	37.38	41.88	582.73	578.23	42.49	577.60	4.5	2	40.506375	-89.987023

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TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G60L	UA/PMP	01/17/2008	615.39	615.39	Top of Riser	612.69	20.12	24.91	592.57	587.78	25.28	587.40	4.8	2	40.506745	-89.986816
G60S	UA	01/16/2008	615.03	615.03	Top of Riser	612.33	31.12	35.91	581.21	576.42	36.29	574.30	4.8	2	40.506732	-89.986815
G61S	UA	01/21/2009	622.58	622.58	Top of Riser	620.11	30.19	34.63	589.92	585.48	35.26	582.10	4.4	2	40.507213	-89.987013
G62L	UA/PMP	01/22/2009	623.48	623.48	Top of Riser	620.37	20.31	29.66	600.06	590.71	30.12	582.40	9.4	2	40.507597	-89.987012
G63L	UA/PMP	02/02/2009	623.03	623.03	Top of Riser	620.27	18.47	27.89	601.80	592.38	28.36	591.90	9.4	2	40.507992	-89.987
G63S	UA	02/02/2009	623.00	623.00	Top of Riser	619.98	34.52	39.01	585.46	580.97	39.47	580.00	4.5	2	40.50798	-89.986998
G64L	UA/PMP	01/22/2009	622.46	622.46	Top of Riser	620.24	18.12	27.48	602.12	592.76	27.95	592.30	9.4	2	40.508378	-89.987007
G64S	UA	01/22/2009	623.06	623.06	Top of Riser	620.25	34.50	38.99	585.75	581.26	39.48	580.30	4.5	2	40.508365	-89.987011
G65L	UA/PMP	01/15/2008	612.76	612.76	Top of Riser	610.29	17.28	22.08	593.01	588.21	22.45	587.80	4.8	2	40.50266	-89.987293
G65S	UA	01/15/2008	612.94	612.94	Top of Riser	610.09	26.92	31.70	583.17	578.39	32.08	577.40	4.8	2	40.502657	-89.987313
G66L	UA/PMP	02/04/2009	617.93	617.93	Top of Riser	614.98	9.84	19.27	605.14	595.71	19.74	595.20	9.4	2	40.503359	-89.987127
G66S	UA	02/04/2009	617.83	617.83	Top of Riser	615.04	35.10	39.59	579.94	575.45	40.59	574.50	4.5	2	40.503346	-89.987129
G67L	--	02/03/2009	617.26	617.26	Top of Riser	614.77	7.36	16.72	607.41	598.05	17.18	597.60	9.4	2	40.504146	-89.987257
G67S	--	02/03/2009	617.77	617.77	Top of Riser	614.81	31.09	35.58	583.72	579.23	36.21	576.80	4.5	2	40.504154	-89.98727
G68L	--	02/09/2009	616.31	616.31	Top of Riser	614.28	15.48	24.85	598.80	589.43	25.31	589.00	9.4	2	40.504213	-89.988407
G68S	--	02/09/2009	616.93	616.93	Top of Riser	614.24	34.75	39.22	579.49	575.02	39.88	568.20	4.5	2	40.50421	-89.988421
G69L	--	02/10/2009	616.95	616.95	Top of Riser	614.56	15.31	24.68	599.25	589.88	25.15	589.40	9.4	2	40.504194	-89.989567
G69S	--	02/10/2009	617.65	617.65	Top of Riser	614.68	36.08	40.58	578.60	574.10	41.01	573.70	4.5	2	40.504194	-89.989552
G70L	--	11/18/2008	617.76	617.76	Top of Riser	615.08	20.19	29.54	594.89	585.54	30.00	585.10	9.4	2	40.503721	-89.990033
G71L	--	11/20/2008	617.52	617.52	Top of Riser	615.13	19.80	29.29	595.33	585.84	30.20	584.90	9.5	2	40.502994	-89.989596
G71S	--	11/20/2008	617.81	617.81	Top of Riser	615.24	33.96	37.96	581.28	577.28	38.40	575.20	4	2	40.503005	-89.989603
G72L	--	11/19/2008	617.71	617.71	Top of Riser	614.86	14.65	24.01	600.21	590.85	24.79	590.10	9.4	2	40.502439	-89.988767
G72S	--	11/19/2008	617.61	617.61	Top of Riser	615.03	30.16	34.64	584.87	580.39	35.09	575.60	4.5	2	40.502439	-89.988785

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TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G73L	--	02/06/2009	617.64	617.64	Top of Riser	614.78	24.63	33.98	590.15	580.80	34.76	580.00	9.4	2	40.502492	-89.987727
P60	UA/PMP	03/15/2017	622.22	622.22	Top of Riser	619.82	29.55	34.14	590.27	585.68	34.60	585.20	4.6	2	40.506753	-89.987023
P61	UA/PMP	09/23/2021	613.96	613.96	Top of PVC	611.09	7.55	18.37	602.38	592.72	18.76	591.09	9.66	2	40.507167	-89.986146
P62	UA/PMP	09/23/2021	613.54	613.54	Top of PVC	610.81	11.18	15.78	599.63	595.03	16.30	594.51	4.6	2	40.507762	-89.986782
P63	UA/PMP	09/23/2021	614.47	614.47	Top of PVC	612.33	13.04	17.63	599.29	594.70	18.25	594.08	4.59	2	40.508145	-89.986768
P64	UA/PMP	09/23/2021	616.47	616.47	Top of PVC	614.04	6.17	15.96	607.87	598.08	16.47	597.57	9.79	2	40.508911	-89.986794
R61L	PMP	03/14/2017	622.39	622.39	Top of Riser	619.66	18.54	28.17	601.12	591.49	28.70	591.00	9.6	2	40.507228	-89.987014
R72S	--	11/09/2016	617.57	617.57	Top of Riser	614.81	29.83	34.49	584.98	580.32	35.00	579.90	4.7	2	40.502442	-89.988803
X301	S	--	--	--	--	--	--	--	--	--	--	--	--	--	40.504777	-89.990046
XTPW02	CCR	06/23/2021	617.20	617.20	Top of PVC Casing	615.00	3.02	5.02	611.98	609.98	5.14	609.50	2	1	40.519976	-89.98991

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
BGS = below ground surface
BR = bedrock
CCR = coal combustion residuals
ft = foot or feet
HSU = Hydrostratigraphic Unit
PMP = potential migration pathway
PVC = polyvinyl chloride
S = source water
UA = uppermost aquifer
UA/PMP = uppermost aquifer/potential migration pathway

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TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Date	G51L Groundwater Elevation (ft NAVD88) PMP	G51S Groundwater Elevation (ft NAVD88) UA	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
4/14/2021	610.50	610.69	-0.19	12.68	-0.01	up
4/28/2021	609.12	609.35	-0.23	12.68	-0.02	up
5/10/2021	610.72	610.93	-0.21	12.68	-0.02	up
6/1/2021	609.14	609.44	-0.30	12.68	-0.02	up
6/10/2021	606.57	606.98	-0.41	12.68	-0.03	up
6/21/2021	608.97	609.37	-0.40	12.68	-0.03	up
7/12/2021	610.66	610.91	-0.25	12.68	-0.02	up
7/26/2021	608.51	608.84	-0.33	12.68	-0.03	up
8/5/2021	605.95	606.34	-0.39	12.68	-0.03	up
			Middle of screen elevation G51L			602.4
			Middle of screen elevation G51S			589.7

Date	G54L Groundwater Elevation (ft NAVD88) PMP	G54S Groundwater Elevation (ft NAVD88) UA	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
4/14/2021	591.47	590.44	1.03	16.97	0.06	down
4/28/2021	591.11	590.52	0.59	16.61	0.04	down
5/10/2021	591.22	590.53	0.69	16.72	0.04	down
6/1/2021	591.52	590.80	0.72	17.02	0.04	down
6/10/2021	591.78	591.07	0.71	17.28	0.04	down
6/21/2021	592.11	591.23	0.88	17.61	0.05	down
7/12/2021	592.97	591.76	1.21	13.66	0.09	down
7/26/2021	592.50	591.98	0.52	18.00	0.03	down
8/5/2021	592.79	592.55	0.24	18.29	0.01	down
			Middle of screen elevation G54L			588.2
			Middle of screen elevation G54S			574.5

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TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Date	G54S Groundwater Elevation (ft NAVD88) UA	G54C Groundwater Elevation (ft NAVD88) BCU	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
4/14/2021	590.44	581.99	8.45	51.04	0.17	down
4/28/2021	590.52	581.10	9.42	51.04	0.18	down
5/10/2021	590.53	580.11	10.42	51.04	0.20	down
6/1/2021	590.80	581.00	9.80	51.04	0.19	down
6/10/2021	591.07	580.47	10.60	51.04	0.21	down
6/21/2021	591.23	579.83	11.40	51.04	0.22	down
7/12/2021	591.76	582.36	9.40	51.04	0.18	down
7/26/2021	591.98	581.64	10.34	51.04	0.20	down
8/5/2021	592.55	578.99	13.56	51.04	0.27	down
			Middle of screen elevation G54S			574.5
			Middle of screen elevation G54C			523.5

Date	G57L Groundwater Elevation (ft NAVD88) PMP	G57S Groundwater Elevation (ft NAVD88) UA	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
4/14/2021	603.07	601.83	1.24	13.35	0.09	down
4/28/2021	602.15	601.99	0.16	12.43	0.01	down
5/10/2021	604.41	602.61	1.80	14.69	0.12	down
6/1/2021	603.88	603.89	-0.01	14.16	0.00	flat
6/10/2021	603.17	603.20	-0.03	13.45	0.00	up
6/21/2021	602.45	602.52	-0.07	12.73	-0.01	up
7/12/2021	604.81	604.68	0.13	12.68	0.01	down
7/26/2021	604.43	604.41	0.02	14.71	0.00	flat
8/5/2021	603.00	603.51	-0.51	13.28	-0.04	up
			Middle of screen elevation G57L			602.4
			Middle of screen elevation G57S			589.7

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TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Date	G60L Groundwater Elevation (ft NAVD88)	G60S Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	PMP	UA				
4/14/2021	606.78	590.16	16.62	11.36	1.5	down
4/28/2021	603.75	589.76	13.99	11.36	1.2	down
5/10/2021	606.16	590.34	15.82	11.36	1.4	down
6/1/2021	605.20	590.54	14.66	11.36	1.3	down
6/10/2021	603.76	590.02	13.74	11.36	1.2	down
6/21/2021	603.43	589.48	13.95	11.36	1.2	down
7/12/2021	609.27	591.02	18.25	11.36	1.6	down
7/26/2021	605.97	590.71	15.26	11.36	1.3	down
8/5/2021	604.40	590.05	14.35	11.36	1.3	down
			Middle of screen elevation G60L			590.2
			Middle of screen elevation G60S			578.8

[O:EDP 8/26/21 U: LDC 09/09/21, C: SSW 09/17/21]

Notes:
1. Distance change was calculated using the midpoint of the piezometer screen and water table surface. If the water table surface was above the top of the monitoring well screen, then distance change was calculated using the midpoint of both screens.
2. Vertical gradients between ±0.0015 are considered flat, and typically have less than 0.02 foot difference in groundwater elevation between wells.

-- = Not calculated
BCU = bedrock confining unit
dh = head change
dl = distance change
ft = feet
NAVD88 = North American Vertical Datum of 1988
PMP = potential migration pathway
UA = uppermost aquifer

TABLE 3-3. FIELD HYDRAULIC CONDUCTIVITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well ID	Gradient Position	Bottom of Screen Elevation (ft NAVD88)	Screen Length [1] (ft)	Field Identified Screened Material	Slug Type	Analysis Method	Falling Head (Slug In) K (cm/s)	Rising Head (Slug Out) K (cm/s)	Minimum Hydraulic Conductivity (cm/s)	Maximum Hydraulic Conductivity (cm/s)	Hydraulic Conductivity Geometric Mean (cm/s)
Uppermost Aquifer (Peoria/Roxana Loess, Upper Radnor Till, Shallow Sand)											
G50L	U	604.53	4.70	ML/CL	Solid	KGS Model	2.30E-03	2.10E-03	3.00E-05	3.90E-03	3.6E-04
G51L	U	600.01	4.80	ML/CL	Solid	KGS Model	3.00E-05	---			
G53L	D	594.02	9.40	CL/ML	Solid	KGS Model	1.10E-04	1.10E-04			
G54L	D	583.43	9.40	CL/ML	Solid	Bouwer-Rice	4.90E-05	2.20E-04			
G60L	D	587.78	4.80	CL/ML	Solid	KGS Model	2.30E-04	2.60E-04			
G50S	U	586.85	4.80	S(ML), CL/ML	Solid	KGS Model	6.50E-05	1.50E-04			
G51S	U	588.04	4.80	CL/ML, SP	Solid	Bouwer-Rice / KGS Model	7.20E-05	1.10E-04			
G53S	D	585.23	4.50	ML/CL, SP	Solid	KGS Model	3.80E-03	3.20E-03			
G54S	D	572.28	4.50	ML/CL, SP	Solid	Bouwer-Rice	1.20E-04	2.10E-04			
G57S	D	586.02	4.50	SP, S(CL), ML/CL	Solid	KGS Model	2.60E-03	6.80E-04			
G60S	D	576.42	4.80	ML/CL, SP	Solid	KGS Model	3.90E-03	3.50E-03			
G63S	D	580.97	4.50	ML, ML/CL, SP	Solid	KGS Model	3.00E-04	2.90E-04			
Bedrock Confining Unit											
G54C	D	518.09	9.07	Shale	Solid	Hvorslev	1.60E-04	1.40E-04	1.40E-04	1.60E-04	1.50E-04

[O: EDP 8/25/21, C: SSW 09/17/21]

Notes:
1. All wells are constructed from 2 inch PVC with 0.01 inch slotted screens.
- - - = no data collected on date / no vertical gradient calculated
CL/ML = Silty clay
cm/s = centimeters per second
D = downgradient
GMF = Gypsum Management Facility
ft = foot/feet
K = hydraulic conductivity
KGS = Kansas Geological Survey
ML = Silt
NAVD88 = North American Vertical Datum of 1988
U = upgradient
USCS = Unified Soil Classification System
ML/CL = Clayey silt
S(CL) = Sandy clay
S(ML) = Sandy silt
SM = Silty sand
SP= Poorly graded sand

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TABLE 3-4. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

$V = K i / n_e$ V = Groundwater Velocity
K = Hydraulic Conductivity [1]
i = hydraulic gradient
n_e = Effective Porosity [2]

Northern GMF Pond Uppermost Aquifer (G50S to G64S)

Distance between Wells (ft): 1008
Hydraulic Conductivity (ft/day): 0.66
Effective Porosity (%): 17.5 Assumes: clay/sand

Date	G50S Groundwater Elevation (ft NAVD88)	G64S Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	612.98	599.04	13.94	0.0138	0.052
4/28/2021	611.54	599.38	12.16	0.0121	0.045
5/10/2021	612.71	599.64	13.07	0.0130	0.049
6/1/2021	611.87	600.28	11.59	0.0115	0.043
6/10/2021	611.15	599.97	11.18	0.0111	0.042
6/21/2021	611.57	599.51	12.06	0.0120	0.045
7/12/2021	613.25	600.50	12.75	0.0126	0.048
7/26/2021	612.06	600.60	11.46	0.0114	0.043
8/5/2021	611.21	600.04	11.17	0.0111	0.042
			Average	0.0121	0.045

Central GMF Pond Uppermost Aquifer (G50S to G60S)

Distance between Wells (ft): 1269
Hydraulic Conductivity (ft/day): 5.46
Effective Porosity (%): 15 Assumes: silt/sand

Date	G50S Groundwater Elevation (ft NAVD88)	G60S Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	612.98	590.16	22.82	0.0180	0.654
4/28/2021	611.54	589.76	21.78	0.0172	0.624
5/10/2021	612.71	590.34	22.37	0.0176	0.641
6/1/2021	611.87	590.54	21.33	0.0168	0.611
6/10/2021	611.15	590.02	21.13	0.0167	0.606
6/21/2021	611.57	589.48	22.09	0.0174	0.633
7/12/2021	613.25	591.02	22.23	0.0175	0.637
7/26/2021	612.06	590.71	21.35	0.0168	0.612
8/5/2021	611.21	590.05	21.16	0.0167	0.606
			Average	0.0172	0.625

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TABLE 3-4. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Southern GMF Pond Uppermost Aquifer (G51S to G54S)

Distance between Wells (ft): 906
Hydraulic Conductivity (ft/day): 0.36
Effective Porosity (%): 17.5 Assumes: clay/sand

Date	G51S Groundwater Elevation (ft NAVD88)	G54S Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	610.69	590.44	20.25	0.0224	0.046
4/28/2021	609.35	590.52	18.83	0.0208	0.042
5/10/2021	610.93	590.53	20.40	0.0225	0.046
6/1/2021	609.44	590.80	18.64	0.0206	0.042
6/10/2021	606.98	591.07	15.91	0.0176	0.036
6/21/2021	609.37	591.23	18.14	0.0200	0.041
7/12/2021	610.91	591.76	19.15	0.0211	0.043
7/26/2021	608.84	591.98	16.86	0.0186	0.038
8/5/2021	606.34	592.55	13.79	0.0152	0.031
			Average	0.0199	0.041

[O: EDP 8/28/21, C: LDC 09/17/21]

Notes:
[1] Hydraulic conductivity values used above are the geometric mean of hydrostratigraphic unit hydraulic conductivity values calculated from slug tests completed in April 2021 by Ramboll.
[2] Effective porosity used in these calculations was derived from an average between estimated values of 0.20 for silt material, 0.267 for gravel, 0.07 for clay, and 0.28 for sand from Morris, D.A and A.I. Johnson, 1967. Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey. U.S. Geological Survey Water-Supply Paper 1839-D, 42p. and Heath, R.C., 1983. Basic ground-water hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p. Effective porosity may be as high as maximum total porosity (56%) calculated in Table 2-1.
% = percent
ft/day = feet per day
ft/ft = feet per feet
ft= feet
NAVD88 = North American Vertical Datum of 1988
UA = uppermost aquifer

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G02S	12/02/2015	<0.003	0.0077	0.2	<0.001	0.13	<0.001	97	3.2	<0.004	<0.002	0.359	0.0015	<0.01	<0.0002	<0.001	6.6	1.86	<0.001	<1	<0.001	400
G02S	02/03/2016	<0.003	0.0071	0.22	<0.001	0.044	<0.001	92	3	0.0046	<0.002	0.274	0.002	<0.01	<0.0002	0.0042	6.6	0.371	<0.001	<1	<0.001	390
G02S	04/20/2016	<0.003	0.0059	0.23	<0.001	0.039	<0.001	110	2.7	<0.004	<0.002	0.365	0.0011	<0.01	<0.0002	<0.001	6.6	0.827	<0.001	<1	<0.001	600
G02S	08/18/2016	<0.003	0.0041	0.17	<0.001	0.03	<0.001	98	2.6	<0.004	<0.002	0.33	0.0012	<0.01	<0.0002	<0.001	6.8	2.26	<0.001	<1	<0.001	350
G02S	10/19/2016	<0.003	0.0069	0.19	<0.001	0.034	<0.001	97	2.5	<0.004	<0.002	0.366	0.0011	<0.01	<0.0002	<0.001	6.9	0.191	<0.001	<1	<0.001	400
G02S	01/12/2017	<0.003	0.0077	0.22	<0.001	0.039	<0.001	94	3.7	<0.004	<0.002	0.564	<0.001	<0.01	<0.0002	<0.001	6.9	1.18	<0.001	<1	<0.001	420
G02S	04/22/2017	<0.003	0.0051	0.16	<0.001	0.04	<0.001	89	2.9	<0.004	<0.002	0.315	<0.001	<0.01	0.0024	<0.001	6.8	0.347	<0.001	<1	<0.001	440
G02S	06/28/2017	<0.003	0.0067	0.22	<0.001	0.042	<0.001	89	2.6	<0.004	<0.002	0.374	<0.001	<0.01	<0.0002	<0.001	6.8	0.761	<0.001	<1	<0.001	370
G02S	11/10/2017	--	--	--	--	0.036	--	95	3.1	--	--	0.41	--	--	--	--	6.9	--	--	2.9	--	390
G02S	01/17/2018	--	--	--	--	--	--	--	2.7	--	--	--	--	--	--	--	6.9	--	--	--	--	--
G02S	06/06/2018	--	--	--	--	0.042	--	95	2.4	--	--	0.369	--	--	--	--	6.9	--	--	<1	--	340
G02S	07/06/2018	--	--	--	--	--	--	--	2.9	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G02S	10/04/2018	--	--	--	--	0.046	--	97	2.7	--	--	0.285	--	--	--	--	7.1	--	--	<1	--	340
G02S	02/06/2019	--	--	--	--	0.048	--	99	2.5	--	--	0.379	--	--	--	--	7.0	--	--	<1	--	400
G02S	07/08/2019	--	--	--	--	0.05	--	96	<5	--	--	0.394	--	--	--	--	7.0	--	--	<1	--	420
G02S	01/06/2020	--	--	--	--	0.044	--	100	<5	--	--	0.476	--	--	--	--	6.6	--	--	<1	--	440
G02S	08/11/2020	--	--	--	--	0.049	--	97	<5	--	--	0.27	--	--	--	--	6.4	--	--	<1	--	420
G02S	02/19/2021	--	--	--	--	0.037	--	95	2.6	--	--	0.411	--	--	--	--	6.5	--	--	<1	--	340
G02S	04/14/2021	<0.003	0.0092	0.29	<0.001	0.11	<0.001	89	2.3	<0.004	<0.002	0.336	<0.001	<0.02	<0.0002	<0.001	6.7	0.992	<0.001	<1	<0.001	380
G02S	04/29/2021	<0.003	0.0059	0.16	<0.001	0.047	<0.001	96	1.6	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	6.8	0.194	<0.001	<1	<0.001	370
G02S	05/12/2021	<0.003	0.0061	0.15	<0.001	0.091	<0.001	96	2.5	<0.004	<0.002	0.35	<0.001	<0.02	<0.0002	<0.001	6.7	0	<0.001	<1	<0.001	290
G02S	06/01/2021	<0.003	0.0069	0.17	<0.001	0.12	<0.001	94	8.2	<0.004	<0.002	0.358	<0.001	<0.02	<0.0002	<0.001	6.8	0.0133	<0.001	2.7	<0.001	450

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G02S	06/15/2021	<0.003	0.0078	0.18	<0.001	0.064	<0.001	100	4	<0.004	<0.002	0.307	<0.001	<0.02	<0.0002	<0.001	6.8	0.618	<0.001	2.1	<0.001	390
G02S	06/21/2021	<0.003	0.0063	0.17	<0.001	0.11	<0.001	98	3.5	<0.004	<0.002	0.498	<0.001	<0.02	<0.0002	<0.001	6.8	0.268	<0.001	1.1	<0.001	440
G02S	07/12/2021	<0.003	0.0064	0.18	<0.001	0.043	<0.001	96	1.9	<0.004	<0.002	0.322	<0.001	<0.02	<0.0002	<0.001	6.7	0.372	<0.001	<1	<0.001	420
G02S	07/28/2021	<0.003	0.0059	0.17	<0.001	0.17	<0.001	99	1.4	<0.004	<0.002	0.324	<0.001	<0.02	<0.0002	<0.001	6.9	2	0.0012	<1	<0.001	440
G50S	01/30/2015	--	0.0016	--	--	0.021	--	94	4.5	--	--	--	0.0011	--	--	--	6.8	--	--	25	--	--
G50S	04/17/2015	--	<0.001	--	--	0.02	--	91	4.6	--	--	--	<0.001	--	--	--	7.3	--	--	23	--	--
G50S	07/24/2015	--	0.0012	--	--	0.015	--	96	5.4	--	--	--	0.0014	--	--	--	7.4	--	--	23	--	--
G50S	10/15/2015	--	<0.001	--	--	0.025	--	85	5.2	--	--	--	<0.001	--	--	--	7.4	--	--	19	--	--
G50S	12/03/2015	<0.003	0.005	0.12	<0.001	0.022	<0.001	98	6	<0.004	<0.002	0.311	0.0015	<0.01	<0.0002	0.001	6.9	0.865	<0.001	22	<0.001	340
G50S	01/29/2016	<0.003	<0.001	0.072	<0.001	0.024	<0.001	77	5.4	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	<0.001	7.4	0.652	<0.001	21	<0.001	300
G50S	04/25/2016	<0.003	<0.001	0.063	<0.001	0.025	<0.001	81	5.3	<0.004	<0.002	0.373	<0.001	<0.01	<0.0002	<0.001	7.3	0.325	<0.001	21	<0.001	360
G50S	08/10/2016	<0.003	<0.001	0.074	<0.001	0.017	<0.001	86	6.3	<0.004	<0.002	0.284	<0.001	<0.01	0.00031	<0.001	7.3	0.455	<0.001	22	<0.001	320
G50S	10/21/2016	<0.003	<0.001	0.073	<0.001	<0.01	<0.001	76	5.9	<0.004	<0.002	0.297	<0.001	<0.01	<0.0002	<0.001	7.3	0.733	<0.001	23	<0.001	280
G50S	01/21/2017	<0.003	<0.001	0.07	<0.001	0.018	<0.001	60	6	<0.004	<0.002	0.261	<0.001	<0.01	<0.0002	<0.001	7.3	0.0182	<0.001	23	<0.001	340
G50S	04/07/2017	<0.003	0.0016	0.089	<0.001	0.011	<0.001	90	5.6	0.0058	<0.002	0.284	0.0016	<0.01	<0.0002	0.001	7.3	0.529	<0.001	24	<0.001	340
G50S	06/28/2017	<0.003	<0.001	0.08	<0.001	<0.01	<0.001	75	6.6	<0.004	<0.002	0.255	0.0017	<0.01	<0.0002	0.0015	7.1	0.371	<0.001	26	0.001	330
G50S	11/08/2017	--	--	--	--	0.012	--	83	5.9	--	--	0.369	--	--	--	--	7.1	--	--	22	--	310
G50S	06/04/2018	--	--	--	--	0.067	--	87	7.3	--	--	0.301	--	--	--	--	7.1	--	--	33	--	320
G50S	07/13/2018	--	--	--	--	0.018	--	88	--	--	--	0.333	--	--	--	--	7.1	--	--	--	--	350
G50S	10/11/2018	--	--	--	--	0.018	--	97	9.6	--	--	0.264	--	--	--	--	7.2	--	--	34	--	340
G50S	02/05/2019	--	--	--	--	0.016	--	86	7.6	--	--	<0.25	--	--	--	--	7.1	--	--	27	--	360
G50S	07/08/2019	--	--	--	--	0.018	--	88	9.6	--	--	0.351	--	--	--	--	7.4	--	--	34	--	420

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G50S	01/13/2020	--	--	--	--	0.018	--	97	8.6	--	--	0.311	--	--	--	--	6.9	--	--	30	--	360
G50S	08/10/2020	--	--	--	--	0.016	--	91	8.5	--	--	0.28	--	--	--	--	6.8	--	--	38	--	370
G50S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G50S	02/19/2021	--	--	--	--	0.015	--	95	12	--	--	0.335	--	--	--	--	7.0	--	--	41	--	330
G50S	04/14/2021	<0.003	<0.001	0.071	<0.001	0.034	<0.001	88	15	<0.004	<0.002	0.279	<0.001	<0.02	<0.0002	<0.001	7.2	0.644	<0.001	52	<0.001	400
G50S	04/29/2021	<0.003	<0.001	0.071	<0.001	0.025	<0.001	98	14	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.1	0.0455	<0.001	50	<0.001	350
G50S	05/13/2021	<0.003	0.0011	0.076	<0.001	0.016	<0.001	95	13	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0	<0.001	47	<0.001	380
G50S	06/01/2021	<0.003	<0.001	0.066	<0.001	0.041	<0.001	93	12	<0.004	<0.002	0.3	<0.001	<0.02	<0.0002	0.0023	7.0	0.798	<0.001	49	<0.001	410
G50S	06/10/2021	<0.003	<0.001	0.068	<0.001	0.016	<0.001	93	16	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0.342	<0.001	48	<0.001	390
G50S	06/21/2021	<0.003	<0.001	0.071	<0.001	0.04	<0.001	94	11	<0.004	<0.002	0.372	<0.001	<0.02	<0.0002	<0.001	7.1	0	<0.001	44	<0.001	430
G50S	07/13/2021	<0.003	<0.001	0.071	<0.001	0.023	<0.001	92	13	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0.884	<0.001	46	<0.001	420
G50S	07/28/2021	<0.003	<0.001	0.071	<0.001	0.015	<0.001	95	13	<0.004	<0.002	0.323	<0.001	<0.02	<0.0002	<0.001	7.1	1.13	<0.001	46	<0.001	390
G51L	01/30/2015	--	<0.001	--	--	0.18	--	130	18	--	--	--	<0.001	--	--	--	6.9	--	--	130	--	--
G51L	04/17/2015	--	<0.001	--	--	0.14	--	120	15	--	--	--	<0.001	--	--	--	7.0	--	--	120	--	--
G51L	07/24/2015	--	0.0042	--	--	0.047	--	98	17	--	--	--	<0.001	--	--	--	7.1	--	--	110	--	--
G51L	10/15/2015	--	<0.001	--	--	0.17	--	100	15	--	--	--	<0.001	--	--	--	7.1	--	--	95	--	--
G51L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
G51L	02/19/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G51S	01/30/2015	--	0.0061	--	--	0.015	--	100	11	--	--	--	<0.001	--	--	--	7.0	--	--	53	--	--
G51S	04/17/2015	--	0.0094	--	--	0.017	--	100	9.1	--	--	--	<0.001	--	--	--	7.2	--	--	51	--	--
G51S	07/24/2015	--	0.0085	--	--	<0.01	--	92	11	--	--	--	<0.001	--	--	--	7.1	--	--	40	--	--
G51S	10/15/2015	--	0.0051	--	--	0.021	--	91	8.5	--	--	--	<0.001	--	--	--	7.2	--	--	38	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G51S	12/03/2015	<0.003	0.0086	0.13	<0.001	0.02	<0.001	110	10	<0.004	<0.002	0.277	0.002	<0.01	<0.0002	0.0023	7.0	1.28	<0.001	39	<0.001	400
G51S	01/29/2016	<0.003	0.0042	0.097	<0.001	0.02	<0.001	89	11	<0.004	<0.002	<0.25	<0.001	<0.01	0.0004	0.0021	7.0	1.21	<0.001	52	<0.001	380
G51S	04/25/2016	<0.003	0.0048	0.096	<0.001	<0.01	<0.001	92	13	<0.004	<0.002	0.337	<0.001	<0.01	<0.0002	0.0016	7.1	0.517	<0.001	45	<0.001	400
G51S	08/10/2016	<0.003	0.0047	0.11	<0.001	0.014	<0.001	92	25	<0.004	<0.002	0.29	<0.001	<0.01	<0.0002	<0.001	7.1	0.921	<0.001	97	<0.001	350
G51S	10/21/2016	<0.003	0.0054	0.11	<0.001	<0.01	<0.001	89	13	<0.004	<0.002	0.27	<0.001	<0.01	<0.0002	0.0012	7.4	1.46	<0.001	44	<0.001	300
G51S	01/21/2017	<0.003	0.0034	0.083	<0.001	<0.01	<0.001	67	13	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0017	7.3	0.719	<0.001	48	<0.001	380
G51S	04/07/2017	<0.003	0.0029	0.089	<0.001	0.01	<0.001	94	13	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.002	7.0	0.313	<0.001	50	<0.001	380
G51S	06/28/2017	<0.003	0.005	0.11	0.0013	<0.01	<0.001	82	14	<0.004	<0.002	<0.25	0.0015	<0.01	0.00034	0.0029	6.8	1.11	0.0014	41	0.0028	400
G51S	11/08/2017	--	--	--	--	0.013	--	96	12	--	--	0.368	--	--	--	--	7.1	--	--	34	--	320
G51S	06/04/2018	--	--	--	--	0.039	--	97	11	--	--	0.266	--	--	--	--	7.0	--	--	52	--	380
G51S	07/13/2018	--	--	--	--	0.014	--	96	--	--	--	0.31	--	--	--	--	6.9	--	--	--	--	390
G51S	10/11/2018	--	--	--	--	0.015	--	99	13	--	--	0.264	--	--	--	--	7.1	--	--	51	--	380
G51S	02/05/2019	--	--	--	--	0.012	--	90	14	--	--	0.33	--	--	--	--	6.8	--	--	50	--	380
G51S	07/08/2019	--	--	--	--	0.039	--	100	16	--	--	0.332	--	--	--	--	7.0	--	--	48	--	460
G51S	01/14/2020	--	--	--	--	0.016	--	100	13	--	--	<0.25	--	--	--	--	7.1	--	--	53	--	440
G51S	08/10/2020	--	--	--	--	0.01	--	99	8.2	--	--	<0.25	--	--	--	--	6.9	--	--	26	--	390
G51S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G51S	02/19/2021	--	--	--	--	0.022	--	100	19	--	--	0.316	--	--	--	--	7.2	--	--	52	--	410
G51S	04/14/2021	<0.003	0.0042	0.1	<0.001	0.017	<0.001	88	14	<0.004	<0.002	0.258	0.012	<0.02	<0.0002	0.0012	7.1	0	<0.001	51	<0.001	380
G51S	04/29/2021	<0.003	0.0038	0.11	<0.001	0.019	<0.001	100	15	0.0059	<0.002	0.25	0.015	<0.02	<0.0002	0.0013	7.1	0.825	<0.001	51	<0.001	400
G51S	05/13/2021	<0.003	0.0012	0.089	<0.001	0.013	<0.001	94	15	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.2	0	<0.001	55	<0.001	350
G51S	06/01/2021	<0.003	0.0017	0.091	<0.001	0.022	<0.001	94	17	<0.004	<0.002	0.292	0.0046	<0.02	<0.0002	0.002	7.2	0.655	<0.001	51	<0.001	400

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
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DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G51S	06/15/2021	<0.003	0.0023	0.11	<0.001	0.022	<0.001	110	12	<0.004	<0.002	<0.25	0.0019	<0.02	<0.0002	<0.001	7.0	0.0656	<0.001	54	<0.001	410
G51S	06/21/2021	<0.003	0.0013	0.092	<0.001	0.037	<0.001	96	14	<0.004	<0.002	0.415	0.0017	<0.02	<0.0002	<0.001	7.1	0	<0.001	53	<0.001	410
G51S	07/12/2021	<0.003	0.0055	0.11	<0.001	0.014	<0.001	95	16	<0.004	<0.002	<0.25	0.0056	<0.02	<0.0002	0.0013	7.0	0.75	<0.001	51	<0.001	460
G51S	07/27/2021	<0.003	0.002	0.12	<0.001	0.016	<0.001	85	14	<0.004	<0.002	0.265	0.0017	<0.02	0.00098	<0.001	7.1	0.281	<0.001	51	<0.001	360
G52L	01/30/2015	--	<0.001	--	--	0.03	--	190	27	--	--	--	<0.001	--	--	--	6.6	--	--	160	--	--
G52L	04/17/2015	--	0.0015	--	--	0.021	--	230	22	--	--	--	<0.001	--	--	--	6.6	--	--	140	--	--
G52L	07/24/2015	--	<0.001	--	--	0.011	--	220	23	--	--	--	<0.001	--	--	--	6.6	--	--	120	--	--
G52L	10/15/2015	--	<0.001	--	--	0.026	--	220	22	--	--	--	<0.001	--	--	--	7.1	--	--	120	--	--
G52L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G52L	02/19/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.4	--	--	--	--	--
G52S	01/30/2015	--	0.019	--	--	0.04	--	150	14	--	--	--	0.041	--	--	--	6.8	--	--	110	--	--
G52S	04/17/2015	--	0.023	--	--	1.9	--	180	11	--	--	--	0.041	--	--	--	6.9	--	--	95	--	--
G52S	07/24/2015	--	0.012	--	--	0.019	--	160	12	--	--	--	0.023	--	--	--	6.9	--	--	97	--	--
G52S	10/15/2015	--	0.0083	--	--	0.036	--	150	9.7	--	--	--	0.01	--	--	--	6.9	--	--	89	--	--
G53L	01/30/2015	--	<0.001	--	--	0.12	--	110	65	--	--	--	<0.001	--	--	--	6.8	--	--	120	--	--
G53L	04/16/2015	--	<0.001	--	--	0.097	--	110	72	--	--	--	<0.001	--	--	--	6.9	--	--	140	--	--
G53L	07/24/2015	--	<0.001	--	--	0.11	--	110	70	--	--	--	<0.001	--	--	--	6.9	--	--	120	--	--
G53L	10/16/2015	--	<0.001	--	--	0.17	--	110	75	--	--	--	<0.001	--	--	--	6.9	--	--	140	--	--
G53L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G53L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G53S	01/30/2015	--	0.03	--	--	0.027	--	110	15	--	--	--	0.0049	--	--	--	7.0	--	--	79	--	--
G53S	04/16/2015	--	0.022	--	--	0.02	--	110	16	--	--	--	0.0056	--	--	--	7.1	--	--	86	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G53S	07/24/2015	--	0.0096	--	--	0.012	--	120	12	--	--	--	0.003	--	--	--	7.0	--	--	71	--	--
G53S	10/16/2015	--	0.02	--	--	0.024	--	110	11	--	--	--	0.0011	--	--	--	7.2	--	--	75	--	--
G53S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
G53S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G54C	04/14/2021	<0.003	0.0038	0.43	<0.001	0.16	<0.001	110	2.9	0.0081	0.0026	0.41	0.0014	<0.02	<0.0002	0.041	7.3	0.714	<0.001	50	<0.001	660
G54C	04/29/2021	<0.003	0.002	0.39	<0.001	0.13	<0.001	110	2.7	<0.004	<0.002	0.384	<0.001	<0.02	<0.0002	0.032	7.3	1.32	<0.001	45	<0.001	640
G54C	05/12/2021	<0.003	0.0029	0.47	<0.001	0.35	<0.001	110	2.9	<0.004	<0.002	0.465	0.0011	<0.02	<0.0002	0.035	7.2	0	0.0018	55	<0.001	630
G54C	06/01/2021	<0.003	0.0046	0.37	<0.001	0.12	<0.001	110	1.8	<0.004	<0.002	0.404	<0.001	<0.02	<0.0002	0.03	7.3	0.51	<0.001	47	<0.001	650
G54C	06/14/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.38	--	--	--	--
G54L	10/14/2015	--	0.028	--	--	0.041	--	180	11	--	--	--	0.0035	--	--	--	6.6	--	--	1.2	--	--
G54L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G54L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G54L	04/14/2021	<0.003	0.0058	0.18	<0.001	0.022	<0.001	150	21	<0.004	0.0044	<0.25	<0.001	<0.02	<0.0002	0.0027	6.6	0.299	<0.001	95	<0.001	900
G54L	04/29/2021	<0.003	0.01	0.21	<0.001	0.023	<0.001	170	20	<0.004	0.0026	<0.25	<0.001	<0.02	<0.0002	0.0011	6.6	0.516	<0.001	81	<0.001	800
G54L	05/12/2021	<0.003	0.014	0.24	<0.001	0.031	<0.001	160	21	0.0079	<0.002	<0.25	<0.001	<0.02	<0.0002	0.002	6.5	0.873	<0.001	70	<0.001	520
G54L	06/01/2021	<0.003	0.0069	0.16	<0.001	0.024	<0.001	160	21	<0.004	0.0029	<0.25	<0.001	<0.02	<0.0002	<0.001	6.6	0.508	<0.001	65	<0.001	780
G54L	06/14/2021	<0.003	0.006	0.16	<0.001	0.018	<0.001	160	22	<0.004	0.0021	<0.25	<0.001	<0.02	<0.0002	<0.001	6.7	0.766	<0.001	55	<0.001	750
G54L	06/21/2021	<0.003	0.0056	0.19	<0.001	0.03	<0.001	160	19	<0.004	0.0022	0.383	<0.001	<0.02	<0.0002	<0.001	6.5	1.21	<0.001	46	<0.001	700
G54L	07/13/2021	<0.003	0.0033	0.13	<0.001	0.023	<0.001	140	23	<0.004	0.0029	<0.25	<0.001	<0.02	<0.0002	0.002	6.4	0.246	<0.001	97	<0.001	850
G54L	07/27/2021	<0.003	0.0017	0.15	<0.001	0.027	<0.001	120	5.2	<0.004	<0.002	<0.25	<0.001	<0.02	0.00027	0.0047	6.6	1.65	<0.001	100	<0.001	720
G54S	01/30/2015	--	0.0013	--	--	0.045	--	120	<5	--	--	--	<0.001	--	--	--	6.8	--	--	47	--	--
G54S	04/16/2015	--	0.0014	--	--	0.029	--	140	2.2	--	--	--	<0.001	--	--	--	6.8	--	--	51	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G54S	07/23/2015	--	0.0011	--	--	0.05	--	130	2.3	--	--	--	<0.001	--	--	--	6.9	--	--	40	--	--
G54S	10/14/2015	--	0.0021	--	--	0.048	--	140	2.3	--	--	--	<0.001	--	--	--	6.9	--	--	41	--	--
G54S	12/04/2015	<0.003	<0.001	0.2	<0.001	0.027	<0.001	130	4.5	<0.004	<0.002	<0.25	<0.001	0.01	<0.0002	0.0016	6.5	1.28	<0.001	43	<0.001	600
G54S	01/29/2016	<0.003	0.0014	0.25	<0.001	0.046	<0.001	130	2.6	<0.004	<0.002	<0.25	<0.001	0.01	<0.0002	0.0019	6.9	0.787	<0.001	47	<0.001	570
G54S	05/02/2016	<0.003	<0.001	0.23	<0.001	0.036	<0.001	140	3	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0019	6.7	1.01	<0.001	45	<0.001	520
G54S	08/12/2016	<0.003	0.002	0.24	<0.001	0.03	<0.001	120	2.3	<0.004	<0.002	0.269	<0.001	0.012	<0.0002	0.0019	7.1	0.476	<0.001	43	<0.001	480
G54S	10/21/2016	<0.003	0.0023	0.27	<0.001	0.022	<0.001	120	2.5	<0.004	<0.002	0.259	<0.001	<0.01	0.00021	0.0023	7.2	1.27	<0.001	43	<0.001	520
G54S	01/24/2017	<0.003	0.0017	0.25	<0.001	0.03	<0.001	120	2	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0017	7.5	0.661	<0.001	44	<0.001	550
G54S	04/07/2017	<0.003	0.001	0.22	<0.001	0.028	<0.001	120	2.6	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0017	6.9	0.44	<0.001	45	<0.001	540
G54S	06/28/2017	<0.003	0.0059	0.28	<0.001	0.022	<0.001	110	2.5	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0025	7.1	1.19	<0.001	43	<0.001	520
G54S	11/08/2017	--	--	--	--	0.035	--	130	2.2	--	--	0.342	--	--	--	--	7.1	--	--	42	--	480
G54S	01/18/2018	--	--	--	--	0.052	--	120	--	--	--	--	--	--	--	--	6.9	--	--	--	--	380
G54S	06/04/2018	--	--	--	--	0.059	--	130	2.3	--	--	<0.25	--	--	--	--	7.1	--	--	43	--	500
G54S	07/13/2018	--	--	--	--	0.033	--	130	--	--	--	0.29	--	--	--	--	7.1	--	--	--	--	540
G54S	10/16/2018	--	--	--	--	0.037	--	130	2.5	--	--	<0.25	--	--	--	--	7.2	--	--	44	--	460
G54S	02/05/2019	--	--	--	--	0.032	--	130	2.3	--	--	0.283	--	--	--	--	7.1	--	--	44	--	590
G54S	07/15/2019	--	--	--	--	0.057	--	130	1.5	--	--	<0.25	--	--	--	--	7.1	--	--	46	--	590
G54S	01/14/2020	--	--	--	--	0.043	--	150	2.6	--	--	<0.25	--	--	--	--	6.9	--	--	45	--	620
G54S	08/10/2020	--	--	--	--	0.034	--	140	1.1	--	--	<0.25	--	--	--	--	6.8	--	--	21	--	460
G54S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G54S	02/22/2021	--	--	--	--	0.045	--	120	2.5	--	--	<0.25	--	--	--	--	6.8	--	--	39	--	500
G54S	06/21/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	590

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G55L	01/30/2015	--	<0.001	--	--	0.018	--	100	17	--	--	--	<0.001	--	--	--	6.8	--	--	56	--	--
G55L	04/16/2015	--	<0.001	--	--	<0.01	--	130	23	--	--	--	<0.001	--	--	--	6.8	--	--	67	--	--
G55L	07/23/2015	--	<0.001	--	--	0.02	--	130	20	--	--	--	<0.001	--	--	--	6.9	--	--	59	--	--
G55L	10/14/2015	--	<0.001	--	--	0.02	--	130	18	--	--	--	<0.001	--	--	--	6.9	--	--	63	--	--
G55L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G55L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G55S	01/30/2015	--	0.0053	--	--	0.046	--	130	5.1	--	--	--	0.0075	--	--	--	6.9	--	--	33	--	--
G55S	04/16/2015	--	0.0086	--	--	0.05	--	150	5.1	--	--	--	0.015	--	--	--	7.0	--	--	37	--	--
G55S	07/23/2015	--	0.0033	--	--	0.046	--	140	4.8	--	--	--	0.0047	--	--	--	7.1	--	--	27	--	--
G55S	10/14/2015	--	0.0033	--	--	0.031	--	130	5.5	--	--	--	0.0042	--	--	--	7.0	--	--	28	--	--
G55S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G55S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G56L	07/22/2015	--	<0.001	--	--	0.062	--	130	29	--	--	--	0.0012	--	--	--	6.9	--	--	46	--	--
G56L	10/16/2015	--	0.0047	--	--	0.028	--	130	27	--	--	--	0.0062	--	--	--	7.0	--	--	44	--	--
G56L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G56L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G56S	02/04/2015	--	0.014	--	--	0.049	--	120	--	--	--	--	0.0057	--	--	--	7.2	--	--	58	--	--
G56S	04/16/2015	--	0.013	--	--	0.019	--	190	17	--	--	--	0.014	--	--	--	6.8	--	--	65	--	--
G56S	07/22/2015	--	0.051	--	--	0.053	--	150	13	--	--	--	0.0086	--	--	--	6.9	--	--	57	--	--
G56S	10/16/2015	--	0.012	--	--	0.022	--	130	11	--	--	--	0.0046	--	--	--	6.9	--	--	56	--	--
G56S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G56S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G57L	02/04/2015	--	0.018	--	--	0.05	--	120	19	--	--	--	0.0047	--	--	--	7.2	--	--	320	--	--
G57L	02/25/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.2	--	--	--	--	--
G57L	04/16/2015	--	0.0069	--	--	0.019	--	150	22	--	--	--	0.0026	--	--	--	6.9	--	--	300	--	--
G57L	07/22/2015	--	0.0034	--	--	0.083	--	97	13	--	--	--	0.0026	--	--	--	6.9	--	--	96	--	--
G57L	10/16/2015	--	0.0054	--	--	0.042	--	100	13	--	--	--	0.0026	--	--	--	6.7	--	--	110	--	--
G57L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G57L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G57S	02/04/2015	--	<0.001	--	--	0.019	--	100	19	--	--	--	<0.001	--	--	--	7.1	--	--	53	--	--
G57S	04/16/2015	--	<0.001	--	--	<0.01	--	130	23	--	--	--	<0.001	--	--	--	7.2	--	--	64	--	--
G57S	07/22/2015	--	0.0019	--	--	0.05	--	140	18	--	--	--	0.0058	--	--	--	7.0	--	--	53	--	--
G57S	10/16/2015	--	<0.001	--	--	0.013	--	110	17	--	--	--	<0.001	--	--	--	7.1	--	--	56	--	--
G57S	12/04/2015	<0.003	<0.001	0.14	<0.001	<0.01	<0.001	130	18	<0.004	<0.002	<0.25	0.0012	<0.01	<0.0002	<0.001	6.8	0.804	<0.001	54	<0.001	570
G57S	01/29/2016	<0.003	<0.001	0.13	<0.001	0.021	<0.001	110	19	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	<0.001	6.8	0.194	<0.001	58	<0.001	510
G57S	05/02/2016	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	120	20	<0.004	<0.002	0.277	<0.001	<0.01	<0.0002	<0.001	6.9	0.471	<0.001	56	<0.001	500
G57S	08/12/2016	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	120	20	<0.004	<0.002	0.304	<0.001	<0.01	<0.0002	<0.001	7.0	0.302	<0.001	58	<0.001	480
G57S	10/28/2016	<0.003	<0.001	0.14	<0.001	0.019	<0.001	100	19	<0.004	<0.002	0.321	<0.001	<0.01	<0.0002	<0.001	7.1	0.124	<0.001	55	<0.001	550
G57S	02/03/2017	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	120	20	<0.004	<0.002	0.268	<0.001	<0.01	<0.0002	<0.001	7.2	1.32	<0.001	52	<0.001	530
G57S	05/01/2017	0.0064	<0.001	0.13	0.0027	<0.01	0.0016	110	18	<0.004	<0.002	0.284	0.0032	<0.01	<0.0002	0.0034	7.1	0.0112	<0.001	52	0.0033	510
G57S	06/28/2017	<0.003	<0.001	0.13	<0.001	<0.01	<0.001	130	22	<0.004	<0.002	0.276	<0.001	<0.01	<0.0002	<0.001	7.3	0.607	<0.001	53	<0.001	520
G57S	11/08/2017	--	--	--	--	<0.01	--	120	19	--	--	0.39	--	--	--	--	7.0	--	--	51	--	450
G57S	01/18/2018	--	--	--	--	--	--	180	--	--	--	<0.25	--	--	--	--	7.1	--	--	--	--	370
G57S	06/04/2018	--	--	--	--	0.027	--	120	19	--	--	0.28	--	--	--	--	7.2	--	--	52	--	500

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G57S	07/21/2018	--	--	--	--	0.024	--	110	--	--	--	<0.25	--	--	--	--	7.2	--	--	--	--	540
G57S	10/17/2018	--	--	--	--	0.014	--	130	22	--	--	<0.25	--	--	--	--	7.3	--	--	53	--	470
G57S	02/06/2019	--	--	--	--	0.016	--	130	23	--	--	0.349	--	--	--	--	7.2	--	--	54	--	520
G57S	07/15/2019	--	--	--	--	0.055	--	140	18	--	--	0.327	--	--	--	--	7.1	--	--	55	--	680
G57S	01/14/2020	--	--	--	--	0.011	--	150	20	--	--	<0.25	--	--	--	--	6.8	--	--	55	--	700
G57S	08/10/2020	--	--	--	--	<0.01	--	150	15	--	--	0.292	--	--	--	--	6.6	--	--	51	--	600
G57S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	590
G57S	02/22/2021	--	--	--	--	0.013	--	120	1.8	--	--	0.313	--	--	--	--	6.9	--	--	54	--	680
G58L	04/15/2015	--	0.026	--	--	0.016	--	150	27	--	--	--	0.0072	--	--	--	6.9	--	--	320	--	--
G58L	07/22/2015	--	0.0027	--	--	0.051	--	120	29	--	--	--	0.0023	--	--	--	7.0	--	--	180	--	--
G58L	10/14/2015	--	0.013	--	--	0.024	--	140	23	--	--	--	0.012	--	--	--	7.0	--	--	190	--	--
G58L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G58L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G58S	02/04/2015	--	<0.001	--	--	0.018	--	180	20	--	--	--	<0.001	--	--	--	6.8	--	--	520	--	--
G58S	04/15/2015	--	<0.001	--	--	0.014	--	190	21	--	--	--	<0.001	--	--	--	6.6	--	--	540	--	--
G58S	07/22/2015	--	0.0092	--	--	0.044	--	180	19	--	--	--	0.018	--	--	--	6.8	--	--	250	--	--
G58S	10/14/2015	--	0.0025	--	--	0.18	--	170	17	--	--	--	0.0033	--	--	--	6.9	--	--	300	--	--
G58S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G58S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G59L	07/22/2015	--	0.0029	--	--	0.057	--	100	<25	--	--	--	0.0023	--	--	--	6.7	--	--	110	--	--
G59L	10/14/2015	--	0.013	--	--	0.043	--	110	19	--	--	--	0.014	--	--	--	7.0	--	--	84	--	--
G59L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G59L	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G59S	02/04/2015	--	0.02	--	--	0.038	--	210	8.8	--	--	--	0.016	--	--	--	6.9	--	--	110	--	--
G59S	04/15/2015	--	0.011	--	--	0.026	--	190	9.3	--	--	--	0.012	--	--	--	6.9	--	--	110	--	--
G59S	07/22/2015	--	0.0061	--	--	0.071	--	150	15	--	--	--	0.0046	--	--	--	6.9	--	--	150	--	--
G59S	10/14/2015	--	0.021	--	--	0.056	--	230	12	--	--	--	0.014	--	--	--	7.1	--	--	95	--	--
G59S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G59S	02/22/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G60L	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.3	--	--	--	--	--
G60L	02/23/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.2	--	--	--	--	--
G60L	04/14/2021	<0.003	<0.001	0.019	<0.001	0.034	<0.001	110	19	<0.004	0.0052	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	1.14	<0.001	<250	<0.001	550
G60L	04/29/2021	<0.003	<0.001	0.017	<0.001	0.029	<0.001	120	19	<0.004	0.0038	<0.25	<0.001	<0.02	<0.0002	<0.001	6.1	0.0999	<0.001	160	<0.001	580
G60L	05/13/2021	<0.003	<0.001	0.017	<0.001	0.025	<0.001	110	19	<0.004	0.0023	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	0	<0.001	180	<0.001	580
G60L	06/01/2021	<0.003	<0.001	0.014	<0.001	0.029	<0.001	110	20	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	6.3	1.08	<0.001	170	<0.001	560
G60L	06/15/2021	<0.003	<0.001	0.015	<0.001	0.029	<0.001	110	16	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	0.347	<0.001	180	<0.001	530
G60L	06/21/2021	<0.003	<0.001	0.018	<0.001	0.068	<0.001	110	18	<0.004	0.0031	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	0.8	<0.001	180	<0.001	580
G60L	07/12/2021	<0.003	<0.001	0.027	<0.001	0.027	<0.001	110	18	<0.004	0.008	<0.25	<0.001	<0.02	<0.0002	<0.001	6.0	0.168	<0.001	180	<0.001	580
G60L	07/28/2021	<0.003	<0.001	0.019	<0.001	0.022	<0.001	110	15	<0.004	0.0039	<0.25	<0.001	<0.02	<0.0002	<0.001	6.2	2.36	<0.001	160	<0.001	530
G60S	02/04/2015	--	0.0042	--	--	0.024	--	120	12	--	--	--	0.0046	--	--	--	6.8	--	--	62	--	--
G60S	04/15/2015	--	0.018	--	--	0.028	--	250	11	--	--	--	0.022	--	--	--	6.8	--	--	63	--	--
G60S	07/22/2015	--	0.0032	--	--	0.035	--	150	9.6	--	--	--	0.003	--	--	--	6.8	--	--	58	--	--
G60S	10/14/2015	--	0.002	--	--	0.064	--	130	8.6	--	--	--	<0.001	--	--	--	7.1	--	--	60	--	--
G60S	12/04/2015	<0.003	0.0097	0.24	<0.001	0.024	<0.001	180	8.4	0.012	0.0049	0.264	0.0099	0.018	<0.0002	0.0016	6.6	1.74	0.0031	61	<0.001	610

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G60S	01/29/2016	<0.003	0.0016	0.14	<0.001	0.024	<0.001	120	8.8	<0.004	<0.002	<0.25	0.0012	<0.01	<0.0002	<0.001	6.7	0.987	<0.001	65	<0.001	500
G60S	05/02/2016	<0.003	0.0032	0.17	<0.001	0.015	<0.001	160	7.9	0.0052	<0.002	0.276	0.0024	<0.01	<0.0002	<0.001	6.7	0.34	<0.001	64	<0.001	550
G60S	08/20/2016	<0.003	<0.001	0.14	<0.001	<0.01	<0.001	130	8.6	<0.004	<0.002	0.307	<0.001	<0.01	<0.0002	<0.001	6.7	0.876	<0.001	62	<0.001	560
G60S	10/28/2016	<0.003	0.004	0.18	<0.001	0.029	<0.001	120	8.1	<0.004	<0.002	0.331	<0.001	<0.01	<0.0002	0.001	6.6	1.29	<0.001	64	<0.001	540
G60S	02/03/2017	<0.003	<0.001	0.13	<0.001	0.011	<0.001	130	11	<0.004	<0.002	0.268	<0.001	<0.01	<0.0002	<0.001	6.5	1.27	<0.001	60	<0.001	580
G60S	04/25/2017	<0.003	<0.001	0.14	<0.001	0.01	<0.001	120	8.7	<0.004	<0.002	0.287	<0.001	<0.01	<0.0002	<0.001	6.8	0.946	<0.001	61	<0.001	580
G60S	06/29/2017	<0.003	0.0021	0.15	<0.001	<0.01	<0.001	110	10	<0.004	<0.002	0.328	<0.001	<0.01	<0.0002	<0.001	7.0	1.54	<0.001	68	<0.001	580
G60S	11/08/2017	--	--	--	--	0.01	--	120	11	--	--	0.351	--	--	--	--	6.9	--	--	67	--	460
G60S	01/19/2018	--	--	--	--	--	--	100	--	--	--	0.313	--	--	--	--	6.9	--	--	--	--	520
G60S	06/04/2018	--	--	--	--	0.035	--	150	11	--	--	0.316	--	--	--	--	6.9	--	--	73	--	490
G60S	07/21/2018	--	--	--	--	0.022	--	120	--	--	--	<0.25	--	--	--	--	7.0	--	--	--	--	540
G60S	10/17/2018	--	--	--	--	0.018	--	120	12	--	--	<0.25	--	--	--	--	6.9	--	--	72	--	440
G60S	02/06/2019	--	--	--	--	0.04	--	270	19	--	--	0.327	--	--	--	--	7.0	--	--	200	--	760
G60S	04/08/2019	--	--	--	--	--	--	160	13	--	--	--	--	--	--	--	7.0	--	--	240	--	860
G60S	07/15/2019	--	--	--	--	0.024	--	140	10	--	--	0.319	--	--	--	--	6.8	--	--	190	--	800
G60S	01/14/2020	--	--	--	--	0.026	--	150	11	--	--	<0.25	--	--	--	--	6.7	--	--	200	--	790
G60S	08/10/2020	--	--	--	--	0.015	--	140	6.8	--	--	<0.25	--	--	--	--	6.6	--	--	120	--	600
G60S	11/17/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	110	--	630
G60S	02/23/2021	--	--	--	--	0.019	--	130	9.1	--	--	<0.25	--	--	--	--	6.6	--	--	67	--	620
G61S	02/04/2015	--	0.002	--	--	0.051	--	150	22	--	--	--	0.003	--	--	--	7.0	--	--	330	--	--
G61S	04/15/2015	--	0.0022	--	--	0.034	--	120	22	--	--	--	0.0028	--	--	--	7.0	--	--	220	--	--
G61S	07/21/2015	--	0.0012	--	--	0.029	--	120	18	--	--	--	0.0012	--	--	--	6.9	--	--	140	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G61S	10/13/2015	--	0.0012	--	--	0.027	--	140	20	--	--	--	<0.001	--	--	--	7.0	--	--	160	--	--
G61S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
G61S	02/23/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
G62L	02/04/2015	--	0.0031	--	--	0.083	--	120	19	--	--	--	0.0029	--	--	--	6.8	--	--	89	--	--
G62L	04/15/2015	--	0.0025	--	--	0.068	--	160	20	--	--	--	0.0015	--	--	--	6.9	--	--	150	--	--
G62L	07/22/2015	--	0.0016	--	--	0.13	--	68	9.2	--	--	--	0.0011	--	--	--	7.0	--	--	57	--	--
G62L	10/13/2015	--	0.0018	--	--	0.12	--	140	12	--	--	--	0.0023	--	--	--	7.2	--	--	87	--	--
G62L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--
G62L	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G63L	04/15/2015	--	0.0033	--	--	0.03	--	210	26	--	--	--	0.0035	--	--	--	6.9	--	--	350	--	--
G63L	07/22/2015	--	0.0021	--	--	0.091	--	190	13	--	--	--	0.0011	--	--	--	6.9	--	--	230	--	--
G63L	10/13/2015	--	0.0063	--	--	0.04	--	210	24	--	--	--	0.0083	--	--	--	7.2	--	--	270	--	--
G63L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G63L	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
G63S	02/04/2015	--	0.003	--	--	0.023	--	110	3.6	--	--	--	0.0016	--	--	--	7.1	--	--	40	--	--
G63S	04/15/2015	--	<0.001	--	--	0.017	--	110	3.2	--	--	--	<0.001	--	--	--	7.0	--	--	36	--	--
G63S	07/22/2015	--	0.0018	--	--	0.036	--	110	3.4	--	--	--	<0.001	--	--	--	7.2	--	--	38	--	--
G63S	10/13/2015	--	0.0013	--	--	0.02	--	110	3.7	--	--	--	<0.001	--	--	--	7.3	--	--	45	--	--
G63S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G63S	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G64L	02/04/2015	--	0.0019	--	--	0.014	--	100	3.1	--	--	--	0.0023	--	--	--	6.9	--	--	26	--	--
G64L	04/15/2015	--	<0.001	--	--	0.012	--	96	2.9	--	--	--	<0.001	--	--	--	7.1	--	--	25	--	--

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G64L	07/22/2015	--	<0.001	--	--	0.034	--	110	4.5	--	--	--	<0.001	--	--	--	7.0	--	--	120	--	--
G64L	10/13/2015	--	0.0031	--	--	0.11	--	110	3.9	--	--	--	0.0037	--	--	--	7.1	--	--	93	--	--
G64L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	--	--	--	--	--
G64L	02/25/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G64S	02/04/2015	--	0.0033	--	--	0.023	--	100	4.1	--	--	--	0.0034	--	--	--	7.1	--	--	28	--	--
G64S	04/15/2015	--	0.0038	--	--	0.018	--	110	3.9	--	--	--	0.0033	--	--	--	7.0	--	--	25	--	--
G64S	07/22/2015	--	0.011	--	--	0.037	--	120	3.7	--	--	--	0.0049	--	--	--	7.0	--	--	27	--	--
G64S	10/13/2015	--	0.0037	--	--	0.022	--	110	4.4	--	--	--	<0.001	--	--	--	7.1	--	--	77	--	--
G64S	12/04/2015	<0.003	0.004	0.2	<0.001	0.017	<0.001	110	3.6	<0.004	<0.002	0.3	0.0017	<0.01	<0.0002	0.0019	6.8	0.607	0.0013	25	<0.001	500
G64S	01/29/2016	<0.003	0.0031	0.17	<0.001	0.03	<0.001	98	4.1	<0.004	<0.002	<0.25	0.0033	<0.01	<0.0002	0.0018	7.0	0.634	<0.001	27	<0.001	420
G64S	05/02/2016	<0.003	0.0017	0.17	<0.001	0.017	<0.001	110	4.1	<0.004	<0.002	0.303	0.0015	<0.01	<0.0002	0.0018	7.1	1.43	<0.001	27	<0.001	400
G64S	08/20/2016	<0.003	0.0035	0.21	<0.001	0.011	<0.001	110	4	0.015	<0.002	0.317	0.0028	<0.01	<0.0002	0.0023	7.1	0.782	<0.001	26	<0.001	430
G64S	10/28/2016	<0.003	0.0045	0.22	<0.001	0.036	<0.001	92	3.7	<0.004	<0.002	0.375	0.0051	<0.01	<0.0002	0.002	7.2	1.08	<0.001	28	<0.001	440
G64S	02/03/2017	<0.003	0.0023	0.18	<0.001	0.015	<0.001	99	3.6	<0.004	<0.002	0.314	<0.001	<0.01	<0.0002	0.0016	7.2	1.11	<0.001	26	<0.001	460
G64S	05/01/2017	0.0037	0.0037	0.2	<0.001	0.015	<0.001	100	3.7	<0.004	<0.002	0.32	<0.001	<0.01	<0.0002	0.0023	6.9	0.748	<0.001	32	<0.001	450
G64S	06/29/2017	<0.003	0.0028	0.17	<0.001	<0.01	<0.001	80	3.7	<0.004	<0.002	0.376	<0.001	<0.01	<0.0002	0.0013	6.8	1.19	<0.001	26	<0.001	460
G64S	11/08/2017	--	--	--	--	0.014	--	95	3.5	--	--	0.401	--	--	--	--	6.8	--	--	25	--	380
G64S	01/19/2018	--	--	--	--	--	--	--	--	--	--	0.367	--	--	--	--	6.9	--	--	--	--	--
G64S	06/04/2018	--	--	--	--	0.029	--	91	3.6	--	--	0.316	--	--	--	--	6.9	--	--	25	--	380
G64S	07/21/2018	--	--	--	--	0.019	--	83	--	--	--	0.318	--	--	--	--	6.9	--	--	--	--	390
G64S	10/20/2018	--	--	--	--	0.021	--	98	3.8	--	--	0.256	--	--	--	--	6.9	--	--	28	--	420
G64S	02/06/2019	--	--	--	--	0.024	--	140	4.1	--	--	0.38	--	--	--	--	6.8	--	--	25	--	420

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TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
G64S	07/15/2019	--	--	--	--	0.023	--	100	3.2	--	--	0.333	--	--	--	--	7.2	--	--	25	--	490
G64S	01/15/2020	--	--	--	--	0.024	--	110	3.4	--	--	0.34	--	--	--	--	6.8	--	--	21	--	480
G64S	08/11/2020	--	--	--	--	0.019	--	100	3.7	--	--	0.287	--	--	--	--	7.0	--	--	26	--	440
G64S	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
G64S	02/24/2021	--	--	--	--	0.021	--	100	3.6	--	--	0.385	--	--	--	--	7.0	--	--	22	--	500
G64S	06/21/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	--	--	--	--	450
P60	02/24/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.3	--	--	--	--	--
P60	03/24/2021	--	0.02	--	--	0.056	<0.001	150	32	--	--	--	0.036	--	--	--	6.6	--	--	53	--	--
R61L	11/18/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--
R61L	02/23/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--

Notes:
Detected at concentration greater than the GWPS
-- = data not available
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method. Estimated concentrations below the reporting limit and associated qualifiers are not provided since they are not utilized in statistics to determine exceedances above Part 845 standards.
35 I.A.C. 845.600 = Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G02S	12/02/2015	0	-103	6.6	785	12.7	226
G02S	02/03/2016	0	-90	6.6	750	11.4	495
G02S	04/20/2016	0	-105	6.6	812	13.2	1000
G02S	08/18/2016	0	-101	6.8	922	16.5	1000
G02S	10/19/2016	0	-126	6.9	829	15.8	1000
G02S	01/12/2017	0	-148	6.9	920	13.0	1000
G02S	04/22/2017	0	-154	6.8	957	13.9	1000
G02S	06/28/2017	0	-137	6.8	892	18.8	1000
G02S	11/10/2017	0	-146	6.9	917	12.9	1000
G02S	01/17/2018	0	-115	6.9	961	10.8	1000
G02S	06/06/2018	0	-118	6.9	1060	16.2	792
G02S	07/06/2018	0	-119	7.0	1020	14.1	779
G02S	10/04/2018	0	-120	7.1	1080	16.3	790
G02S	02/06/2019	0	-122	7.0	1028	12.0	104
G02S	07/08/2019	0	-128	7.0	1028	16.3	97.9
G02S	01/06/2020	0.12	-144	6.6	792.1	10.8	39.7
G02S	08/11/2020	1.00	-54.7	6.4	801	14.2	70.7
G02S	02/19/2021	0.08	-53.1	6.5	766.2	8.3	116
G02S	04/14/2021	0.32	-79.8	6.7	788.2	11.8	85.6
G02S	04/29/2021	1.00	-83.5	6.8	697	13.0	19.5
G02S	05/12/2021	0.16	-64.1	6.6	789	14.5	38.9
G02S	06/01/2021	0.02	-123	6.8	789	15.4	7.5
G02S	06/15/2021	0.34	-116	6.8	673	13.7	6.07
G02S	06/21/2021	0.09	-125	6.8	788.8	12.8	5.68
G02S	07/12/2021	0.14	-108	6.7	796	17.7	0
G02S	07/28/2021	0.58	-88.5	6.9	766	16.8	20.7
G50S	01/30/2015	--	--	6.8	704	--	--
G50S	04/17/2015	--	--	7.3	1118	--	--
G50S	07/24/2015	--	--	7.4	622	--	--
G50S	10/15/2015	--	--	7.4	718	--	--
G50S	12/03/2015	0	-76	6.9	622	13.1	38.7
G50S	01/29/2016	0	-70	7.4	710	11.3	49.3
G50S	04/25/2016	0	-77	7.3	841	13.3	62.1
G50S	08/10/2016	0	-95	7.3	930	17.0	46.1
G50S	10/21/2016	0	-92	7.3	860	15.7	48.5
G50S	01/21/2017	0	-101	7.3	935	14.2	59
G50S	04/07/2017	0	-79	7.3	701	13.4	38.8
G50S	06/28/2017	0	-87	7.1	796	19.2	50.1
G50S	11/08/2017	0	-84	7.1	782	12.5	8.5
G50S	06/04/2018	0	-77	7.1	790	15.3	57.1
G50S	07/13/2018	0	-78	7.1	820	15.0	48
G50S	10/11/2018	0	-86	7.2	780	15.4	34.3
G50S	02/05/2019	0	-90	7.1	819	12.0	47.1
G50S	07/08/2019	0	-64	7.4	654	16.0	48.1

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G50S	01/13/2020	0.95	67.2	6.9	707.5	11.4	69
G50S	08/10/2020	2.30	80.1	6.8	720	16.1	9.83
G50S	11/18/2020	--	--	7.0	656	--	--
G50S	02/19/2021	1.20	50.7	7.0	573.7	9.4	304
G50S	04/14/2021	4.00	119	7.2	699.8	12.4	27.8
G50S	04/29/2021	6.20	41.3	7.1	738.9	13.5	4.44
G50S	05/13/2021	5.00	112	7.2	677	15.0	54.5
G50S	06/01/2021	4.20	78.7	7.0	702.4	14.9	4.89
G50S	06/10/2021	3.60	109	7.2	699	18.6	60.2
G50S	06/21/2021	2.50	53.8	7.1	611	14.9	0.46
G50S	07/13/2021	2.50	82.5	7.2	575	17.2	15.2
G50S	07/28/2021	3.00	73.4	7.1	737	22.1	6.7
G51L	01/30/2015	--	--	6.9	942	--	--
G51L	04/17/2015	--	--	7.0	1390	--	--
G51L	07/24/2015	--	--	7.1	772	--	--
G51L	10/15/2015	--	--	7.1	823	--	--
G51L	11/18/2020	--	--	6.9	845	--	--
G51L	02/19/2021	--	--	6.8	566	--	--
G51S	01/30/2015	--	--	7.0	766	--	--
G51S	04/17/2015	--	--	7.2	1061	--	--
G51S	07/24/2015	--	--	7.1	720	--	--
G51S	10/15/2015	--	--	7.2	758	--	--
G51S	12/03/2015	0	-95	7.0	700	12.7	738
G51S	01/29/2016	0	-69	7.0	780	11.9	539
G51S	04/25/2016	0	-60	7.1	870	12.8	1000
G51S	08/10/2016	0	-67	7.1	863	17.3	1000
G51S	10/21/2016	0	-92	7.4	928	14.9	1000
G51S	01/21/2017	0	-82	7.3	935	14.5	1000
G51S	04/07/2017	0	-72	7.0	852	13.3	8.5
G51S	06/28/2017	0	-74	6.8	880	17.6	3.8
G51S	11/08/2017	0	-61	7.1	848	12.9	4.2
G51S	06/04/2018	0	-42	7.0	902	16.1	8.9
G51S	07/13/2018	0	-71	6.9	910	14.2	11
G51S	10/11/2018	8.60	-110	7.1	812	15.3	22.1
G51S	02/05/2019	0	-59	6.8	900	11.9	14.1
G51S	07/08/2019	0	-60	7.0	716	16.3	52.1
G51S	01/14/2020	4.40	62.7	7.1	686.6	11.4	111
G51S	08/10/2020	2.30	-9.5	6.9	752.8	20.7	42.5
G51S	11/18/2020	--	--	7.0	673	--	--
G51S	02/19/2021	5.80	-9	7.2	686.9	9.3	299
G51S	04/14/2021	1.90	-8.3	7.1	559	15.1	48.5
G51S	04/29/2021	1.80	4.3	7.1	728.8	17.0	17.9
G51S	05/13/2021	2.20	-5.8	7.2	720	13.8	10.6
G51S	06/01/2021	1.10	50.1	7.2	720.1	16.2	25.6

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G51S	06/15/2021	1.90	-29.4	7.0	747	15.4	19.6
G51S	06/21/2021	0.30	-38.8	7.1	713	14.2	26
G51S	07/12/2021	0.36	-59.4	7.0	720	16.6	72.7
G51S	07/27/2021	1.60	53.9	7.1	688	19.8	20.2
G52L	01/30/2015	--	--	6.6	1807	--	--
G52L	04/17/2015	--	--	6.6	2220	--	--
G52L	07/24/2015	--	--	6.5	1277	--	--
G52L	10/15/2015	--	--	7.1	922	--	--
G52L	11/18/2020	--	--	6.5	1642	--	--
G52L	02/19/2021	--	--	6.4	1444	--	--
G52S	01/30/2015	--	--	6.8	1064	--	--
G52S	04/17/2015	--	--	6.9	1099	--	--
G52S	07/24/2015	--	--	6.9	873	--	--
G52S	10/15/2015	--	--	6.9	845	--	--
G53L	01/30/2015	--	--	6.8	942	--	--
G53L	04/16/2015	--	--	6.9	890	--	--
G53L	07/24/2015	--	--	6.9	858	--	--
G53L	10/16/2015	--	--	6.9	952	--	--
G53L	11/18/2020	--	--	6.6	1312	--	--
G53L	02/22/2021	--	--	6.8	1235	--	--
G53S	01/30/2015	--	--	7.0	903	--	--
G53S	04/16/2015	--	--	7.1	814	--	--
G53S	07/24/2015	--	--	7.0	763	--	--
G53S	10/16/2015	--	--	7.2	893	--	--
G53S	11/18/2020	--	--	6.9	988	--	--
G53S	02/22/2021	--	--	6.8	698	--	--
G54C	04/14/2021	0.99	-103	7.3	1158	13.3	167
G54C	04/29/2021	0.50	-79.9	7.3	1200	14.5	76.7
G54C	05/12/2021	1.60	-66.9	7.2	1172	15.8	39.2
G54C	06/01/2021	1.60	-70.3	7.3	1200	16.8	27.6
G54L	10/14/2015	--	--	6.6	992	--	--
G54L	11/17/2020	--	--	6.5	1290	--	--
G54L	02/22/2021	--	--	6.6	1216	--	--
G54L	04/14/2021	0.64	-14	6.6	1508	14.1	35.7
G54L	04/29/2021	0.71	-32.1	6.6	1426	15.9	16
G54L	05/12/2021	2.20	-40.2	6.5	1423	19.5	26.6
G54L	06/01/2021	1.20	-72.4	6.6	1370	21.7	5.74
G54L	06/14/2021	1.80	-82.6	6.7	1344	20.8	16.4
G54L	06/21/2021	1.60	-44.6	6.5	1329	15.3	25.8
G54L	07/13/2021	2.00	-23.9	6.4	1351	25.1	33
G54L	07/27/2021	2.20	37.9	6.6	1383	16.4	24.7
G54S	01/30/2015	--	--	6.8	1044	--	--
G54S	04/16/2015	--	--	6.8	936	--	--
G54S	07/23/2015	--	--	6.9	885	--	--

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G54S	10/14/2015	--	--	6.9	806	--	--
G54S	12/04/2015	0	-15	6.5	992	12.6	8.4
G54S	01/29/2016	0	-17	6.9	925	11.6	8.5
G54S	05/02/2016	0	-21	6.7	951	13.1	7.3
G54S	08/12/2016	0	-29	7.1	980	17.7	12.8
G54S	10/21/2016	0	-52	7.2	970	16.0	11.4
G54S	01/24/2017	0	-60	7.5	1115	15.6	25.1
G54S	04/07/2017	0	-63	6.9	840	13.5	14.2
G54S	06/28/2017	0	-58	7.1	913	19.2	17.9
G54S	11/08/2017	0	-61	7.1	799	13.3	19.4
G54S	01/18/2018	0	-72	6.9	855	11.3	24.2
G54S	06/04/2018	0	-52	7.1	930	15.6	15
G54S	07/13/2018	0	-58	7.1	910	14.8	25.4
G54S	10/16/2018	0	-59	7.2	898	14.1	17.8
G54S	02/05/2019	0	-61	7.1	892	12.0	20.3
G54S	07/15/2019	0	-71	7.1	960	15.9	15.2
G54S	01/14/2020	4.80	27.7	6.9	1010	10.8	111
G54S	08/10/2020	1.90	-12.8	6.8	1046	20.6	28.7
G54S	11/17/2020	--	--	6.7	999	--	--
G54S	02/22/2021	1.00	-10	6.8	961.2	12.2	43.3
G54S	06/21/2021	0.39	-23.6	7.0	875	15.0	17.1
G55L	01/30/2015	--	--	6.8	956	--	--
G55L	04/16/2015	--	--	6.8	663	--	--
G55L	07/23/2015	--	--	6.9	843	--	--
G55L	10/14/2015	--	--	6.9	747	--	--
G55L	11/17/2020	--	--	6.5	1023	--	--
G55L	02/22/2021	--	--	6.7	1020	--	--
G55S	01/30/2015	--	--	6.9	893	--	--
G55S	04/16/2015	--	--	7.0	808	--	--
G55S	07/23/2015	--	--	7.1	788	--	--
G55S	10/14/2015	--	--	7.0	696	--	--
G55S	11/17/2020	--	--	6.6	801	--	--
G55S	02/22/2021	--	--	6.8	843	--	--
G56L	07/22/2015	--	--	6.9	885	--	--
G56L	10/16/2015	--	--	7.0	803	--	--
G56L	11/17/2020	--	--	6.7	1266	--	--
G56L	02/22/2021	--	--	6.5	1253	--	--
G56S	02/04/2015	--	--	7.2	918	--	--
G56S	04/16/2015	--	--	6.8	855	--	--
G56S	07/22/2015	--	--	6.9	760	--	--
G56S	10/16/2015	--	--	6.9	885	--	--
G56S	11/17/2020	--	--	6.7	878	--	--
G56S	02/22/2021	--	--	6.6	900	--	--
G57L	02/04/2015	--	--	7.2	570	--	--

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G57L	02/25/2015	--	--	7.2	570	--	--
G57L	04/16/2015	--	--	6.9	908	--	--
G57L	07/22/2015	--	--	6.9	825	--	--
G57L	10/16/2015	--	--	6.7	932	--	--
G57L	11/17/2020	--	--	7.0	797	--	--
G57L	02/22/2021	--	--	6.8	978	--	--
G57S	02/04/2015	--	--	7.1	973	--	--
G57S	04/16/2015	--	--	7.2	920	--	--
G57S	07/22/2015	--	--	7.0	803	--	--
G57S	10/16/2015	--	--	7.1	888	--	--
G57S	12/04/2015	10.00	13	6.8	925	13.0	7.6
G57S	01/29/2016	0	19	6.8	880	12.9	9.1
G57S	05/02/2016	0	30	6.9	930	13.4	11.9
G57S	08/12/2016	0	56	7.0	970	18.9	19.2
G57S	10/28/2016	0	75	7.1	1046	14.6	19.4
G57S	02/03/2017	0	69	7.2	1005	14.8	18
G57S	05/01/2017	0	62	7.1	932	14.2	12.1
G57S	06/28/2017	0	79	7.3	1040	18.3	15.9
G57S	11/08/2017	0	78	7.0	1020	13.1	12.1
G57S	01/18/2018	0	64	7.1	895	12.7	16
G57S	06/04/2018	0	89	7.2	1100	17.0	14.3
G57S	07/21/2018	0	73	7.2	1005	15.0	38.1
G57S	10/17/2018	0	71	7.3	1060	14.0	17
G57S	02/06/2019	0	79	7.2	1033	11.7	18.5
G57S	07/15/2019	0	-60	7.1	1096	16.1	18.6
G57S	01/14/2020	0.83	159	6.8	1115	12.0	128
G57S	08/10/2020	0.67	60.8	6.6	1161	16.3	18.3
G57S	11/17/2020	2.30	56.9	7.0	1029	12.8	3.86
G57S	02/22/2021	2.10	12.5	6.9	1236	11.0	10.9
G58L	04/15/2015	--	--	6.9	1294	--	--
G58L	07/22/2015	--	--	7.0	935	--	--
G58L	10/14/2015	--	--	7.0	955	--	--
G58L	11/18/2020	--	--	7.0	1063	--	--
G58L	02/22/2021	--	--	6.8	1087	--	--
G58S	02/04/2015	--	--	6.8	1487	--	--
G58S	04/15/2015	--	--	6.5	1450	--	--
G58S	07/22/2015	--	--	6.8	946	--	--
G58S	10/14/2015	--	--	6.9	996	--	--
G58S	11/18/2020	--	--	6.6	949	--	--
G58S	02/22/2021	--	--	6.6	974	--	--
G59L	07/22/2015	--	--	6.7	871	--	--
G59L	10/14/2015	--	--	7.0	1043	--	--
G59L	11/18/2020	--	--	6.8	983	--	--
G59L	02/22/2021	--	--	6.6	971	--	--

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G59S	02/04/2015	--	--	6.9	949	--	--
G59S	04/15/2015	--	--	6.9	967	--	--
G59S	07/22/2015	--	--	6.9	877	--	--
G59S	10/14/2015	--	--	7.1	1032	--	--
G59S	11/18/2020	--	--	6.7	842	--	--
G59S	02/22/2021	--	--	6.8	913	--	--
G60L	11/17/2020	--	--	6.3	998	--	--
G60L	02/23/2021	--	--	6.2	1069	--	--
G60L	04/14/2021	2.50	144	6.2	959.1	11.5	55.1
G60L	04/29/2021	2.10	111	6.1	974	12.4	60.6
G60L	05/13/2021	1.70	86	6.2	899.4	15.2	1.97
G60L	06/01/2021	2.40	111	6.3	917	14.6	1.01
G60L	06/15/2021	1.30	90.1	6.2	908	15.9	1.28
G60L	06/21/2021	0.97	87.7	6.2	914.4	13.8	11.8
G60L	07/12/2021	0.42	64.1	6.0	937	17.3	11.5
G60L	07/28/2021	0.63	106	6.2	840	17.0	22.4
G60S	02/04/2015	--	--	6.8	973	--	--
G60S	04/15/2015	--	--	6.8	999	--	--
G60S	07/22/2015	--	--	6.8	804	--	--
G60S	10/14/2015	--	--	7.1	849	--	--
G60S	12/04/2015	0	-41	6.6	958	12.3	75.9
G60S	01/29/2016	0	-65	6.7	990	12.1	38.9
G60S	05/02/2016	0	-42	6.7	1040	12.7	63.6
G60S	08/20/2016	0	-51	6.7	1015	18.0	56
G60S	10/28/2016	0	-45	6.6	916	14.1	70.8
G60S	02/03/2017	0	-47	6.5	948	14.4	70.2
G60S	04/25/2017	0	-62	6.8	735	14.1	30.5
G60S	06/29/2017	0	-58	7.0	710	17.5	36.4
G60S	11/08/2017	0	-52	6.9	718	13.6	27.4
G60S	01/19/2018	0	-60	6.9	701	12.6	39.7
G60S	06/04/2018	0	-68	6.9	802	15.9	43.4
G60S	07/21/2018	0	-60	7.0	724	15.2	41.8
G60S	10/17/2018	0	-51	6.9	764	14.4	38.4
G60S	02/06/2019	0	-65	7.0	698	12.0	42.4
G60S	04/08/2019	0	-60	7.0	1030	14.5	41.7
G60S	07/15/2019	0	-60	6.8	1150	15.8	14
G60S	01/14/2020	0.57	122	6.6	1226	12.2	33.5
G60S	08/10/2020	1.90	57.4	6.6	1110	21.0	1230
G60S	11/17/2020	0.99	-0.6	6.8	978	11.8	75.3
G60S	02/23/2021	1.20	-2.1	6.6	937.2	11.9	15.7
G61S	02/04/2015	--	--	7.0	1679	--	--
G61S	04/15/2015	--	--	7.0	1533	--	--
G61S	07/21/2015	--	--	6.9	1059	--	--
G61S	10/13/2015	--	--	7.0	1095	--	--

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G61S	11/18/2020	--	--	6.6	1514	--	--
G61S	02/23/2021	--	--	6.5	1511	--	--
G62L	02/04/2015	--	--	6.8	1356	--	--
G62L	04/15/2015	--	--	6.9	1507	--	--
G62L	07/22/2015	--	--	7.0	643	--	--
G62L	10/13/2015	--	--	7.2	790	--	--
G62L	11/18/2020	--	--	6.8	1578	--	--
G62L	02/24/2021	--	--	6.7	1275	--	--
G63L	04/15/2015	--	--	6.9	1767	--	--
G63L	07/22/2015	--	--	6.9	1117	--	--
G63L	10/13/2015	--	--	7.2	852	--	--
G63L	11/18/2020	--	--	7.0	1615	--	--
G63L	02/24/2021	--	--	6.7	1123	--	--
G63S	02/04/2015	--	--	7.1	866	--	--
G63S	04/15/2015	--	--	7.0	890	--	--
G63S	07/22/2015	--	--	7.2	718	--	--
G63S	10/13/2015	--	--	7.3	919	--	--
G63S	11/18/2020	--	--	7.0	548	--	--
G63S	02/24/2021	--	--	7.0	918	--	--
G64L	02/04/2015	--	--	6.9	818	--	--
G64L	04/15/2015	--	--	7.1	818	--	--
G64L	07/22/2015	--	--	7.0	858	--	--
G64L	10/13/2015	--	--	7.1	955	--	--
G64L	11/18/2020	--	--	7.1	1054	--	--
G64L	02/25/2021	--	--	7.0	1009	--	--
G64S	02/04/2015	--	--	7.1	819	--	--
G64S	04/15/2015	--	--	7.0	881	--	--
G64S	07/22/2015	--	--	7.0	807	--	--
G64S	10/13/2015	--	--	7.1	870	--	--
G64S	12/04/2015	2.80	-60	6.8	773	12.7	234
G64S	01/29/2016	0	-57	7.0	788	11.3	296
G64S	05/02/2016	0	-79	7.1	695	13.1	124
G64S	08/20/2016	0	-70	7.1	688	18.9	97.3
G64S	10/28/2016	0	-84	7.2	731	15.0	110
G64S	02/03/2017	0	-62	7.2	710	14.5	101
G64S	05/01/2017	0	-65	6.9	859	14.3	15.3
G64S	06/29/2017	0	-90	6.8	818	19.2	21.6
G64S	11/08/2017	0	-79	6.8	798	13.9	21.9
G64S	01/19/2018	0	-72	6.9	825	12.6	21.7
G64S	06/04/2018	0	-68	6.9	851	16.1	21.4
G64S	07/21/2018	0	-91	6.9	840	15.4	25.1
G64S	10/20/2018	0	-74	6.9	855	13.7	24.5
G64S	02/06/2019	0	-91	6.8	802	11.8	27.5
G64S	07/15/2019	0	70	7.2	750	16.0	14.7

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
G64S	01/15/2020	0.83	-12.3	6.8	781.2	11.4	41.4
G64S	08/11/2020	4.30	-1.3	7.0	688.9	18.5	42.8
G64S	11/18/2020	--	--	7.0	769	--	--
G64S	02/24/2021	3.00	-55.9	7.0	727.4	11.4	60.7
G64S	06/21/2021	0.76	-57.1	7.1	761	16.2	21.3
P60	02/24/2021	3.40	54	6.3	830	16.4	236
P60	03/24/2021	3.60	41.4	6.6	862	--	1620
R61L	11/18/2020	--	--	6.7	1162	--	--
R61L	02/23/2021	--	--	6.6	1058	--	--

Notes:
Field readings are reported with as many significant figures as provided by analytical laboratory.
-- = data not available
cm = centimeter
deg. C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTU = nephelometric turbidity units
SU = standard units

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FIGURES

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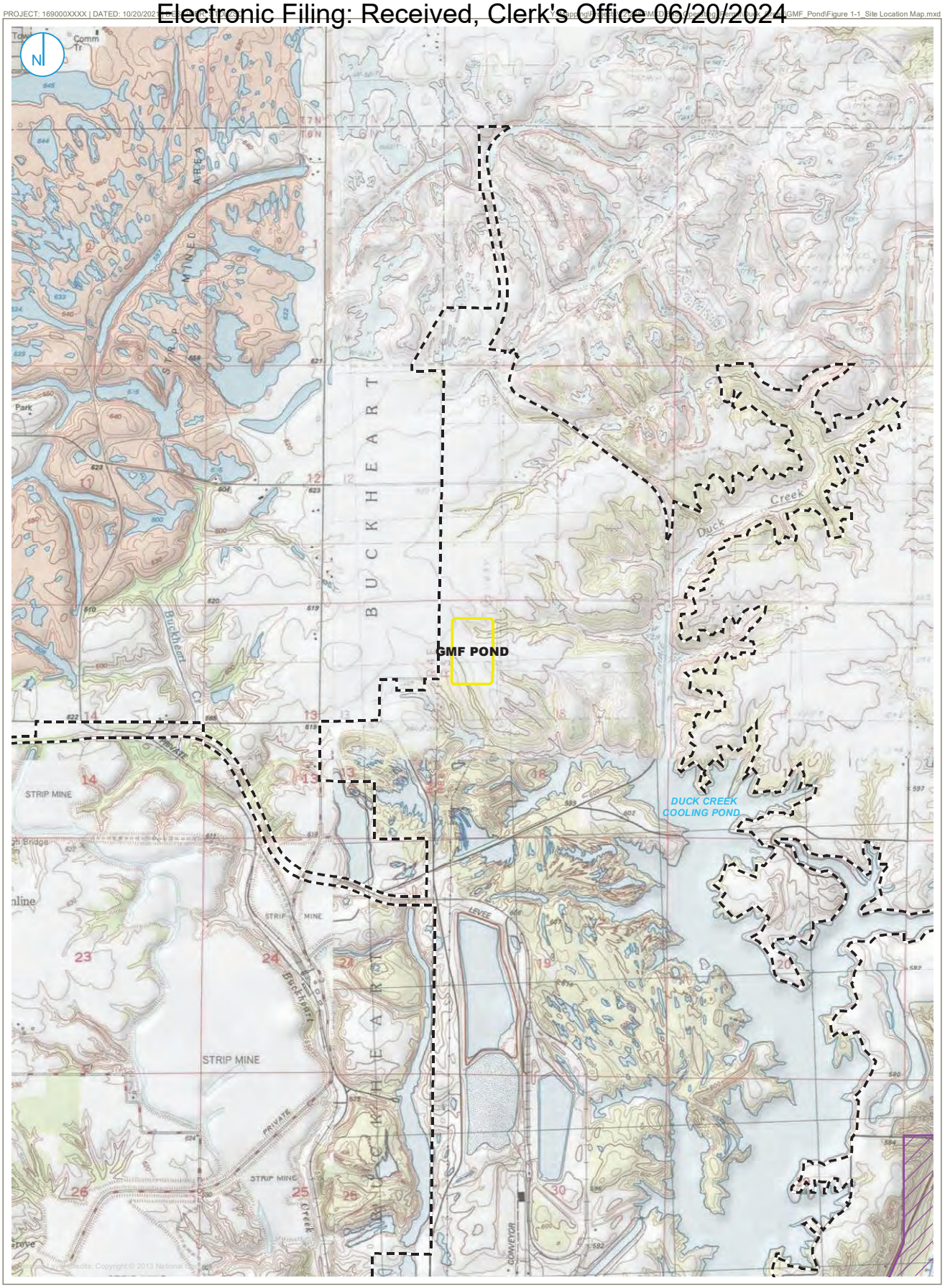
PROJECT: 169000XXXX | DATED: 10/20/2021 | DESIGNER: [illegible] | Y:\Mapping\[illegible]\GMF_Pond\Figure 1-1_Site Location Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY
COFFEEN LAKE STATE FISH AND WILDLIFE AREA

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-1

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: CLERK | Y:\Projects\2021\2021\GIS\Geoprocessing\Ramboll_Duck_Creek\GMF_Pond\Figure 1-2_Site Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SITE MAP

FIGURE 1-2

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: CLERK | CLIENT: ... Creek\GMF_Pond\Figure 2-1_Topo Map.mxd



10 FOOT ELEVATION CONTOUR (NAVD88)
2 FOOT ELEVATION CONTOUR (NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SITE TOPOGRAPHIC MAP

FIGURE 2-1

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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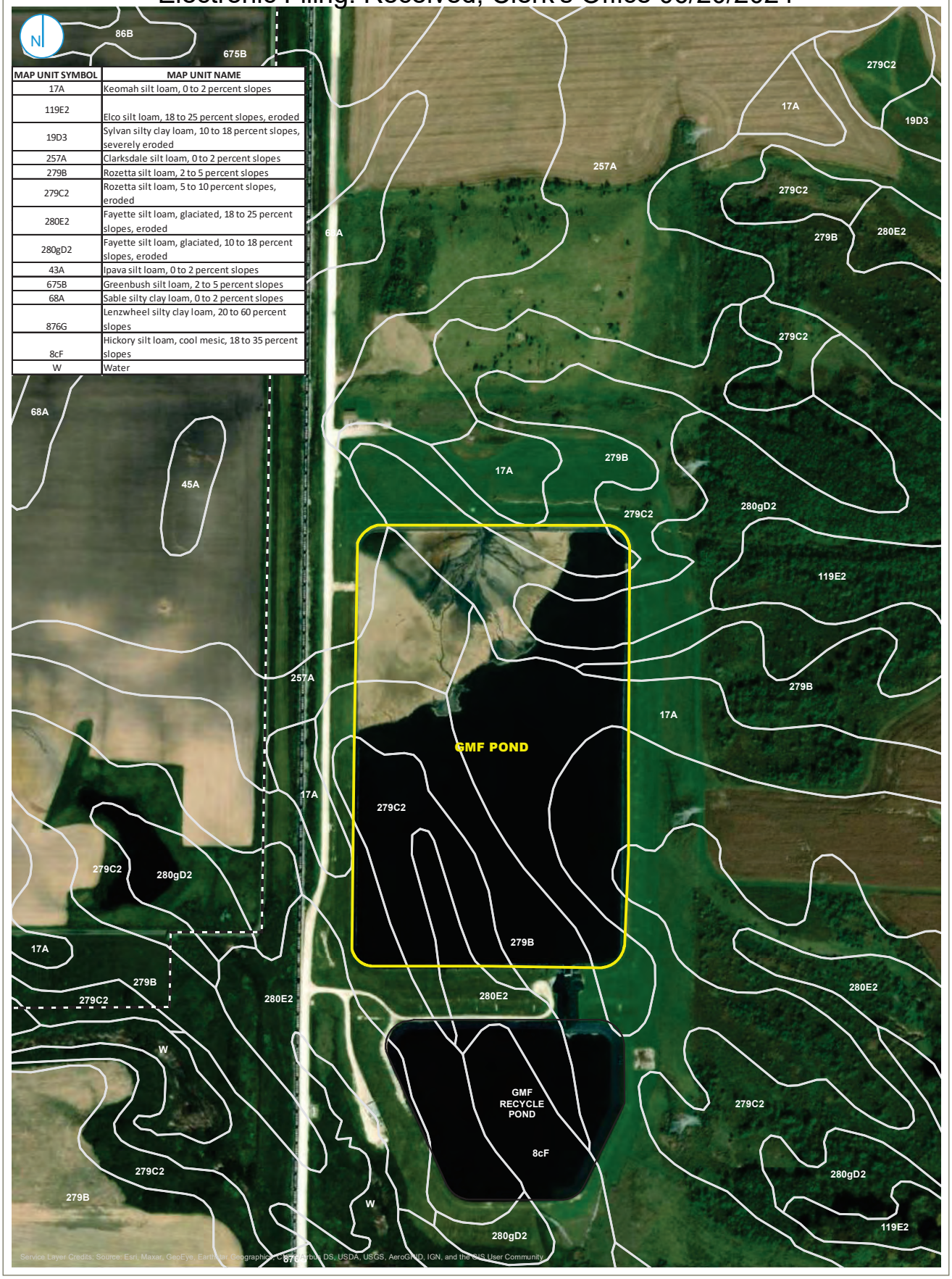
PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: ALEX CLOSE | Y:\Marketing\Projects\2\2285\00\2-845 Duck Creek\GMF_Pond\Figure 2-2_Soil Survey.mxd



MAP UNIT SYMBOL	MAP UNIT NAME
17A	Keomah silt loam, 0 to 2 percent slopes
119E2	Elco silt loam, 18 to 25 percent slopes, eroded
19D3	Sylvan silty clay loam, 10 to 18 percent slopes, severely eroded
257A	Clarksdale silt loam, 0 to 2 percent slopes
279B	Rozetta silt loam, 2 to 5 percent slopes
279C2	Rozetta silt loam, 5 to 10 percent slopes, eroded
280E2	Fayette silt loam, glaciated, 18 to 25 percent slopes, eroded
280gD2	Fayette silt loam, glaciated, 10 to 18 percent slopes, eroded
43A	Ipava silt loam, 0 to 2 percent slopes
675B	Greenbush silt loam, 2 to 5 percent slopes
68A	Sable silty clay loam, 0 to 2 percent slopes
876G	Lenzwheel silty clay loam, 20 to 60 percent slopes
8cF	Hickory silt loam, cool mesic, 18 to 35 percent slopes
W	Water

PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY
NRCS SOIL SURVEY MAP UNIT BOUNDARY

0 150 300 Feet

SOIL SURVEY MAP

FIGURE 2-2

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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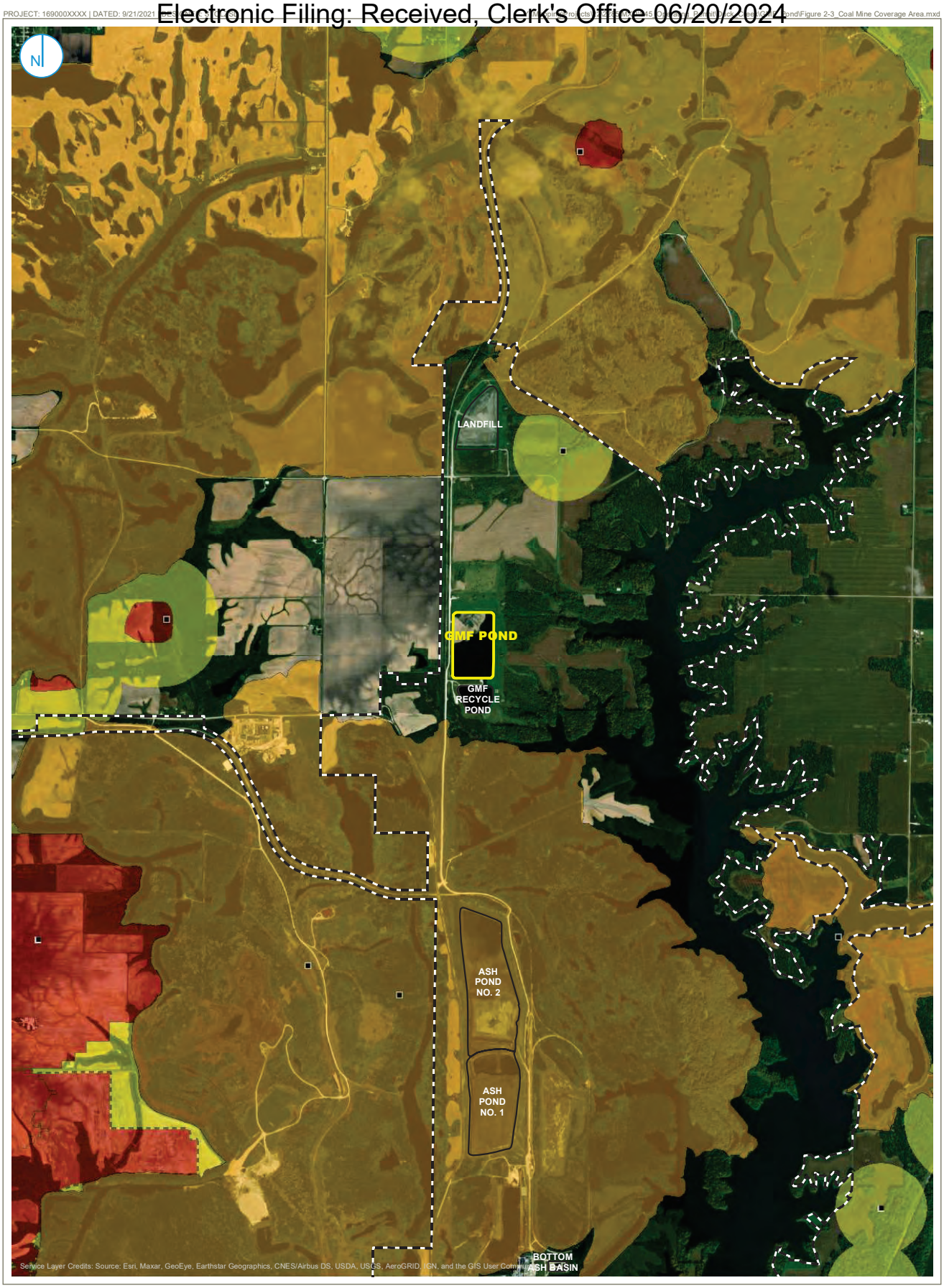
PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: [illegible] | Mapping Projects [illegible] Pond\Figure 2-3_Coal Mine Coverage Area.mxd



- COAL MINE SHAFT
- SURFACE COAL MINE
- UNDERGROUND COAL MINE
- UNDERGROUND MINE BUFFER REGION
- PART 845 REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- PROPERTY BOUNDARY

0 1,000 2,000 Feet

COAL MINE COVERAGE AREA

FIGURE 2-3

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: ... | Mapping Projects\2022\...\Figure 2-4_Surficial Geologic Deposits.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY
RADNOR TILL MEMBER

0 150 300 Feet

SURFICIAL GEOLOGIC DEPOSITS

FIGURE 2-4

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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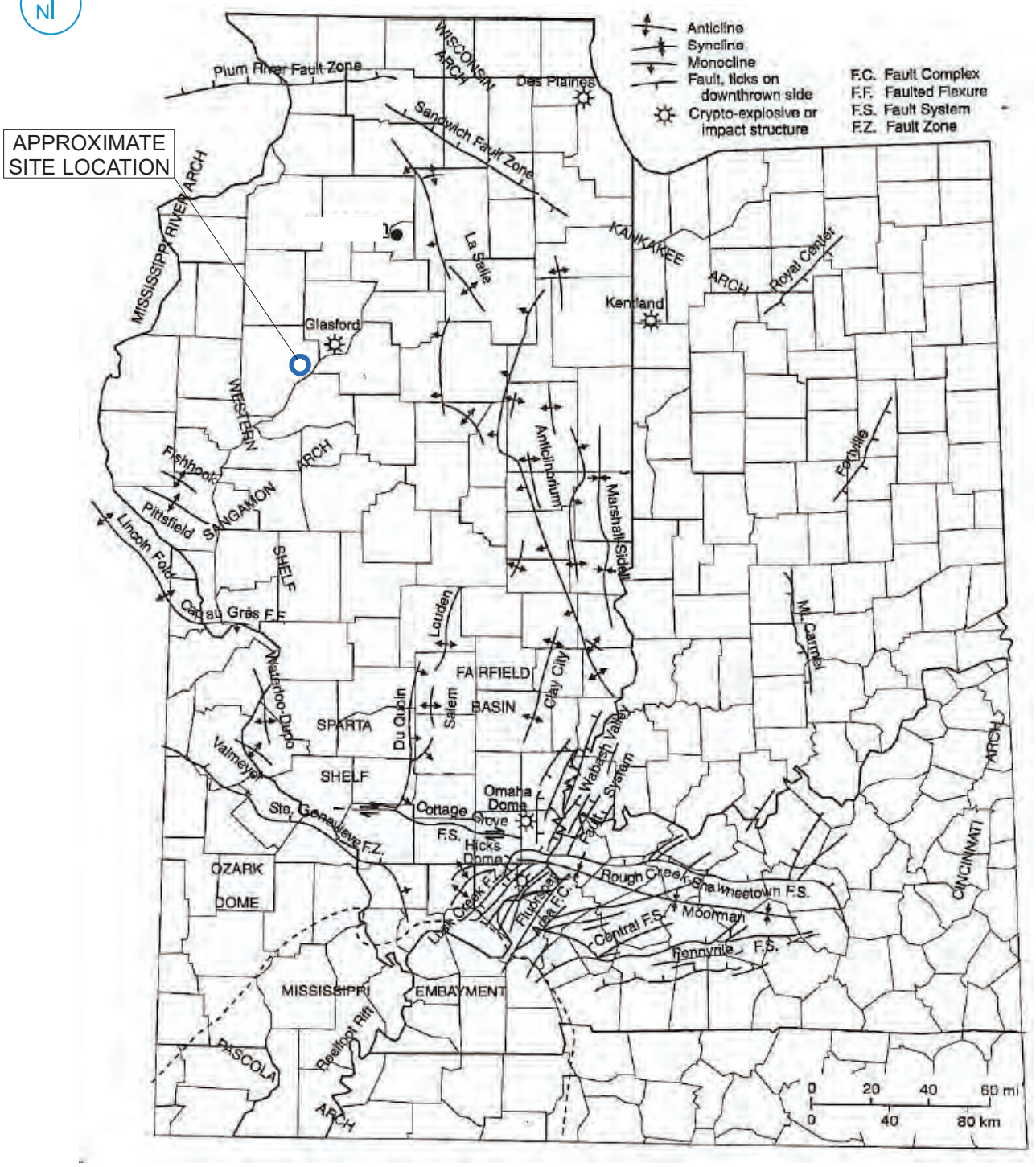

SOURCE NOTE: MODIFIED FROM "NELSON, W.J. 1995, STRUCTURAL FEATURES IN ILLINOIS, ILLINOIS STATE GEOLOGICAL SURVEY, BULLETIN 100, CHAMPAIGN, ILLINOIS."

Service Layer Credits:

Y:\Mapping\Projects\22285\MXD\845_Operating_Permit\Duck_Creek\GMF_Pond\Figure 2-5_Major Structural Features of Illinois.mxd

PROJECT: 169000XXXX | DATED: 9/17/2021 | DESIGNER: STOLZSD

MAJOR STRUCTURAL FEATURES OF ILLINOIS

FIGURE 2-5

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: ... | Figure 2-6_Field Investigation Location Map.mxd



MONITORING WELL
SOLID SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

FIELD INVESTIGATION LOCATION MAP

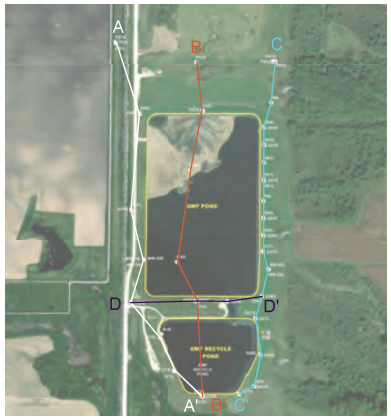
FIGURE 2-6

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

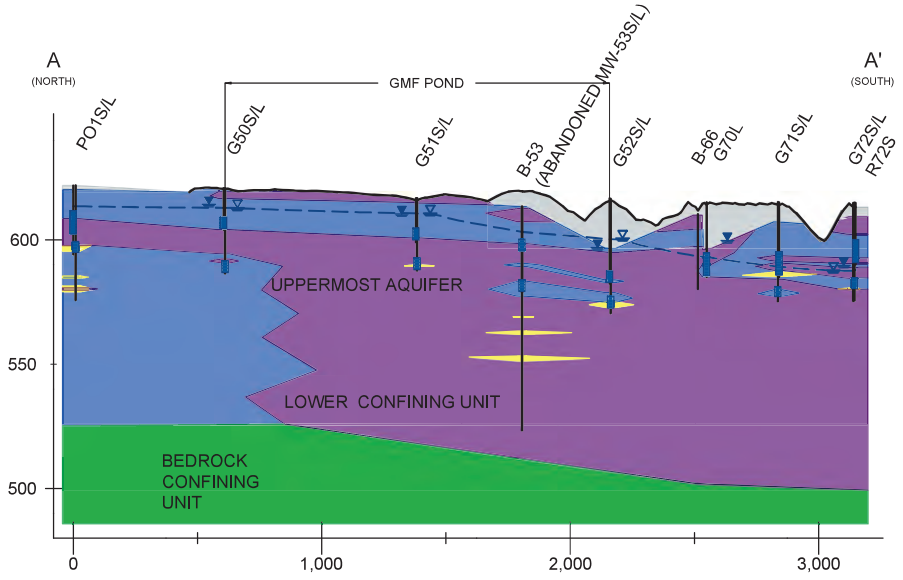
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

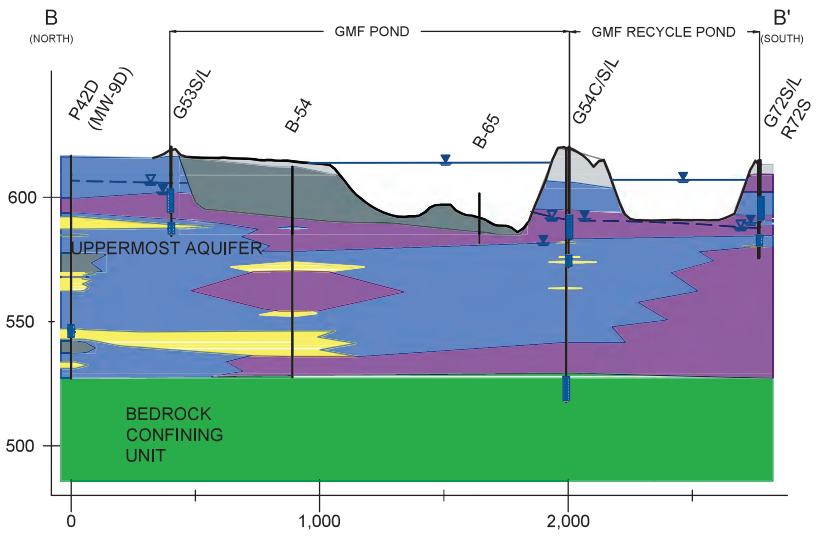
RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

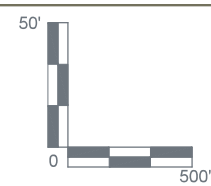


NOTES
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on April 14, 2021.





LEGEND
- COAL COMBUSTION RESIDUAL (CCR) (GYPSUM)
- FILL
- CLAY (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- WELL SCREEN INTERVAL
- UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
- UPPER AQUIFER GROUNDWATER ELEVATION
- BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)
- SURFACE WATER



GEOLOGIC CROSS SECTIONS
A-A' & B-B'

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 2-7

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 1940100806

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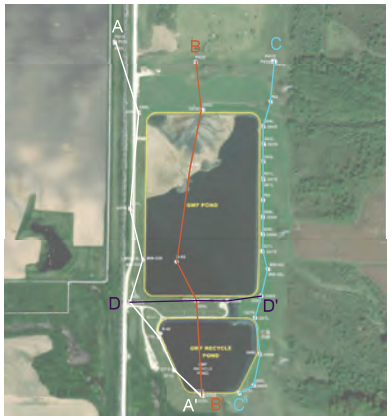
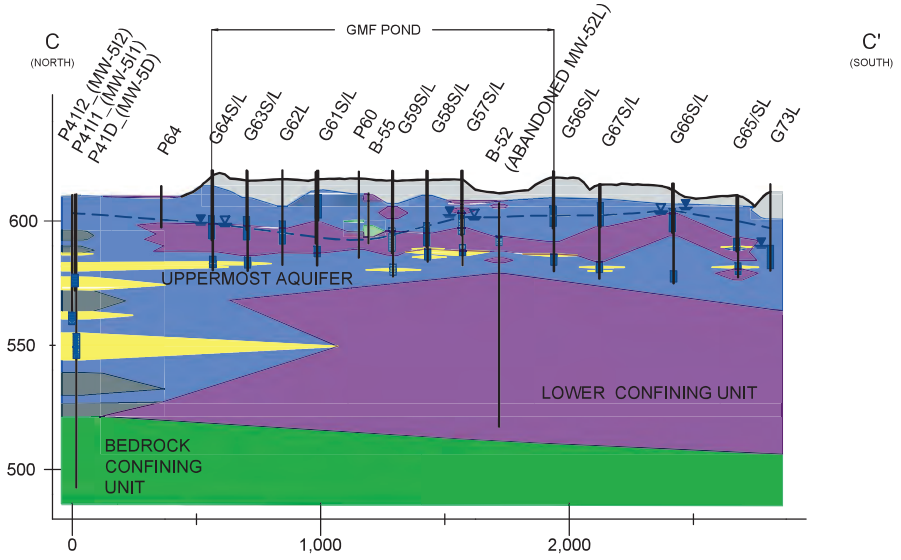
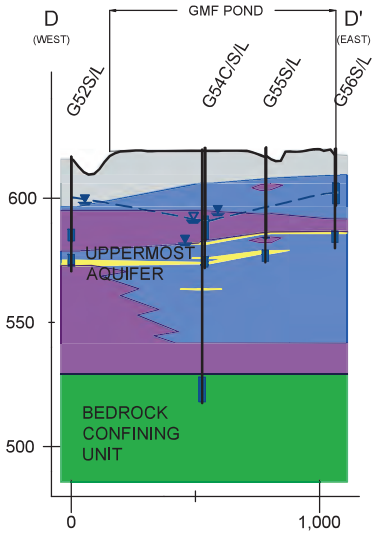


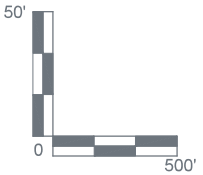
NOTES
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on April 14, 2021.





LEGEND

- COAL COMBUSTION RESIDUAL (CCR) (GYPSUM)
- FILL
- CLAY (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- PEAT
- WELL SCREEN INTERVAL
- UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
- UPPER AQUIFER GROUNDWATER ELEVATION
- BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)



GEOLOGIC CROSS SECTIONS
C-C' & D-D'

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 2-8

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT 1940100806 \\ramboll.com\data\Projects\2019\940100806\Avistra Shared Documents\CCR GW\Deliverables\Part 845 Operating Permits\Sites\Duck Creek\EVS\working files\CAD\Cross Sections\DC-GMF cross sections.dwg

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/12/2021 | DESIGNER: [illegible] | [illegible]\Figure 2-9_Bottom of CCR Map.mxd



10 FOOT CONSTRUCTION ELEVATION CONTOUR
2 FOOT CONSTRUCTION ELEVATION CONTOUR
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

BOTTOM OF CCR MAP

FIGURE 2-9

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/19/2021 | DESIGNER: STOUGHS | Figure 3-1_Monitoring Well Location Map.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

MONITORING WELL LOCATION MAP

FIGURE 3-1

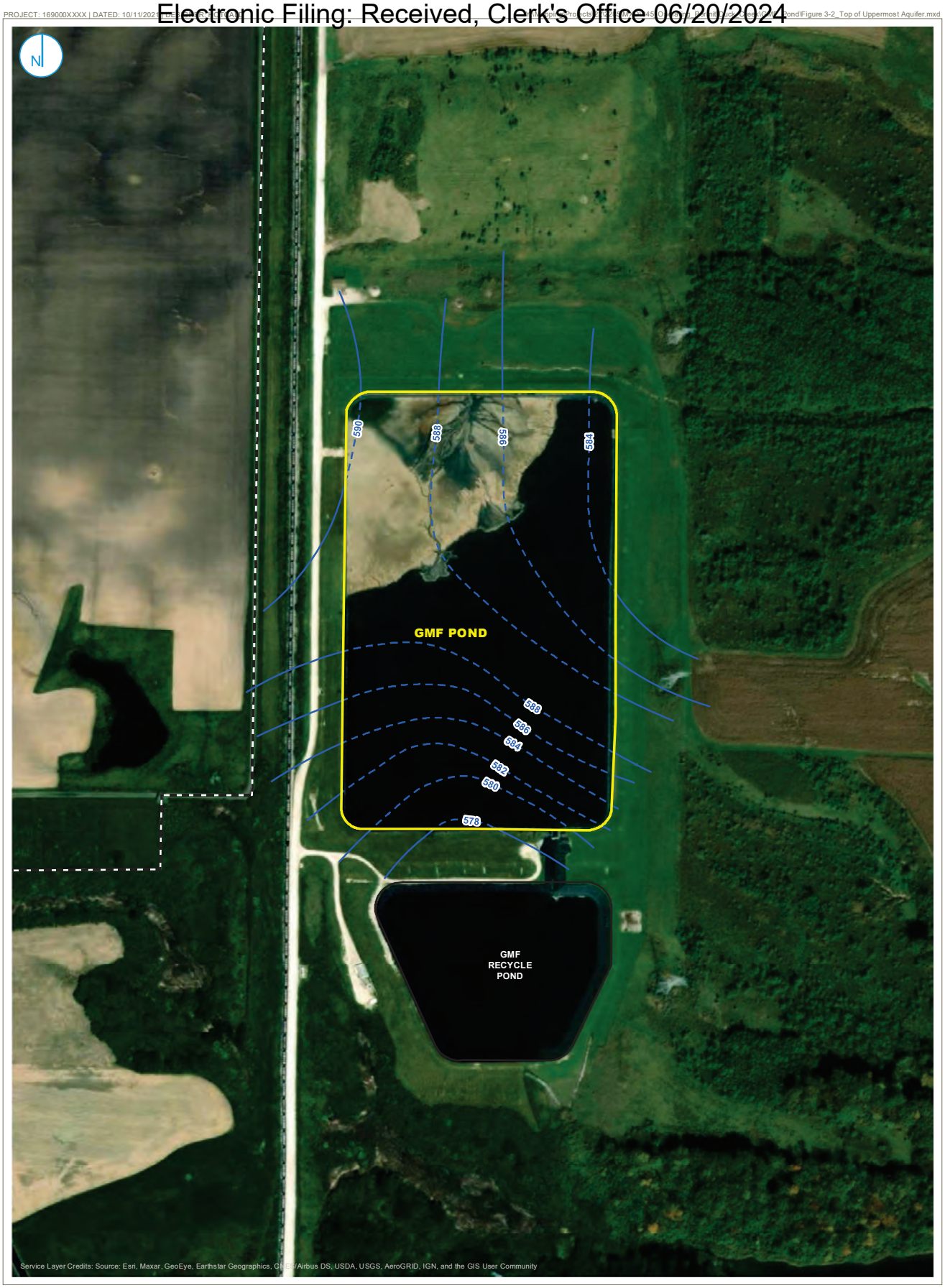
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/11/2021 | DESIGNED BY: [illegible] | Figure 3-2_Top of Uppermost Aquifer.mxd



UPPERMOST AQUIFER ELEVATION, TOP OF SAND (2-FOOT CONTOUR)

INFERRED UPPERMOST AQUIFER ELEVATION, TOP OF SAND (2-FOOT CONTOUR)

PART 845 REGULATED UNIT (SUBJECT UNIT)

SITE FEATURE

PROPERTY BOUNDARY

0 150 300 Feet

TOP OF UPPERMOST AQUIFER

FIGURE 3-2

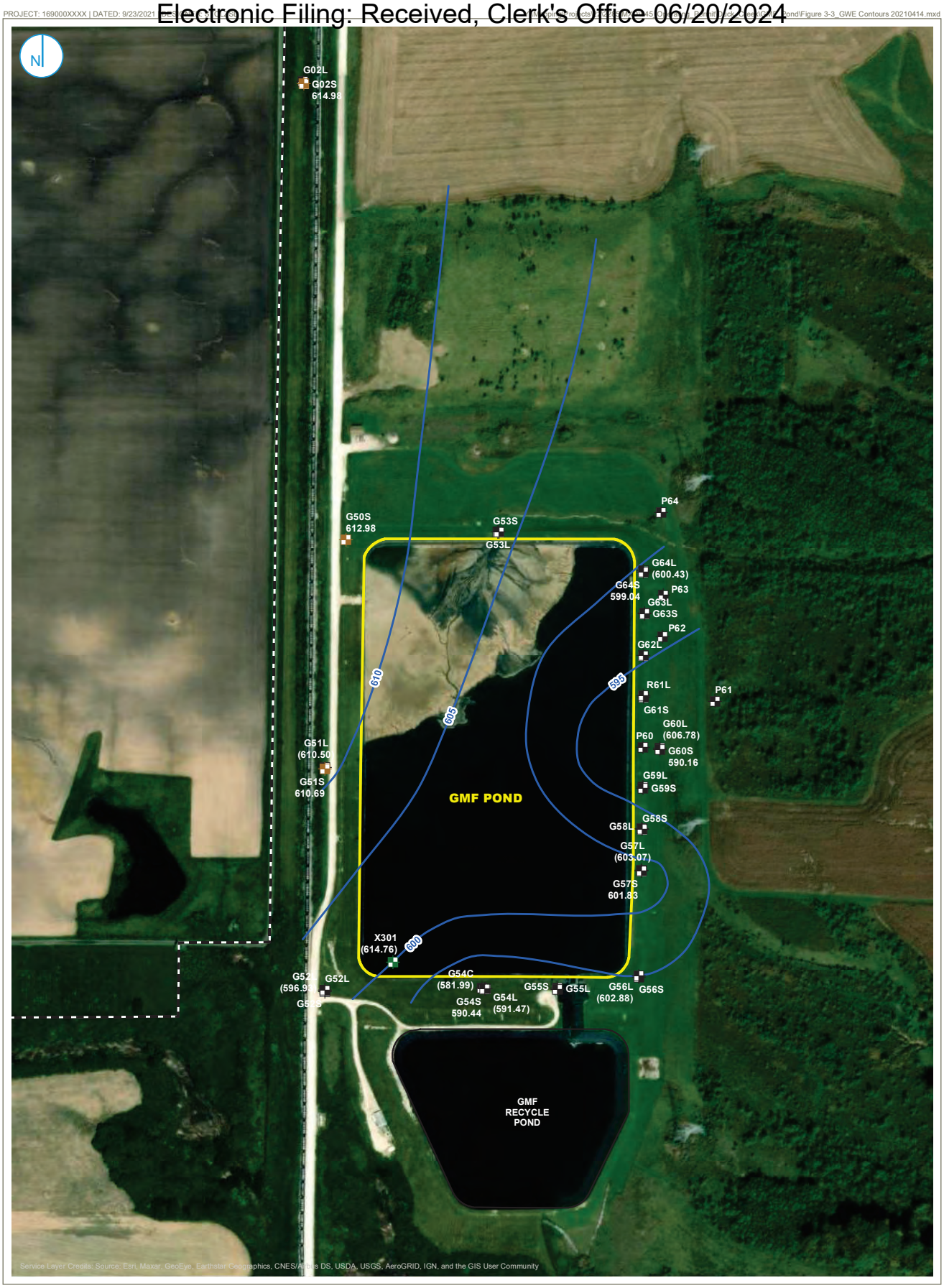
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 9/23/2021 | DESIGN: ... | Multiple Projects 2022 GMF 845 Operating Permit Duck Creek GMF Pond\Figure 3-3_GWE Contours 20210414.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS APRIL 14, 2021

FIGURE 3-3

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/12/2021 | DESIGNED: [illegible] | Figure 3-4_GWE Contours 20210510.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS
MAY 10, 2021

FIGURE 3-4

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

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APPENDICES

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APPENDIX A
INFORMATION PERTINENT TO 35 I.A.C. § 845.220(a)(3)

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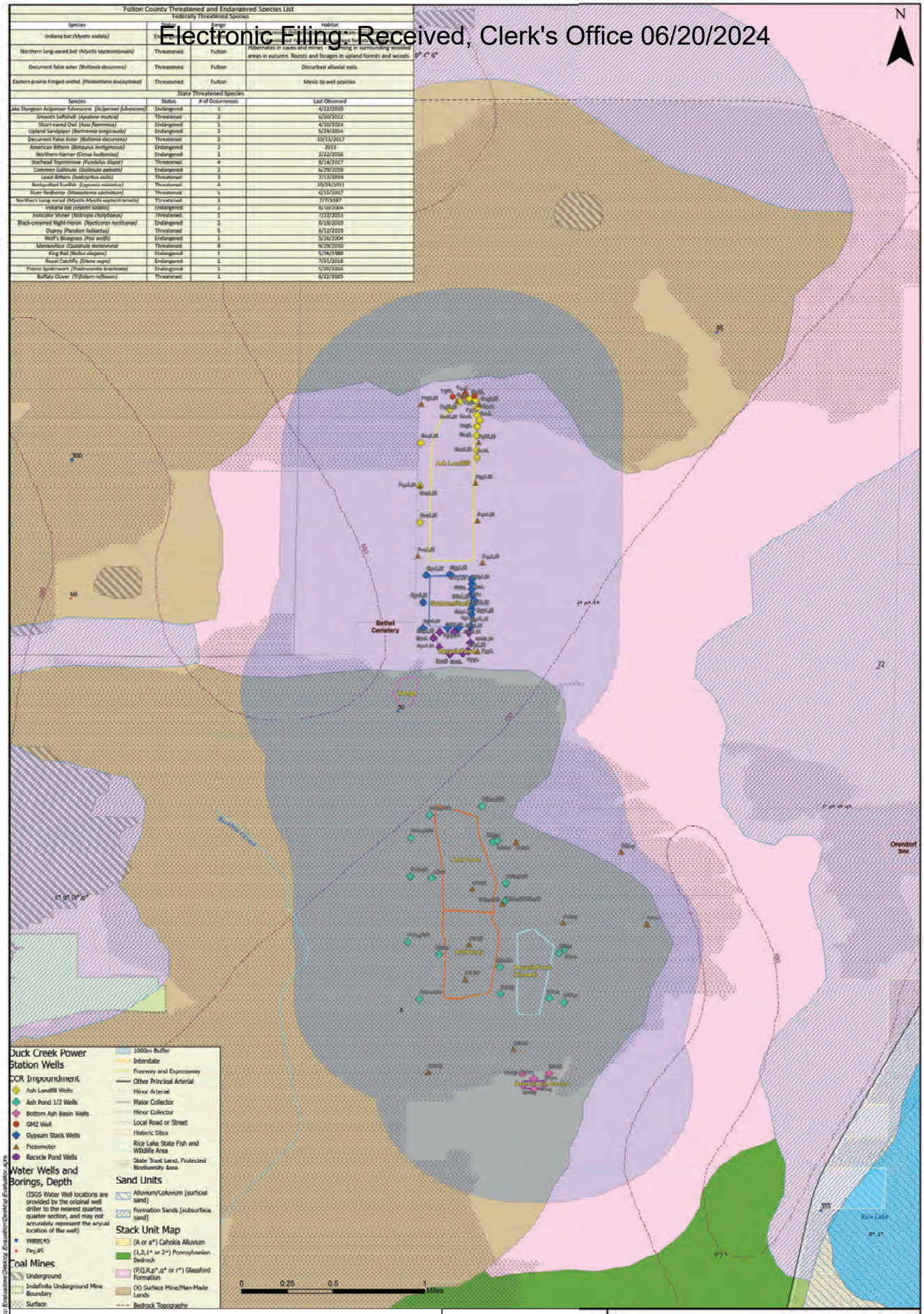
Fulton County Threatened and Endangered Species List			
Federally Threatened Species			
Species	Status	Range	Habitat
Indiana bat (*Myotis sodalis*)	Endangered	Fulton	Hibernates in caves and mines - roosting in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods.
Northern long-eared bat (*Myotis septentrionalis*)	Threatened	Fulton	Hibernates in caves and mines - roosting in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods.
Decurrent false aster (*Boltonia decurrens*)	Threatened	Fulton	Disturbed alluvial soils
Eastern prairie fringed orchid (*Platanthera leucophaea*)	Threatened	Fulton	Mesic to wet prairies
State Threatened Species			
Species	Status	# of Occurrences	Last Observed
Lake Sturgeon Acipenser fulvescens (*Acipenser fulvescens*)	Endangered	1	4/22/2010
Smooth Softshell (*Apalone mutica*)	Threatened	2	6/20/2012
Short-eared Owl (*Asio flammeus*)	Endangered	1	4/10/2014
Upland Sandpiper (*Bartramia longicauda*)	Endangered	2	5/29/2014
Decurrent False Aster (*Boltonia decurrens*)	Threatened	2	10/11/2017
American Bittern (*Botaurus lentiginosus*)	Endangered	2	2011
Northern Harrier (*Circus hudsonius*)	Endangered	1	2/22/2016
Starhead Topminnow (*Fundulus dispar*)	Threatened	4	8/14/2017
Common Gallinule (*Gallinula galeata*)	Endangered	2	6/29/2019
Least Bittern (*Ixobrychus exilis*)	Threatened	2	7/12/2019
Redspotted Sunfish (*Lepomis miniatus*)	Threatened	4	10/24/2011
River Redhorse (*Moxostoma carinatum*)	Threatened	1	6/15/2017
Northern Long-eared (*Myotis Myotis septentrionalis*)	Threatened	1	7/7/1987
Indiana bat (*Myotis sodalis*)	Endangered	1	8/10/2004
Isocolor Shiner (*Notropis chalybaeus*)	Threatened	1	7/22/2013
Black-crowned Night-Heron (*Nycticorax nycticorax*)	Endangered	2	6/18/2019
Osprey (*Pandion haliaetus*)	Threatened	5	6/12/2019
Wolf's Bluegrass (*Poa wolfii*)	Endangered	1	5/26/2004
Monkeyface (*Quadrula metanevra*)	Threatened	8	9/29/2010
King Rail (*Rallus elegans*)	Endangered	1	5/26/1988
Royal Catchfly (*Silene regia*)	Endangered	1	7/31/2018
Prairie Spiderwort (*Tradescantia bracteata*)	Endangered	1	5/20/2016
Buffalo Clover (*Trifolium reflexum*)	Threatened	1	6/22/2005



HANSON
Hanson Professional Services Inc.

Duck Creek Power Station

Work Plan Desktop Evaluation
Fulton County
Canton, Illinois

Job Number: 20E0111A

Sheet 1

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX B
BORING LOGS AND WELL CONSTRUCTION LOGS

Electronic Filing: Received, Clerk's Office 06/20/2024

BORING AND WELL LOCATIONS MAP

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/14/2021 | DESIGNER: [illegible] | Y:\Maps\[illegible]\Soil Boring and Well Location Mapmxd.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SOIL BORING AND WELL LOCATION MAP

FIGURE B-1

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

BORING LOGS

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	18/24 75%	SS	2-2 4-5 N=6			1.5	0	Fill - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% yellowish brown (10YR4/6) mottles, moist SILT with little clay, trace roots, and trace sand.		618	
	21/24 88%	SS	2-5 6-7 N=11			2.0	2	Fill - Yellowish brown (10YR5/6) with 30% light brownish gray (10YR6/2) mottles, moist, soft SILT with little clay, trace sand, and trace gravel.		616	
	22/24 92%	SS	2-7 10-12 N=17			2.5	4	Fill - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, firm SILT with little clay and trace sand.		614	
	19/24 79%	SS	3-7 9-11 N=16			4.5	6	Fill - Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		612	
	20/24 83%	SS	3-7 9-10 N=16			4.5	8	Grayish brown (10YR5/2) firm SILT with little clay, trace sand, and trace gravel.		610	
	21/24 88%	SS	3-4 7-10 N=11			4.5	10	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/6) mottles, firm SILT with little clay, trace sand, and trace gravel.		608	
	21/24 88%	SS	3-7 12-15 N=19			4.5	12	Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		606	
ST8	20/24 83%	SH				4.0	14			604	
	18/24 75%	SS	1-4 4-5 N=8			0.5	16	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, soft SILT with little clay.		602	
	19/24 79%	SS	1-3 4-4 N=7			1.0	18			600	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	18/24 75%	SS	1-2 4-5 N=6			1.0	22	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft SILT with little clay.		598	
	20/24 83%	SS	1-3 4-7 N=7			1.0	24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft SILT with little clay.		596	
	19/24 79%	SS	1-3 3-4 N=6			1.5		Grayish brown (10YR5/2) moist, soft, CLAY with little silt.			
	22/24 92%	SS	woh-1 3-3 N=4			1.5	26	Gray (10YR5/1) moist, soft, CLAY with little silt.		594	
	21/24 88%	SS	1-2 3-4 N=5			1.0	28			592	
	22/24 92%	SS	1-3 5-5 N=8			2.0	30	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) soft CLAY with little silt.		590	
ST17	24/24 100%	SH				0.5	32			588	
	21/24 88%	SS	2-3 4-3 N=7			1.0	34			586	
	21/24 88%	SS	1-4 5-8 N=9			1.5	36	Gray (10YR6/1) wet, soft CLAY with little silt and trace sand.		584	
	20/24 83%	SS	woh-1 3-4 N=4			1.0	38	Dark gray (10YR4/1) wet, fine SAND with trace silt.		582	
								Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand.		580	
							40				

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	4/24 17%	SS	1-2 5-10 N=7					Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand. *[Continued from previous page]*			
							42			578	
	23/24 96%	SS	2-6 12-11 N=18			3.0					
							44	Dark grayish brown (10YR4/2) moist, firm SILT with little clay, trace sand, and trace gravel.		576	
ST23	23/24 96%	SH				4.5					
							46			574	
	24/24 100%	SS	3-6 8-14 N=14			4.5					
							48			572	
	24/24 100%	SS	3-8 13-20 N=21			4.5					
							50	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.		570	
	24/24 100%	SS	3-10 14-19 N=24			4.5					
							52			568	
	24/24 100%	SS	6-9 15-16 N=24			4.5					
							54			566	
	24/24 100%	SS	4-10 28-50/3" N=38			4.5		Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.			
							56			564	
	24/24 100%	SS	10-47 50/3.25-50/1.25			2.5		Dark gray (10YR4/1) wet, soft SAND with little clay and trace silt.			
							58			562	
	24/24 100%	SS	19-29 44-72 N=73			4.5		Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.			
							60			560	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
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Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	14-29 42-54 N=71			4.5	62	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel. *[Continued from previous page]*		558	
	23/24 96%	SS	12-14 30-48 N=44			4.5	64			556	
	23/24 96%	SS	10-22 25-34 N=47			4.5					
	24/24 100%	SS	10-19 26-34 N=45			4.5	66			554	
	24/24 100%	SS	11-19 24-33 N=43			4.5	68			552	
	23/24 96%	SS	11-22 22-34 N=44			4.5		Dark gray (10YR4/1) firm SILT with little clay, trace sand, and trace gravel.			
	24/24 100%	SS	9-13 20-22 N=33			4.5	70			550	
	24/24 100%	SS	6-8 12-15 N=20			4.5	72			548	
ST39	11/24 46%	SH				4.5	74			546	
	14/24 58%	SS	7-10 17-20 N=27			4.5	76	Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt.		544	
							78			542	
								Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel.			
							80			540	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel. *[Continued from previous page]*			
	24/24 100%	SS	6-8 11-15 N=19			4.5	82			538	
	24/24 100%	SS	3-7 9-10 N=16			4.5		Dark gray (10YR4/1) firm CLAY with trace silt and gravel.		536	
	24/24 100%	SS	4-8 12-15 N=20			4.5	84				
	24/24 100%	SS	5-7 11-14 N=18			4.0	86	Dark gray (10YR4/1) with 5% gray (10YR5/1) mottles, firm, CLAY with little silt, trace sand, and trace gravel.		534	
	24/24 100%	SS	5-8 11-14 N=19			4.5	88			532	
	24/24 100%	SS	5-9 13-15 N=22			4.5	90	Dark gray (10YR4/1) CLAY with little silt, trace sand, and trace gravel.		530	
	24/24 100%	SS	4-7 10-13 N=17			4.5	92	Grayish green (5GY5/2) with 30% dark grayish green (5GY4/2) mottles, firm, CLAY with trace silt and gravel. (WEATHERED SHALE)		528	
	24/24 100%	SS	3-6 8-11 N=14			4.0	94			526	
	24/24 100%	SS	4-8 11-13 N=19			3.0	96	Very dark grayish green (5GY3/2) firm, CLAY with trace silt. (WEATHERED SHALE)		524	
	21/24 88%	SS	5-7 10-12 N=17			3.0	98			522	
								Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE)			
							100			520	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks
	24/24 *100%*	SS	*3-7* *9-11* N=16			*2.5*		Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE) *[Continued from previous page]*	518
							102	**End of boring = 102 feet**	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P61
Well ID: P61
Surface Elev: 611.09 ft. MSL
Completion: 20.00 ft. BGS
Station: 1,398,670.81N
2,346,779.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	ss	--- ---				0	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		610	
2A	19/24 79%	ss	1-3 3-3 N=6				2	Yellowish brown (10YR5/6) with 5% gray (10YR5/1) mottles, moist, medium CLAY with some silt and trace sand.		608	
3A	21/24 88%	ss	2-4 4-5 N=8				4	Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		606	
4A	19/24 79%	ss	woh-2 4-4 N=6				6	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, soft, SILT with few clay and trace sand.		604	
5A	10/24 42%	ss	1-2 2-3 N=4				▼ 8	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.		602	
6A	17/24 71%	ss	2-2 3-3 N=5				10	Yellowish brown (10YR5/8), moist, soft, SILT with few clay and trace sand.		600	
								Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, soft, SILT with few clay and trace sand.			
7A	24/24 100%	ss	woh-1 2-2 N=3				12	Brown (10YR4/3), wet, soft, SILT with few clay and trace sand.		598	
8A	24/24 100%	ss	1-2 3-3 N=5				14	Black (10YR2/1), moist, medium, CLAY with few silt and trace sand.		596	
9A	24/24 100%	ss	1-3 3-4 N=6				16	Gray (10YR5/1), moist, medium CLAY with some silt and trace sand.		594	
10A	24/24 100%	ss	1-1 3-3 N=4				18			592	
							20	End of boring = 20 ft.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P62
Well ID: P62
Surface Elev: 610.81 ft. MSL
Completion: 16.30 ft. BGS
Station: 1,398,887.32N
2,346,602.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = Dry - durring drilling
▽ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---				0	Yellowish brown (10YR5/6), moist, medium, SILT with some clay and trace sand.		610	
2A	23/24 96%	SS	1-7 9-9 N=16				2	Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.			
								Yellowish brown (10YR5/6), moist, hard, SILT with few clay, trace sand, and trace gravel.		608	
3A	24/24 100%	SS	2-5 5-6 N=10				4				
								Gray (10YR5/1), moist, medium, SILT with few clay, trace sand, and trace gravel.		606	
4A	24/24 100%	SS	4-4 7-8 N=11				6				
										604	
5A	24/24 100%	SS	2-5 5-6 N=10				8	Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.			
										602	
6A	24/24 100%	SS	3-4 6-10 N=10				10	Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		600	
7A	23/24 96%	SS	2-3 5-6 N=8				12	Dark yellowish brown (10YR4/6), moist, medium, SILT with few clay and trace sand.		598	
8A	24/24 100%	SS	1-2 3-4 N=5				14	Gray (10YR5/1) with 5% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand, and trace gravel		596	
	0/4 0%	BD					16				

End of boring = 16.3 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P63
Well ID: P63
Surface Elev: 612.33 ft. MSL
Completion: 18.25 ft. BGS
Station: 1,399,026.62N
2,346,605.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---				0	Grayish brown (10R5/2), moist, medium, CLAY with some silt, trace sand, and trace gravel.		612	
2A	24/24 100%	SS	3-7 7-10 N=14				2			610	
							4	Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.		608	
3A	24/24 100%	SS	2-4 4-4 N=8				6	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.		606	
4A	22/24 92%	SS	1-1 4-5 N=5				8	Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, moist, soft, SILT with few clay and trace sand.		604	
5A	21/24 88%	SS	2-2 3-4 N=5				10	Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, wet, soft, SILT with few clay and trace sand.		602	
6A	23/24 96%	SS	2-3 3-5 N=6				12			600	
7A	20/24 83%	SS	2-2 3-4 N=5				14	Dark yellowish brown (10YR3/4), moist, medium SILT with few clay and trace sand.		598	
8A	24/24 100%	SS	2-2 3-3 N=5				16	Gray (10YR5/1) with 35% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.		596	
9A	24/24 100%	SS	1-2 3-3 N=5				18	Yellowish brown(10YR5/6), moist, soft, CLAY with some silt, trace sand, and trace gravel.			
	0/4 0%	BD						**End of boring = 18.25 ft.**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/25/2021
Finish: 2/25/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P64
Well ID: P64
Surface Elev: 614.04 ft. MSL
Completion: 16.47 ft. BGS
Station: 1,399,305.91N
2,346,597.96E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 6.70 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---				0	Yellowish brown (10YR5/6), medium CLAY with some silt and trace sand.			
2A	23/24 96%	SS	2-4 4-5 N=8				2			612	
								Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace sand.			
3A	23/24 96%	SS	2-2 2-3 N=4				4			610	
								Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, soft, SILT with few clay, trace sand, and trace wood fragments.			
4A	20/24 83%	SS	1-2 4-4 N=6				6 ▼			608	
5A	15/24 63%	SS	1-2 2-3 N=4				8	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.		606	
6A	19/24 79%	SS	1-2 2-3 N=4				10			604	
7A	24/24 100%	SS	1-1 2-3 N=3				12			602	
								Yellowish brown (10YR5/6), moist, soft, SILT with some clay and trace sand.			
8A	24/24 100%	SS	1-2 2-3 N=4				14			600	
								Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, soft, CLAY with some silt and trace sand.			
	0/6 0%	BD					16			598	

End of boring = 16.5 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB50
Well ID: n/a
Surface Elev: 620.9 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,399,205.58N
2,345,536.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	20/24 83%	SS	1-4 5-6 N=9			2.5	0	Very dark brown (10YR2/2) with 15% brownish yellow (10YR6/8) mottles, soft, SILT with trace roots, and gravel.		620	
	15/24 63%	SS	1-5 5-6 N=10			3.5	2	Very dark brown (10YR2/2) with 50% yellowish brown (10YR5/8) mottles, soft, CLAY with little silt and trace roots.		618	
	22/24 92%	SS	2-2 3-4 N=5			2.5	4	Yellowish brown (10YR6/8) with 30% light brownish gray (10YR6/2) mottles, firm SILT with little clay.		616	
	17/24 71%	SS	0-2 3-4 N=5			1.0	6	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR6/8) mottles, firm, wet CLAY with little silt and trace black oxidation.		614	
	14/24 58%	SS	1-3 2-4 N=5			1.0	8	Grayish brown (10YR5/2) with 30% yellowish brown (10YR6/8) mottles, firm SILT with little clay and trace black oxidation.		612	
ST6	23/24 96%	SH				1.0	10			610	
	20/24 83%	SS	1-2 3-4 N=5			1.5	12	Light brownish gray (10YR6/2) with 15% brownish yellow (10YR6/1) mottles, firm, wet, SILT with little clay and trace black oxidation.		608	
	24/24 100%	SS	1-2 3-3 N=5			1.0	14	Brown (10YR5/3) firm, moist SILT with little clay and trace black oxidation.		606	
	24/24 100%	SS	1-2 2-3 N=4			1.0	16	Yellowish brown (10YR5/4) firm, moist SILT with little clay and trace black oxidation.		604	
	24/24 100%	SS	1-2 3-4 N=5			2.0	18	Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/8) mottles, firm, moist CLAY.		602	
							20				

NOTE(S): Borehole sealed with high solids bentonite grout.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB50
Well ID: n/a
Surface Elev: 620.9 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,399,205.58N
2,345,536.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	2-2 3-4 N=5			1.8				600	
							22	Dark gray (10YR4/1), wet, CLAY with trace gravel.			
ST12	23/24 96%	SH				1.5				598	
							24				
	24/24 100%	SS	1-1 1-4 N=2			0.5		Gray (10YR6/1) with 30% brownish yellow (10YR6/6) mottles, firm, wet CLAY		596	
								Brownish yellow (10YR6/6) firm, wet CLAY with little silt.			
							26				
	24/24 100%	SS	woh-3 3-5 N=6			1.0		Brownish yellow (10YR6/6) firm, wet CLAY with trace gravel.		594	
							28				
	23/24 96%	SS	1-5 6-6 N=11			3.5		Brownish yellow (10YR6/8) with 15% gray (10YR6/1) mottles, firm CLAY with trace gravel.		592	
							30				
	23/24 96%	SS	1-3 7-8 N=10			4.5		Grayish brown (10YR5/2) firm CLAY.		590	
								Dark gray (10YR4/1) wet, firm CLAY with trace gravel.			
							32				
	18/24 75%	SS	1-2 2-4 N=4			1.5		Dark gray (10YR4/1) wet, firm CLAY with little silt and trace gravel.		588	
							34				
	22/24 92%	SS	3-5 10-16 N=15			4.0		Gray (10YR5/1) firm CLAY with trace gravel.		586	
							36				
	21/24 88%	SS	4-8 12-17 N=20			4.5		Gray (10YR5/1) firm CLAY with trace sand and trace gravel.		584	
							38				
	20/24 83%	SS	4-17 29-50 N=46			4.5		Dark grayish brown (10YR4/2) hard SILT with little clay, trace sand, and trace gravel.		582	
							40				

NOTE(S): Borehole sealed with high solids bentonite grout.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB50
Well ID: n/a
Surface Elev: 620.9 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,399,205.58N
2,345,536.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	7-35 40-42 N=75			4.5		Grayish brown (10YR5/2) with 5% brownish yellow (10YR6/6) mottles, hard SILT with little clay, trace sand, and trace gravel.		580	
							42				
	24/24 100%	ss	9-24 32-40 N=56			4.5		Gray (10YR5/1) hard SILT with little clay, trace sand, and trace gravel.		578	
							44				
	24/24 100%	ss	12-35 41-43 N=76			4.5		Dark gray (10YR4/1) hard SILT with little clay, trace sand, and trace gravel.		576	
							46				
	24/23 104%	ss	7-22 50-50 N=72			4.5		Grayish brown (10YR5/2) hard SILT with little clay, trace sand, and trace gravel.		574	
							48				
	24/24 100%	ss	6-21 26-36 N=47			4.5				572	
							50	End of boring = 50 feet			

NOTE(S): Borehole sealed with high solids bentonite grout.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/3/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB62
Well ID: n/a
Surface Elev: 619.8 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,398,819.94N
2,346,534.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	16/24 67%	SS	2-3 5-4 N=8			2.0	0	Fill - Yellowish brown (10YR5/6) with 5% Gray (10YR6/1) and 15% dark yellowish brown (10YR4/6) mottles, soft SILT with little clay, and trace roots.		620	
	19/24 79%	SS	1-6 9-10 N=15			2.5	2			618	
	23/24 96%	SS	4-9 10-9 N=19			4.5	4	Fill - Dark yellowish brown (10YR4/6) with 5% light brownish gray (10YR6/2) mottles, soft SILT with little clay, trace sand, and trace gravel.		616	
	23/24 96%	SS	3-6 7-9 N=13			3.5	6	Fill - Yellowish brown (10YR5/4) with 10% light brownish gray (10YR6/2) mottles, firm SILT with little clay, trace sand, and trace gravel.		614	
	23/24 96%	SS	2-5 7-8 N=12			2.5	8			612	
	23/24 96%	SS	2-5 7-8 N=12			3.0	10	Grayish brown (10YR5/2) firm SILT with little clay, trace sand, and trace gravel.		610	
ST7	15/24 63%	SH				2.5	12			608	
	21/24 88%	SS	1-4 8-12 N=12			3.0	14	Grayish brown (10YR5/2) with 30% dark yellowish brown(10YR4/6) mottles, hard SILT with little clay and trace gravel.		606	
	22/24 92%	SS	6-11 7-7 N=18			1.0	16			604	
	19/24 79%	SS	1-3 4-3 N=7			1.0	18	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, slightly moist, soft SILT with little clay.		602	
							20			600	

NOTE(S): Borehole sealed with high solids bentonite grout

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/3/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB62
Well ID: n/a
Surface Elev: 619.8 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,398,819.94N
2,346,534.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	1-3 4-4 N=7			1.5	22	Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, slightly moist, soft SILT with little clay.		598	
	21/24 88%	SS	1-2 2-4 N=4			1.0	24	Dark grayish brown (10YR4/2) CLAY with little silt and trace gravel.		596	
	24/24 100%	SS	1-2 2-3 N=4			1.0	26	Dark gray (10YR4/1) with 3% reddish yellow (10YR6/8) mottles, soft CLAY with little silt and trace gravel		594	
ST14	23/24 96%	SH				1.5	28			592	
	24/24 100%	SS	1-3 2-3 N=5			1.0	30	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft CLAY with little silt, trace sand, and trace gravel.		590	
	24/24 100%	SS	woh-1 1-2 N=2			1.0	32	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, wet, soft CLAY with little silt, trace sand, and trace gravel.		588	
	21/24 88%	SS	2-2 4-6 N=6			2.0	34	Grayish green (5GY5/2) with 5% olive gray (5Y4/2) soft CLAY with little silt, trace sand, and trace gravel.		586	
	24/24 100%	SS	3-5 7-9 N=12			4.5	36			584	
	24/24 100%	SS	3-6 7-10 N=13			4.5	38	Dark gray (10YR4/1) hard SILT with little clay, trace sand, and trace gravel.		582	
ST20	16/24 67%	SH				4.5	40			580	

NOTE(S): Borehole sealed with high solids bentonite grout

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/3/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: SB62
Well ID: n/a
Surface Elev: 619.8 ft. MSL
Completion: 50.0 ft. BGS
Station: 1,398,819.94N
2,346,534.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

SAMPLE			TESTING					
Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	23/24 96%	ss	3-12 21-19 N=33			4.0		Gray (10YR5/1) hard SILT with little clay, trace sand, and trace gravel.			
							42	Gray (10YR5/1) wet, fine SAND with trace silt.		578	
	23/24 96%	ss	6-11 12-18 N=23			4.5		Gray (10YR5/1) moist, hard SILT with little clay, trace sand, and trace gravel.			
							44			576	
	24/24 100%	ss	4-18 19-23 N=37			4.5		Gray (10YR5/1) with 15% grayish olive (10Y5/2) mottles, moist, hard SILT with little clay, trace sand, and trace gravel.			
							46			574	
	24/24 100%	ss	8-24 39-48 N=63			4.5		Gray (10YR5/1) with 40% grayish olive (10Y5/2) mottles, hard SILT with little clay, trace sand, and trace gravel.			
							48			572	
	20/24 83%	ss	5-25 50-50/5" N=75			4.5		Dark grayish brown (10YR4/2) hard SILT with little clay, trace sand, and trace gravel.			
							50			570	

End of boring = 50 feet

NOTE(S): Borehole sealed with high solids bentonite grout

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark brown (10YR2/2) clayey SILT, trace sand			
1A	24/24 100%	SS	2-3 3-4 N=6	24		2.52 B		Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, silty CLAY, trace sand			
1B				27				Yellowish brown (10YR5/8) with 40% dark yellowish brown (10YR4/6) mottles, very silty CLAY, trace sand		606	
	20/24 83%	SS	3-3 5-6 N=8				2	Gray (10YR6/1) with 40% yellowish brown (10YR5/8) mottles, clayey SILT, trace sand		604	
2A				22		1.75 BSh	4	Light brownish gray (10YR6/2) with 15% yellowish brown (10YR5/8) mottles, clayey SILT, trace sand			
	20/24 83%	SS	3-7 6-6 N=13							602	
3A				23		1.96 Sh	6	Dark yellowish brown (10YR4/6) with 5% very dark brown (10YR2/2) mottles, clayey SILT, trace sand			
	22/24 92%	SS	6-6 6-5 N=12							600	
4A				29		1.24 B	8				
	18/24 75%	SH						Dark grayish brown (10YR4/2) with 45% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand		598	
							10				
	20/24 83%	SS	1-2 3-3 N=5					Grayish brown (10YR5/2) with 50% yellowish brown (10YR5/8)mottles, clayey SILT, trace sand		596	
6A				23		2.27 B	12				
	24/24 100%	SS	5-5 6-7 N=11					Yellowish brown (10YR5/8) with 10% grayish brown (10YR5/2) mottles, clayey SILT, trace sand		594	
7A				25		1.75 B					
7B				25		1.35 B	14	Grayish brown (10YR5/2) with 50% yellowish brown (10YR5/8) silty CLAY, trace sand			
	24/24 100%	SS	1-3 4-5 N=7							592	
8A				23		1.31 B	▼ 16	Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/8) mottles, silty CLAY, trace sand and gravel			
9A	24/24 100%	SS	4-6 6-7 N=12	20		2.27 BSh				590	
9B				19		1.24 BSh	▼ 18	Dark greenish gray (10GY4/1) with 10% grayish green (5G4/1) mottles, silty CLAY, trace sand and gravel			
10A	24/24 100%	SS	1-3 4-5 N=7	16		1.75 BSh				588	
10B				13			20	Greenish gray (10Y5/1), clayey SILT, little sand and gravel			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11-1								Greenish gray (10Y5/1), clayey SILT, little sand and gravel			
11-2	19/24 *79%*	SH		17				*[Continued from previous page]*			
11-3								Dark greenish gray (10Y4/1), clayey SILT, little sand and gravel		586	
							22				
	24/24 *100%*	SS	*4-5* *8-9* N=13					Dark gray (N4/1), silty CLAY, trace sand and gravel		584	
12A				13		5.77 *B*	24				
	24/24 *100%*	SS	*4-10* *8-8* N=18					Dark gray (N4/1), clayey SILT, little sand and gravel		582	
13A				12		6.30 *Sh*	26				
	24/24 *100%*	SS	*5-6* *9-9* N=15					Dark gray (N4/1), clayey SILT, trace sand and gravel		580	
14A				25		3.30 *SP*	28				
	24/24 *100%*	SS	*5-7* *13-16* N=20							578	
15A				11		11.56 *Sh*	30				
								Dark gray (N4/1), silty CLAY, trace sand, gravel and cobbles		576	
	48/60 *80%*	CS					32				
										574	
							34				
16A				13						572	
							36				
	3/60 *5%*	CS						Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel		570	
							38				
										568	
17A				11			40				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 *0%*	ss	*27-38 37-54* N=75								
18A				13		13.52 *Sh*	42			566	
	0/24 *0%*	ss	*18-28 47-56* N=75								
19A				14		16.00 *None*	44			564	
20A											
	24/24 *100%*	ss	*30-39 48-59* N=87								
							46			562	
	24/24 *100%*	ss	*25-19 33-40* N=52								
21A				17		8.24 *BSh*	48			560	
	24/24 *100%*	ss	*4-8 16-22* N=24								
22A				12		11.56 *Sh*	50	Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel *[Continued from previous page]*		558	
	24/24 *100%*	ss	*10-12 14-19* N=26								
23A				15		9.16 *Sh*	52			556	
	24/24 *100%*	ss									
24A				15		10.72 *B*	54			554	
	24/24 *100%*	ss									
25A				12		14.02 *Sh*	56			552	
	24/24 *100%*	ss									
26A				9			58			550	
	24/24 *100%*	ss									
27A				17			60			548	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
28A	24/24 100%	ss	6-6 11-14 N=17				62	Dark greenish gray (10Y3/1) with 35% dark greenish gray (5G3/1) mottles, silty CLAY, trace sand and gravel		546	
29A	24/24 100%	ss					64			544	
30A	24/24 100%	ss					66	Dark green gray (10GY4/1) with 15% dark yellowish brown (10YR3/4) mottles, silty CLAY, trace sand and gravel		542	
31A	24/24 100%	ss					68			540	
32A	24/24 100%	ss					70	Dark green gray (10GY4/1) with 50% dark yellowish brown (10YR3/4) mottles, silty CLAY, trace sand and gravel		538	
33A	24/24 100%	ss					72			536	
34A	24/24 100%	ss					74	Dark yellowish brown (10YR3/4) with 20% dark greenish gray (10GY4/1) mottles, silty CLAY, trace sand and gravel		534	
35A	24/24 100%	ss					76			532	
36A	24/24 100%	ss					78	Very dark gray (N3/1), silty CLAY, trace sand and gravel		530	
37A	24/24 100%	ss					80	Dark yellowish brown (10YR3/4) with 30% dark greenish gray (10GY4/1) mottles, silty CLAY, trace sand and gravel		528	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/14/2007
Finish: 3/20/2007
WEATHER: Overcast, rainy, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-52
Well ID: hole abandoned
Surface Elev: 607.19 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,919.6N
1,033.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 18.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
38A	24/24 *100%*	SS					82	Dark yellowish brown (10YR3/4) with 30% dark greenish gray (10GY4/1) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*		526	
39A	24/24 *100%*	SS					84	Dark greenish gray (10Y4/1) with 15% dark yellowish brown (10YR3/4) mottles, silty CLAY, trace sand and gravel		524	
40A	24/24 *100%*	SS					86	Dark greenish gray (10Y4/1), silty CLAY, trace sand and gravel		522	
41A	24/24 *100%*	SS					88	Very dark gray (N3/1), silty CLAY, trace sand and gravel		520	
42A	24/24 *100%*	SS					90	**End of Boring = 90.0 ft. BGS**		518	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Very dark brown (10YR2/2), clayey SILT, trace sand			
	22/24 92%	SS	2-2 4-4 N=6					Dark grayish brown (10YR4/2), silty CLAY, trace sand		612	
1A				20		3.49 BSh					
1B				25		3.71 Sh	2	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/8) mottles, silty CLAY, trace sand			
2A	24/24 100%	SS	2-4 5-5 N=9	25		3.27 BSh				610	
2B				27		1.85 B	4	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/8) and trace very dark gray (10YR3/1) mottles, silty CLAY, trace sand			
	20/24 83%	SS	3-7 6-6 N=13					Brownish yellow (10YR6/8) with 20% light gray (10YR7/1) mottles, very silty CLAY, trace sand		608	
3A				24		2.47 B	6				
	24/24 100%	SS	2-4 4-3 N=8							606	
4A				25		2.06 B	8	Yellowish brown (10YR5/8) with trace light gray (10YR7/1) mottles, clayey SILT, trace sand			
	24/24 100%	SH								604	
							▼ 10				
	19/24 79%	SS	2-2 3-4 N=5							602	
6A				25							
6B				25			12	Light gray (10YR7/1) with 50% yellowish brown (10YR5/8)mottles, clayey SILT, trace sand			
	19/24 79%	SS	4-4 4-4 N=8							600	
7A				26		2.18 BSh		Dark grayish brown (10YR4/2), clayey SILT, trace sand			
7B				25		2.52 BSh	14	Dark yellowish brown (10YR4/6) with 50% brown (10YR4/3) mottles, clayey SILT, trace sand			
8A	24/24 100%	SS	1-2 3-3 N=5	25		2.27 B				598	
8B				26		2.13 B	16	Grayish brown (10YR5/2) with 5% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand			
	24/24 100%	SS	3-4 5-6 N=9							596	
9A				25		2.13 B	18				
	22/24 92%	SS	1-3 3-5 N=6					Dark grayish brown (10YR4/2) with 50% dark yellowish brown (10YR4/6) mottles, silty CLAY, trace sand and gravel		594	
10A				25			20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SH						Dark grayish brown (10YR4/2) with 50% dark yellowish brown (10YR4/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*			
							22	Dark greenish gray (5GY4/1), silty CLAY, trace sand and gravel		592	
12A	24/24 100%	SS	3-4 5-6 N=9	21		0.39 B					
12B				16		1.75 BSh	24	Greenish gray (10Y5/1), sandy SILT, trace clay		590	
	22/24 92%	SS	3-3 3-4 N=6					Greenish gray (5GY6/1), sandy CLAY, trace silt			
13A				17		2.13 B		Dark greenish gray (10Y4/1), sandy CLAY, trace gravel		588	
13B				13		7.20 BSh	26				
	24/24 100%	SS	1-2 3-4 N=5							586	
14A				17		3.50 B	28	Very dark greenish gray (10Y3/1), sandy CLAY, trace gravel			
	24/24 100%	SS	4-6 6-8 N=12							584	
15A				14		5.24 B	30				
	24/24 100%	SS	2-3 3-3 N=6							582	
16A				30		1.16 B	32	Dark gray (10YR4/1), sandy SILT, trace gravel			
17-1	8/24 33%	SH								580	
17-2				440							
	24/24 100%	SS	3-4 7-9 N=11				34	Dark green gray (10Y4/1), sandy SILT, trace clay			
18A				13		5.04 B				578	
	20/24 83%	SS	2-3 7-9 N=10				36				
19A				14		5.24 B				576	
	15/24 63%	SS	3-3 5-6 N=8				38	Dark green gray (10Y4/1), sandy CLAY, trace gravel			
20A				13		7.86				574	
							40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh		Dark green gray (10Y4/1), sandy CLAY, trace gravel			
										572	
	47/60 *78%*	CS					42	Dark green gray (10Y4/1), sandy CLAY, trace gravel *[Continued from previous page]*			
										570	
21A				18			44				
21B				14				Dark green gray (10Y4/1), silty, fine to medium SAND			
21C				12						568	
							46				
								Dark greenish gray (10Y4/1), sandy CLAY, trace gravel			
22A	53/60 *88%*	CS		12		4.83 *B*				566	
							48				
										564	
22B				9		4.48 *B*	50				
								Gray (10Y4/1), fine to medium SAND, trace silt			
23A				16						562	
	44/48 *92%*	CS					52	Dark green gray (10Y4/1), sandy CLAY, trace silt and gravel			
23B				11		6.40 *Sh*				560	
23C							54				
	24/24 *100%*	SS								558	
24A				11		13.52 *Sh*	56				
	24/24 *100%*	SS						Dark gray (10YR4/1), silty CLAY, little sand, trace gravel		556	
25A				10		11.78 *None*	58				
	24/24 *100%*	SS								554	
26A				11		8.73	60				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
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Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
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Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
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SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						BSh					
	16/24 *67%*	ss						Dark gray (10YR4/1), silty, fine to medium SAND		552	
27A				20			62				
	19/24 *79%*	ss								550	
28A				14		9.16 *BSh*	64				
	22/24 *92%*	ss								548	
29A				17		8.07 *BSh*	66				
	24/24 *100%*	ss								546	
30A				15		11.33 *B*	68				
	24/24 *100%*	ss								544	
31A				15		6.59 *B*	70				
	24/24 *100%*	ss						Dark gray (10YR4/1) with 15% dark greenish gray (5GY4/1) mottles, silty CLAY, trace sand and gravel		542	
32A				17		4.85 *B*	72				
	24/24 *100%*	ss								540	
33A				19		5.43 *B*	74				
	24/24 *100%*	ss								538	
34A				15		5.43 *B*	76				
	24/24 *100%*	ss								536	
35A				15		7.76 *B*	78				
	24/24 *100%*	ss								534	
36A				15		6.59	80				

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/20/2007
Finish: 3/22/2007
WEATHER: sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-53
Well ID: hole abandoned
Surface Elev: 613.36 ft. MSL
Completion: 90.00 ft. BGS
Station: 14,987.8N
30.2E

TOPOGRAPHIC MAP INFORMATION:
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Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = 21.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						B					
	24/24 *100%*	SS									
37A				16		8.53 *BSh*	82	Dark gray (10YR4/1), silty CLAY, trace sand and gravel		532	
	24/24 *100%*	SS								530	
38A				19		6.59 *BSh*	84				
	24/24 *100%*	SS								528	
39A				17		5.04 *BSh*	86	Dark gray (10YR4/1) with trace yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel			
	24/24 *100%*	SS								526	
40A				17		4.12 *BSh*	88				
	24/24 *100%*	SS								524	
41A				15		8.92 *B*	90	**End of Boring = 83.3 ft. BGS**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark grayish brown (10YR3/2) with 15% very dark gray (10YR3/1)mottles, silty CLAY, trace sand			
1A	24/24 100%	ss	1-3 2-3 N=5	24							
1B				30		2.33 B	2	Brown (10YR4/3) with 40% very dark grayish brown (10YR3/2) mottles, silty CLAY, trace sand		616	
2A				32		2.13 B					
	24/24 100%	ss	2-3 2-6 N=5					Yellowish brown (10YR5/8) with 30% gray (10YR6/1) and 15% dark gray brown (10YR4/2) mottles, silty CLAY, trace sand		614	
2B				28		1.94 B	4				
	24/24 100%	ss	2-2 2-3 N=4							612	
3A				30		0.58 B	6				
	18/24 75%	ss	3-4 4-5 N=8				▼	Brownish yellow (10YR6/8) with 40% light brownish gray (10YR6/2) mottles, clayey SILT, trace sand		610	
4A				24		1.55 B	8				
	20/24 83%	ss	1-2 3-3 N=5							608	
5A				25			10	Dark yellowsih brown (10YR4/6) with 30% gray (10YR6/1) mottles, clayey SILT, trace sand			
	20/24 83%	ss	0-2 3-3 N=5							606	
6A				31		1.75 B	12				
	21/24 88%	ss	3-4 4-4 N=8				▼	Gray (10YR6/1) with 10% yellowish brown (10YR5/8) mottles, clayey SILT, trace sand		604	
7A				28		4.07 BSh		Grayish brown (10YR5/2) with 15% yellowish brown (10YR5/8) mottles, very silty CLAY, trace sand			
7B				39		1.36 B	14	Black (10YR2/1) with 40% dark yellowish brown (10YR4/4) mottles, clayey SILT, trace sand			
8A				25		1.16 B					
	24/24 100%	ss	1-2 3-5 N=5					Dark grayish brown (10YR4/2) with trace yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand		602	
8B				25		1.75 B	16				
	24/24 100%	ss	2-4 3-3 N=7					Dark grayish brown (10YR4/2), silty CLAY, trace sand		600	
9A				28		1.16 B	18				
								Dark gray (10YR4/1) with 35% dark yellowish brown (10YR3/6) mottles, silty CLAY, trace sand			
10A	24/24 100%	ss	2-3 3-4 N=6	29		2.18 B					
								Dark gray (10YR4/1), silty CLAY, trace sand		598	
10B				27		1.36	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						B					
	24/24 100%	ss	0-0 5-2 N=5					Greenish gray (5G5/1) with 50% greenish gray (10Y5/1) mottles, sandy CLAY, trace gravel		596	
11A				22		0.58 B	22				
	24/24 100%	ss	0-0 1-2 N=1					Greenish gray (5GY5/1), sandy CLAY, little silt, trace gravel		594	
12A				18			24				
13A	24/24 100%	ss	2-2 4-5 N=6	21				Green gray (10Y6/1), sandy SILT			
								Green gray (5G6/1), sandy CLAY, trace gravel		592	
13B				17		3.10 B	26				
	24/24 100%	ss	3-3 4-4 N=7					Dark gray (N4/1), very silty CLAY, trace sand and gravel		590	
14A				15		1.55 B	28				
15A	20/24 83%	ss	2-3 3-5 N=6	18		2.83 B		Greenish gray (10Y5/1), sandy CLAY, trace gravel		588	
15B				17		3.49 BSh	30				
	24/24 100%	ss						Dark greenish gray (10Y4/1), very silty CLAY, trace sand and gravel		586	
16A				17		5.36 BSh	32				
	24/24 100%	ss								584	
17A				17		4.65 B	34				
	22/24 92%	ss						Dark greenish gray (10Y4/1), sandy SILT		582	
18A				21		3.49 B	36				
	21/24 88%	ss						Dark greenish gray (10Y4/1) with 20% pale red (10R6/3) mottles, sandy SILT, trace gravel		580	
19A				12			38				
	6/24 25%	ss						Gray (10Y4/1), fine to coarse SAND, trace gravel and silt		578	
20A				14			40				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/29/2007
Finish: 3/29/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-54
Well ID: hole abandoned
Surface Elev: 617.28 ft. MSL
Completion: 84.67 ft. BGS
Station: 15,718.2N
404.6E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	3/24 *13%*	ss					42	Gray (10Y4/1), fine to coarse SAND, trace gravel and silt *[Continued from previous page]*		576	
21A				11							
	24/24 *100%*	ss					44			574	
22A				16		6.21 *BSh*					
	24/24 *100%*	ss					46			572	
23A				14		8.34 *B*					
	24/24 *100%*	ss					48			570	
24A				19		7.56 *BSh*					
	24/24 *100%*	ss					50	Dark gray (N4/1), silty CLAY, trace sand and gravel		568	
25A				14							
	24/24 *100%*	ss					52			566	
26A				17		5.36 *BSh*					
	22/24 *92%*	ss					54			564	
27A				14		3.93 *Sh*					
	23/24 *96%*	ss					56			562	
28A				16		4.27 *BSh*					
	16/24 *67%*	ss					58			560	
29A				19							
	4/24 *17%*	ss					60	Gray (10Y4/1), silty fine to medium SAND		558	
30A				17							

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
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DATES: Start: 3/29/2007
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SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
31A	8/8 100%	ss	31-50/2"	12			62	Green gray (10Y5/1) with trace yellowish brown (10YR5/6) mottles, sandy SILT, trace clay and gravel		556	
32A	12/12 100%	ss	33-50/6"	9		7.37 B	64	Green gray (10Y5/1), sandy SILT, trace gravel and clay		554	
33A	7/7 100%	ss	39-50/1"	12			66			552	
34A	20/24 83%	ss		18			68			550	
35A	18/24 75%	ss		19			70	Greenish gray (10Y5/1), silty, fine SAND		548	
36A	15/24 63%	ss		21			72			546	
37A	15/24 63%	ss		21			74			544	
38A	16/24 67%	ss		19			76	Greenish gray (10Y5/1), silty, fine to medium SAND		542	
39A	10/24 42%	ss		14			78	Greenish gray (10GY5/1), sandy CLAY, trace gravel		540	
40A	18/24 75%	ss		11			80	Dark gray (10YR4/1), sandy CLAY, trace gravel		538	

NOTE(S):

FIELD BORING LOG

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HANSON

CLIENT: Ameren
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404.6E

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WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = 13.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	14/24 *58%*	ss								536	
41A				9			82	Dark gray (10YR4/1), sandy CLAY, trace gravel *[Continued from previous page]*			
	10/24 *42%*	ss								534	
42A						6.55 *BSh*	84				
43A	8/8 *100%*	ss				6.33 *BSh*		Gray (N6/1), SHALE			

End of Boring = 84.7 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: **Start:** 4/1/407
Finish: 4/4/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler

FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-55
Well ID: hole abandoned
Surface Elev: 611.07 ft. MSL
Completion: 20.00 ft. BGS
Station: 15,438.7N
987.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark brown, clayey TOPSOIL (OL)			
1A	15/18 *83%*	ss	*2-3* *3* N=6	29		1.75 *B*	2	Brown-gray, silty CLAY, trace sand (CL)		610	
2A	16/18 *89%*	ss	*3-4* *5* N=9	22		0.78 *BSh*	4			608	
3A	16/18 *89%*	ss	*3-4* *4* N=8	26			6	Brown-gray, clayey SILT, trace sand (ML)		606	
4A	15/18 *83%*	ss	*3-4* *5* N=9	26		1.94 *BSh*	8			604	
5A	18/18 *100%*	ss	*2-3* *4* N=7	33		1.32 *B*	10	Gray-brown, clayey SILT, trace sand (ML)		602	
6A	18/18 *100%*	ss	*3-4* *5* N=9	20		1.16 *BSh*	12			600	
							14	Black, PEAT (PT)		598	
							16			596	
							18	Gray, silty CLAY, trace sand and gravel (CL)		594	
							20	**End of Boring = 20.0 ft. BGS**		592	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: **Start:** 4/5/2007
Finish: 4/5/2007
WEATHER: Ptly sunny, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-65
Well ID: hole abandoned
Surface Elev: 601.57 ft. MSL
Completion: 20.00 ft. BGS
Station: 14,972.6N
301.1E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 5.50 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark brown, clayey TOPSOIL (OL)			
1A	16/18 *89%*	ss	*0-0* *2* N=2	30		1.16 *B*	2	Dark brown-brown, very silty CLAY, trace sand (CL)		600	
2A	12/18 *67%*	ss	*3-3* *3* N=6	37			4	Dark brown, clayey SILT, trace sand, (ML)		598	
							5.5 ▼			596	
3A	18/18 *100%*	ss	*2-3* *4* N=7	27		1.55 *B*	6	Gray-brown, silty CLAY, trace sand (CL)		594	
4A	14/18 *78%*	ss	*3-4* *4* N=8	26		2.06 *B*	8	Brown-gray, silty CLAY, trace sand (CL)		592	
							10			590	
5A	16/18 *89%*	ss	*3-3* *7* N=10	19			12	Gray-brown, silty, fine SAND, little medium to coarse sand, trace gravel (SM)		588	
							14			586	
6A	15/18 *83%*	ss	*4-6* *10* N=16	15		9.16 *Sh*	16	Gray, very silty CLAY, trace sand and gravel (CL)		584	
							18			582	
							20	**End of Boring = 20.0 ft. BGS**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 4/5/2007
Finish: 4/5/2007
WEATHER: Ptly sunny, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-66
Well ID: hole abandoned
Surface Elev: 610.34 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,397.6N
173.1E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 5.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
								Dark brown, clayey TOPSOIL (OL)	610	
1A	14/18 78%	ss	2-3 4 N=7	27		2.89 BSh	2	Brown-gray, silty CLAY, trace sand (CL)	608	
2A	18/18 100%	ss	2-2 3 N=5	29		1.16 B	4 ▼	Brown-gray-black, very silty CLAY, trace sand (CL)	606	
3A	13/18 72%	ss	2-4 5 N=9	28		2.47 Sh	6	Brown-gray, clayey SILT, trace sand (ML)	604	
4A	16/18 89%	ss	2-2 3 N=5	28		2.68 Sh	8		602	
							10	Gray-brown, clayey SILT, trace sand (ML)	600	
							12		598	
5A	15/18 83%	ss	1-2 3 N=5	27		1.75 B	14	Brown, very silty CLAY, trace sand (CL)	596	
							16 ▼		594	
							18	Brown-gray, silty CLAY, trace sand and gravel (CL)	592	
6A	15/18 83%	ss	2-3 4 N=7	21		1.55	20			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 4/5/2007
Finish: 4/5/2007
WEATHER: Ptly sunny, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-66
Well ID: hole abandoned
Surface Elev: 610.34 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,397.6N
173.1E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - during drilling
▼ = 5.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						B		Brown-gray, silty CLAY, trace sand and gravel (CL) *[Continued from previous page]*		590	
							22				
										588	
							24	Gray-brown, very silty CLAY, little sand, trace gravel (CL)			
7A	18/18 *100%*	ss	*3-5* *6* N=11	15		2.13 *B*				586	
							26				
										584	
							28	Gray, very silty CLAY, trace sand and gravel (CL)			
										582	
8A	18/18 *100%*	ss	*3-4* *5* N=9	18		4.65 *B*	30				

End of Boring = 30.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

G02L (MW-4L)

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-10/MW-4
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	619.4
Foreman	Randy Howard	Drilling Method	HSA
Engineer/Geologist	OMI	Sampling Method	SS/Core
Weather & Temp.	Upper 60's, Cloudy	Hammer Type	Auto
Date: Start	9/22/2003 0900	Water Depth: DD	25
Finish	9/23/2003 1605	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	2.0	Top soil, brn. silt w/clay, moist.	SS-1	1.5	3.5	2-3-5-6 Rec = 18" Qp = 2.0
2.0	4.0	Brn. and gray clayey silt and silty clay, so sand.	SS-2	4.0	6.0	1-2-2-2 Rec = 24" Qp = 0.25
4.0	7.8	Reddish brn and gray silty clay, soft.	SS-3	6.5	8.5	0-2-2-2 Rec = 19.5" Qp = -
7.8	9.8	Reddish brn. and gray clayey silt, v. soft.	SS-4	9.0	11.0	1-2-3-4 Rec = 22" Qp = 3.0
9.8	12.1	Gray (sl. red) silt, tr. clay, stiff, moist.	SS-5	11.5	13.5	1-1-2-4 Rec = 24" Qp = -
12.1	15.0	Dk. brn. silty sand w/ small wood pieces, moist.	SS-6	14.0	16.0	3-3-6-5 Rec = 24" Qp = 3.0
15.0	16.5	Dk. brn. sandy silty clay (till) to sandy clayey silt, moist.	SS-7	16.5	18.5	1-1-2-2 Rec = 24" Qp = -
16.5	19.8	Dk. brn. clay, w/ so. sand and silt, soft.	SS-8	19.0	21.0	1-2-2-2 Rec = 24" Qp = 0.25
19.8	24.6	Gray sandy clay, so. silt, v. soft and moist. More sand at 21.5' (gets coarser w/ depth).	SS-9	21.5	23.5	1-2-3-5 Rec = Qp = 0.75
24.6	25.0	Gray v. coarse sand w/ clay, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 23" Qp = -
25.0	26.9	Gray sandy clayey silt (till), wet.	SS-11	26.5	28.5	1-2-2-4 Rec = 24" Qp = 3.0 (in cohesive)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.9	28.2	Gray v. coarse sand w/gravel, wet.	SS-12	29.0	31.0	1-2-4-7 Rec = 24" Qp = 3.0
28.2	31.5	Gray sandy clayey silt (till), wet.	SS-13	31.5	33.5	3-6-8-10 Rec = 24" Qp = 4.5
31.5	36.2	Gray sandy silt, tr. gravel, v. stiff.	SS-14	34.0	36.0	2-4-6-8 Rec = 24" Qp = 4.5+
36.2	36.8	Red and gray clayey silty sand.	SS-15	36.5	38.5	4-7-9-13 Rec = 24" Qp = 0.5 to 4.5+
36.8	46.5	Gray sandy silt, tr. gravel, v stiff, more sand and gravel from 41.5' to 44.1'.	SS-16	39.0	41.0	3-6-10-13 Rec = 24" Qp = 3.5
46.5	52.0	Gray silt w/gravel, sl. dry w/rough surface structure, breaks down w/small pressure.	SS-17	41.5	43.5	3-4-9-11 Rec = 24" Qp = 4.0
52.0	54.8	Brn. and gray sandy clayey silt, tr. gravel, reddish brown at bottom, sl. moist.	SS-18	44.0	46.0	6-9-15-20 Rec = 24" Qp = 4.5+
54.8	56.5	Gray v. coarse sand w/gravel, v. dense, wet.	SS-19	46.5	48.5	11-21-29-40 Rec = 24" Qp = -
56.5	57.0	Gray v.f. sand, medium dense, moist.	SS-20	49.0	50.5	19-47-50/5" Rec = Qp = -
57.0	57.5	V. coarse sand w/gravel, wet.	SS-21	51.5	53.5	22-42-31-43 Rec = Qp = 2.5
57.5	61.5	Gray v.f. sand, so. gravel, v. dense, moist. No gravel from 58.6'.	SS-22	54.0	55.75	20-42-47-50/3" Rec = 24" Qp = -
61.5	64.9	Gray v.f. sandy silt, v. dense, so. gravel from 64.5' to 64.9', wet.	SS-23	56.5	57.8	13-28-50/4" Rec = 24" Qp = -
64.9	68.4	Gray silty clay and clayey silt, v. stiff, moist. So. gravel from 66.5' to 68.4'.	SS-24	59.0	60.3	15-29-50/4" Rec = 15" Qp = -
68.4	68.5	Limestone fragments.	SS-25	61.5	62.8	20-45-50/4" Rec = 15" Qp = -
68.5	77.5	Gray clayey sandy silt w/gravel, v. stiff.	SS-26	64.0	66.0	20-16-20-31 Rec = 24" Qp = 4.5

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
77.5	80.5	Dk. gray silty sand.	SS-27	66.5	68.5	11-15-21-33 Rec = 24" Qp = 4.5+
80.5	81.5	Gray sandy silt, stiff, moist.	SS-28	69.0	71.0	15-20-37-50/5" Rec = 24" Qp = 4.5+
81.5	85.0	Gray silty sand, moist. Coal at 83.4'.	SS-29	71.5	73.5	16-29-33-38 Rec = 24" Qp = 4.5+
85.0	89.0	V. coarse sand w/rock fragments.	SS-30	74.0	76.0	12-23-32-50 Rec = 24" Qp = 4.5+
89.0	91.5	Gray siltstone, hard, moist. Auger refusal. Will core using a tricone to 91.5' and try to get another sample. SPT refusal at 91.5'.	SS-31	76.5	78.5	12-18-27-31 Rec = 24" Qp = -
		Begin Coring at 91.5'.	SS-32	79.0	81.0	12-24-35-50 Rec = 24" Qp = 2.0 (in silt)
			SS-33	81.5	83.5	9-19-28-34 Rec = 24" Qp = -
			SS-34	84.0	86.0	34-32-21-42 Rec = 18" Qp = -
			SS-35	86.5	88.5	11-13-26-20 Rec = 17" Qp = -
			SS-36	89.0	89.3	50/3" Rec = 2" Qp = -
			SS-37	91.5	91.7	50/2" Rec = Qp = -

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 1 OF 2

PROJECT NAME: Ameren Duck Creek

DATE 9/23/2003

Engineer/Geologist: Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
	Start Coring at 91.5 ft.	1	100% / 89%	1		100%	Dk. Gray	490	
92.5	Gray silty shale; thin bedded; v. soft and weathered 91.5 - 91.9 (may be slough); mod. soft; micaceous; so. plant fossils.								
93.5	Gray shaley sandstone, w/so. lt. gray partings below 91.9 ft.								
94.5									
95.5									
96.5									
97.5									
98.5		98.5'							
	Same as above.	2	100% / 99%		1' 26"	100%		500	
99.5	Core barrel plugged as soon as we resumed at 98.5 ft.							600 @ 105.5 ft	
	Temporarily plugged at 103.7 ft.				1' 30"				
100.5	Lost 2.7 ft of core (likely fell out the bottom upon retrieval). Recovered remaining 2.7 ft as part of Run #3. RQD & REC includes recovery in Run #3.			100.8' / 2	1' 51"				
101.5									

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 2 OF 2

PROJECT NAME: Ameren Duck Creek

DATE 9/23/2003

Engineer/Geologist: Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
102.5	Same as above.	2		1	1' 42"				
103.5					1' 25"				
104.5					4' 10"				
105.5					47"				
106.5					47"				
107.5					45"				
108.5		108.5'			50"				
109.5		3	100% / 100%	2	1' 23"	100%	Dk Gray	500	
110.5					1' 10"				
111.5	End Run #3 @ 111.5 ft. E.O.B. @ 111.5 ft.				1' 14"				

Electronic Filing: Received, Clerk's Office 06/20/2024

G02S (F02S, MW-4S)

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-10/MW-4 G02S
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	619.4
Foreman	Randy Howard	Drilling Method	HSA
Engineer/Geologist	OMI	Sampling Method	SS/Core
Weather & Temp.	Upper 60's, Cloudy	Hammer Type	Auto
Date: Start	9/22/2003 0900	Water Depth: DD	25
Finish	9/23/2003 1605	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	2.0	Top soil, brn. silt w/clay, moist.	SS-1	1.5	3.5	2-3-5-6 Rec = 18" Qp = 2.0
2.0	4.0	Brn. and gray clayey silt and silty clay, so sand.	SS-2	4.0	6.0	1-2-2-2 Rec = 24" Qp = 0.25
4.0	7.8	Reddish brn and gray silty clay, soft.	SS-3	6.5	8.5	0-2-2-2 Rec = 19.5" Qp = -
7.8	9.8	Reddish brn. and gray clayey silt, v. soft.	SS-4	9.0	11.0	1-2-3-4 Rec = 22" Qp = 3.0
9.8	12.1	Gray (sl. red) silt, tr. clay, stiff, moist.	SS-5	11.5	13.5	1-1-2-4 Rec = 24" Qp = -
12.1	15.0	Dk. brn. silty sand w/ small wood pieces, moist.	SS-6	14.0	16.0	3-3-6-5 Rec = 24" Qp = 3.0
15.0	16.5	Dk. brn. sandy silty clay (till) to sandy clayey silt, moist.	SS-7	16.5	18.5	1-1-2-2 Rec = 24" Qp = -
16.5	19.8	Dk. brn. clay, w/ so. sand and silt, soft.	SS-8	19.0	21.0	1-2-2-2 Rec = 24" Qp = 0.25
19.8	24.6	Gray sandy clay, so. silt, v. soft and moist. More sand at 21.5' (gets coarser w/ depth).	SS-9	21.5	23.5	1-2-3-5 Rec = Qp = 0.75
24.6	25.0	Gray v. coarse sand w/ clay, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 23" Qp = -
25.0	26.9	Gray sandy clayey silt (till), wet.	SS-11	26.5	28.5	1-2-2-4 Rec = 24" Qp = 3.0 (in cohesive)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.9	28.2	Gray v. coarse sand w/gravel, wet.	SS-12	29.0	31.0	1-2-4-7 Rec = 24" Qp = 3.0
28.2	31.5	Gray sandy clayey silt (till), wet.	SS-13	31.5	33.5	3-6-8-10 Rec = 24" Qp = 4.5
31.5	36.2	Gray sandy silt, tr. gravel, v. stiff.	SS-14	34.0	36.0	2-4-6-8 Rec = 24" Qp = 4.5+
36.2	36.8	Red and gray clayey silty sand.	SS-15	36.5	38.5	4-7-9-13 Rec = 24" Qp = 0.5 to 4.5+
36.8	46.5	Gray sandy silt, tr. gravel, v stiff, more sand and gravel from 41.5' to 44.1'.	SS-16	39.0	41.0	3-6-10-13 Rec = 24" Qp = 3.5
46.5	52.0	Gray silt w/gravel, sl. dry w/rough surface structure, breaks down w/small pressure.	SS-17	41.5	43.5	3-4-9-11 Rec = 24" Qp = 4.0
52.0	54.8	Brn. and gray sandy clayey silt, tr. gravel, reddish brown at bottom, sl. moist.	SS-18	44.0	46.0	6-9-15-20 Rec = 24" Qp = 4.5+
54.8	56.5	Gray v. coarse sand w/gravel, v. dense, wet.	SS-19	46.5	48.5	11-21-29-40 Rec = 24" Qp = -
56.5	57.0	Gray v.f. sand, medium dense, moist.	SS-20	49.0	50.5	19-47-50/5" Rec = Qp = -
57.0	57.5	V. coarse sand w/gravel, wet.	SS-21	51.5	53.5	22-42-31-43 Rec = Qp = 2.5
57.5	61.5	Gray v.f. sand, so. gravel, v. dense, moist. No gravel from 58.6'.	SS-22	54.0	55.75	20-42-47-50/3" Rec = 24" Qp = -
61.5	64.9	Gray v.f. sandy silt, v. dense, so. gravel from 64.5' to 64.9', wet.	SS-23	56.5	57.8	13-28-50/4" Rec = 24" Qp = -
64.9	68.4	Gray silty clay and clayey silt, v. stiff, moist. So. gravel from 66.5' to 68.4'.	SS-24	59.0	60.3	15-29-50/4" Rec = 15" Qp = -
68.4	68.5	Limestone fragments.	SS-25	61.5	62.8	20-45-50/4" Rec = 15" Qp = -
68.5	77.5	Gray clayey sandy silt w/gravel, v. stiff.	SS-26	64.0	66.0	20-16-20-31 Rec = 24" Qp = 4.5

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-10/MW-4

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
77.5	80.5	Dk. gray silty sand.	SS-27	66.5	68.5	11-15-21-33 Rec = 24" Qp = 4.5+
80.5	81.5	Gray sandy silt, stiff, moist.	SS-28	69.0	71.0	15-20-37-50/5" Rec = 24" Qp = 4.5+
81.5	85.0	Gray silty sand, moist. Coal at 83.4'.	SS-29	71.5	73.5	16-29-33-38 Rec = 24" Qp = 4.5+
85.0	89.0	V. coarse sand w/rock fragments.	SS-30	74.0	76.0	12-23-32-50 Rec = 24" Qp = 4.5+
89.0	91.5	Gray siltstone, hard, moist. Auger refusal. Will core using a tricone to 91.5' and try to get another sample. SPT refusal at 91.5'.	SS-31	76.5	78.5	12-18-27-31 Rec = 24" Qp = -
		Begin Coring at 91.5'.	SS-32	79.0	81.0	12-24-35-50 Rec = 24" Qp = 2.0 (in silt)
			SS-33	81.5	83.5	9-19-28-34 Rec = 24" Qp = -
			SS-34	84.0	86.0	34-32-21-42 Rec = 18" Qp = -
			SS-35	86.5	88.5	11-13-26-20 Rec = 17" Qp = -
			SS-36	89.0	89.3	50/3" Rec = 2" Qp = -
			SS-37	91.5	91.7	50/2" Rec = Qp = -

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 1 OF 2

PROJECT NAME: Ameren Duck Creek

DATE 9/23/2003

Engineer/Geologist: Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
	Start Coring at 91.5 ft.	1	100% / 89%	1		100%	Dk. Gray	490	
92.5	Gray silty shale; thin bedded; v. soft and weathered 91.5 - 91.9 (may be slough); mod. soft; micaceous; so. plant fossils.								
93.5	Gray shaley sandstone, w/so. lt. gray partings below 91.9 ft.								
94.5									
95.5									
96.5									
97.5									
98.5		98.5'							
	Same as above.	2	100% / 99%		1' 26"	100%		500	
99.5	Core barrel plugged as soon as we resumed at 98.5 ft.							600 @ 105.5 ft	
	Temporarily plugged at 103.7 ft.				1' 30"				
100.5	Lost 2.7 ft of core (likely fell out the bottom upon retrieval). Recovered remaining 2.7 ft as part of Run #3. RQD & REC includes recovery in Run #3.			100.8' / 2	1' 51"				
101.5									

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-10/MW-4

PROJECT No. 03S5010

SHEET 2 OF 2

PROJECT NAME: Ameren Duck Creek

DATE 9/23/2003

Engineer/Geologist: Brett Carney

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
102.5	Same as above.	2		1	1' 42"				
103.5					1' 25"				
104.5					4' 10"				
105.5					47"				
106.5					47"				
107.5					45"				
108.5		108.5'			50"				
109.5		3	100% / 100%	2	1' 23"	100%	Dk Gray	500	
110.5					1' 10"				
111.5	End Run #3 @ 111.5 ft. E.O.B. @ 111.5 ft.				1' 14"				

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FIELD BORING LOG

B-51a (MW51L)

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: **Start:** 3/13/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4½" hollow stem auger - blind drilled within 10 ft of B-51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~B-51a~~
Well ID: ~~MW51L~~
Surface Elev: 620.84 ft. MSL
Completion: 16.71 ft. BGS
Station: 16,174.9N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 5.57 - 3/29/2007
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Very dark brown (10YR2/2), clayey SILT, trace sand		620	
							2	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand			
								Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand		618	
							4				
										616	
							6	▼			
										614	
							8	▼			
								Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand		612	
							10				
										610	
							12				
								Grayish brown (10YR5/2), clayey SILT, trace sand		608	
							14				
								Brown (10YR4/3), clayey SILT, trace sand		606	
							16				

End of Boring = 16.7 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N -5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	2-3 4-5 N=7				0	Very dark brown (10YR2/2), clayey SILT, trace sand		620	
1A				21		1.28 BSh	2	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand			
	22/24 92%	ss	6-3 5-6 N=8							618	
2A				30		1.78 BSh		Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand			
2B				29		1.67 BSh	4				
	18/24 75%	ss	1-3 3-3 N=6							616	
3A				24			6				
	24/24 100%	ss	5-4 5-6 N=9				▼			614	
4A				22		1.71 B	▼ 8	Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand			
	13/24 54%	ss	1-3 5-4 N=8							612	
5A				26		1.28 BSh	10				
	15/24 63%	ss	0-1 3-3 N=4							610	
6A				27		1.36 BSh	12				
	14/24 58%	ss	4-3 5-6 N=8							608	
7A				24			14	Grayish brown (10YR5/2), clayey SILT, trace sand			
	20/24 83%	ss	0-2 2-3 N=4							606	
8A				26			16	Brown (10YR4/3), clayey SILT, trace sand			
	24/24 100%	ss	4-5 5-5 N=10							604	
9A				25			18	Dark yellowish brown (10YR4/4) with 30% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand			
	23/24 96%	ss	0-2 3-3 N=5							602	
10A				26			20	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel			
	20/24		1-3							600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	83%	SS	*3-4* N=6					Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*			
11A				27			22			598	
	22/24 *92%*	SS	*1-3* *4-4* N=7					Dark yellowish brown (10YR4/6) with 30% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, silty CLAY, trace sand and gravel			
12A				24			24			596	
	20/24 *83%*	SS	*2-3* *5-2* N=8					Greenish gray (5GY5/1) with 50% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand and gravel			
13A				28			26			594	
	19/24 *79%*	SS	*0-2* *2-2* N=4					Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand and gravel			
14A				19			28			592	
	20/24 *83%*	SS	*1-3* *5-6* N=8					Dark gray (N4/1), very silty CLAY, trace sand and gravel			
15A				15			30			590	
	24/60 *40%*	CS						Dark gray (N4/1), sandy SILT, trace clay			
							32			588	
							34			586	
16A				13		4.29 *BSh*					
							36	Dark gray (N4/1), silty CLAY, trace sand and gravel		584	
	38/60 *63%*	CS									
							38	Brown (10YR4/3), silty, fine to medium SAND, little gravel		582	
17A				13		6.70 *None*	40				
								Brown (10YR4/3), silty, fine SAND		580	
							42				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	19/60 *32%*	CS						Brown (10YR4/3), fine to medium SAND		578	
								Brown (10YR4/3), silty, fine to coarse SAND, little gravel			
							44	Dark yellow brown (10YR4/4), SANDSTONE			
18A				13		6.70 *None*				576	
							46	Very dark gray (N3/1), sandy SILT, trace clay and gravel			
	48/60 *80%*	CS								574	
							48	Dark gray (N4/1), SHALE			
19A				14		6.70 *None*				572	
							50	Very dark gray (N3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								570	
							52				
										568	
							54				
20A				17		6.70 *None*				566	
							56	Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								564	
							58				
										562	
21A				14				Very dark greenish gray (10Y3/1), silty, fine to coarse SAND, little gravel			
22A				15			60				
22B	18/24 *75%*	SS	*8-15* *25-32* N=40	11				Very dark gray (N3/1), sandy CLAY, little gravel		560	
22C				15				Very dark gray (N3/1), silty, fine SAND, trace medium sand			
							62	Very dark gray (N3/1), sandy CLAY, trace gravel			
	24/24		*15-31*					Very dark gray (N3/1), silty, fine to medium SAND, trace gravel		558	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
23A	100%	SS	29-19 N=60	15		5.24 BSh		Very dark gray (N3/1), sandy CLAY, trace gravel *[Continued from previous page]*			
							64	Very dark gray (N3/1), silty, fine to coarse SAND, trace gravel			
24A	24/24 100%	SS	7-10 14-23 N=24	15		5.24 BSh				556	
24B				15		3.30 B	66	Very dark gray (N3/1), silty CLAY, trace sand and gravel			
	24/24 100%	SS	8-17 24-22 N=41							554	
25A				16		5.13 B	68				
	24/24 100%	SS	7-9 16-15 N=25							552	
26A				12		2.57 BSP		Very dark gray (N3/1), sandy CLAY, trace gravel			
	12/12 100%	CS					70				
27A				11				Very dark gray (N3/1), sandy CLAY		550	
	12/12 100%	CS									
28A				12			72				
										548	
	36/36 100%	CS						Very dark gray (N3/1), silty, fine to coarse SAND, little gravel			
							74				
29				12						546	
							76				
										544	
	60/60 100%	CS						Very dark gray (N3/1), silty, fine SAND, trace gravel			
							78				
										542	
30A				19			80				

End of Boring = 80.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

G50S (MW-51S)

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 3/13/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-650 Track Drill
Drilling Method: 4½" hollow stem auger - blind drilled within 10 ft of B-51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~B-51b~~
Well ID: ~~MW51S/G50S~~
Surface Elev: 620.84 ft. MSL
Completion: 34.32 ft. BGS
Station: 16,180.78N -5.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 5.86 - 3/29/2007
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–1.5	Very dark brown (10YR2/2), clayey SILT, trace sand		620	
							1.5–3.5	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand			
							3.5–4.5	Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand		618	
							4.5–13.5	Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand		616, 614, 612, 610	
							13.5–15.5	Grayish brown (10YR5/2), clayey SILT, trace sand		608	
							15.5–16.5	Brown (10YR4/3), clayey SILT, trace sand		606	
							16.5–18.5	Dark yellowish brown (10YR4/4) with 30% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand		604	
							18.5–20.5	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel		602, 600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 3/13/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-650 Track Drill
Drilling Method: 4½" hollow stem auger - blind drilled within 10 ft of B-51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51b
Well ID: MW51S/G50S
Surface Elev: 620.84 ft. MSL
Completion: 34.32 ft. BGS
Station: 16,180.78N
-5.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 5.86 - 3/29/2007
▽ =

SAMPLE			TESTING					
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description
							22	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*
							24	Dark yellowish brown (10YR4/6) with 30% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, silty CLAY, trace sand and gravel
							26	Greenish gray (5GY5/1) with 50% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand and gravel
							28	Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand and gravel
							30	Dark gray (N4/1), very silty CLAY, trace sand and gravel
							32	Dark gray (N4/1), sandy SILT, trace clay
							34	

Borehole Detail: 598, 596, 594, 592, 590, 588

Remarks

End of Boring = 34.3 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N -5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	2-3 4-5 N=7				0	Very dark brown (10YR2/2), clayey SILT, trace sand		620	
1A				21		1.28 BSh	2	Yellowish brown (10YR5/6) with 40% very dark grayish brown (10YR2/3) mottles, silty CLAY, trace sand			
	22/24 92%	ss	6-3 5-6 N=8							618	
2A				30		1.78 BSh		Pale brown (10YR6/3) with 40% yellowish brown (10YR5/8) silty CLAY, trace sand			
2B				29		1.67 BSh	4				
	18/24 75%	ss	1-3 3-3 N=6							616	
3A				24			6				
	24/24 100%	ss	5-4 5-6 N=9				▼			614	
4A				22		1.71 B	▼ 8	Pale brown (10YR6/3) and yellowish brown (10YR5/8) clayey SILT, trace sand			
	13/24 54%	ss	1-3 5-4 N=8							612	
5A				26		1.28 BSh	10				
	15/24 63%	ss	0-1 3-3 N=4							610	
6A				27		1.36 BSh	12				
	14/24 58%	ss	4-3 5-6 N=8					Grayish brown (10YR5/2), clayey SILT, trace sand		608	
7A				24			14				
	20/24 83%	ss	0-2 2-3 N=4					Brown (10YR4/3), clayey SILT, trace sand		606	
8A				26			16				
	24/24 100%	ss	4-5 5-5 N=10					Dark yellowish brown (10YR4/4) with 30% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand		604	
9A				25			18				
	23/24 96%	ss	0-2 3-3 N=5							602	
10A				26			20	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel			
	20/24		1-3							600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N -5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	83%	SS	*3-4* N=6								
11A				27			22	Dark grayish brown (10YR4/2) with 50% yellowish brown (10YR5/6) mottles, silty CLAY, trace sand and gravel *[Continued from previous page]*			
	22/24 *92%*	SS	*1-3* *4-4* N=7					Dark yellowish brown (10YR4/6) with 30% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, silty CLAY, trace sand and gravel		598	
12A				24			24				
	20/24 *83%*	SS	*2-3* *5-2* N=8					Greenish gray (5GY5/1) with 50% yellowish brown (10YR5/6) mottles, very silty CLAY, trace sand and gravel		596	
13A				28			26				
	19/24 *79%*	SS	*0-2* *2-2* N=4					Light brownish gray (10YR6/2) with 30% yellowish brown (10YR5/6) mottles, clayey SILT, trace sand and gravel		594	
14A				19			28				
	20/24 *83%*	SS	*1-3* *5-6* N=8					Dark gray (N4/1), very silty CLAY, trace sand and gravel		592	
15A				15			30				
	24/60 *40%*	CS						Dark gray (N4/1), sandy SILT, trace clay		590	
							32				
										588	
							34				
16A				13		4.29 *BSh*				586	
							36	Dark gray (N4/1), silty CLAY, trace sand and gravel			
	38/60 *63%*	CS								584	
							38	Brown (10YR4/3), silty, fine to medium SAND, little gravel			
										582	
17A				13		6.70 *None*	40				
								Brown (10YR4/3), silty, fine SAND		580	
							42				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	19/60 *32%*	CS						Brown (10YR4/3), fine to medium SAND		578	
								Brown (10YR4/3), silty, fine to coarse SAND, little gravel			
							44	Dark yellow brown (10YR4/4), SANDSTONE			
18A				13		6.70 *None*				576	
							46	Very dark gray (N3/1), sandy SILT, trace clay and gravel			
	48/60 *80%*	CS								574	
							48	Dark gray (N4/1), SHALE			
19A				14		6.70 *None*				572	
							50	Very dark gray (N3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								570	
							52				
										568	
							54				
20A				17		6.70 *None*				566	
							56	Very dark greenish gray (10Y3/1), silty CLAY, trace sand and gravel			
	60/60 *100%*	CS								564	
							58				
										562	
21A				14				Very dark greenish gray (10Y3/1), silty, fine to coarse SAND, little gravel			
22A				15			60				
22B	18/24 *75%*	SS	*8-15* *25-32* N=40	11				Very dark gray (N3/1), sandy CLAY, little gravel		560	
22C				15				Very dark gray (N3/1), silty, fine SAND, trace medium sand			
							62	Very dark gray (N3/1), sandy CLAY, trace gravel			
	24/24		*15-31*					Very dark gray (N3/1), silty, fine to medium SAND, trace gravel		558	

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 3/12/2007
Finish: 3/13/2007
WEATHER: Sunny, windy, mild

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3½" hollow stem auger w/split spoon and split barrel sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-51
Well ID: hole abandoned
Surface Elev: 620.84 ft. MSL
Completion: 80.00 ft. BGS
Station: 16,177.5N
-5.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.20 - during drilling
▼ = 7.00 - end of boring
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
23A	*100%*	SS	*29-19* N=60	15		5.24 *BSh*		Very dark gray (N3/1), sandy CLAY, trace gravel *[Continued from previous page]*			
							64	Very dark gray (N3/1), silty, fine to coarse SAND, trace gravel			
24A	24/24 *100%*	SS	*7-10* *14-23* N=24	15		5.24 *BSh*				556	
24B				15		3.30 *B*	66	Very dark gray (N3/1), silty CLAY, trace sand and gravel			
	24/24 *100%*	SS	*8-17* *24-22* N=41							554	
25A				16		5.13 *B*	68				
	24/24 *100%*	SS	*7-9* *16-15* N=25					Very dark gray (N3/1), sandy CLAY, trace gravel		552	
26A				12		2.57 *BSP*	70				
	12/12 *100%*	CS						Very dark gray (N3/1), sandy CLAY		550	
27A				11							
	12/12 *100%*	CS									
28A				12			72				
	36/36 *100%*	CS						Very dark gray (N3/1), silty, fine to coarse SAND, little gravel		548	
							74				
29				12						546	
							76				
	60/60 *100%*	CS						Very dark gray (N3/1), silty, fine SAND, trace gravel		544	
							78				
										542	
30A				19			80				

End of Boring = 80.0 ft. BGS

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/28/2008
Finish: 1/28/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 10 ft of of BG51
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG51b~~
Well ID: G51L
Surface Elev: 616.9 ft. MSL
Completion: 17.7 ft. BGS
Station: 15,409.75N
-75.67E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ = 10.57 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark gray (10YR4/2) silty CLAY, moist, trace sand		616	
							1.5	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand			
							2				
							3.5	Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		614	
							4				
							5.5			612	
							6				
							7.5			610	
							8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand			
							9.5	▼		608	
							10				
							10.5	▼			
							11.5			606	
							12				
							13.5	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand		604	
							14				
							15.5			602	
							16				
							17.5	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel		600	

End of Boring = 17.72 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

Number	Recov / Total (in) / % Recovery	Type	Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	4-5 5-6 N=10	21		1.05 Sh	0	Dark gray (10YR4/2) silty CLAY, moist, trace sand	616	
1B				31		0.81 Sh	2	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand		
	23/24 96%	ss	2-3 3-5 N=6				4	Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand	614	
2A				23		1.24 Sh				
	21/24 88%	ss	1-3 2-3 N=5						612	
3A				27		0.74 BSh	6			
	24/24 100%	ss	2-3 1-3 N=4						610	
4A				29		0.74 BSh	8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand		
	22/24 92%	ss	1-2 3-3 N=5				▼		608	
5A				30		0.78 B	10			
	24/24 100%	ss	0-2 1-2 N=3						606	
6A				28		0.62 Sh	12			
7A				28		0.81 BSh				
	24/24 100%	ss	0-2 2-3 N=4						604	
							14	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand		
	24/24 100%	ss	0-1 2-2 N=3						602	
8A				27		0.81 BSh	16			
	23/24 96%	ss	1-2 3-4 N=5						600	
9A				26		1.09 BSh	18	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel		
	24/24 100%	ss	2-2 4-4 N=6						598	
10A				25		1.09	20			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						BSh					
	24/24 *100%*	ss	*1-2* *2-3* N=4					Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		596	
11A				22			22				
12A	24/24 *100%*	ss	*3-4* *3-4* N=7	26		0.39 *B*		Olive yellow (2.5Y6/6) with 50% green gray (5GY6/1) mottles, wet, silty CLAY, trace sand and gravel		594	
12B				21		0.50 *B*	24				
	24/24 *100%*	ss	*0-2* *3-3* N=5					Olive (5Y5/3) with 50% green gray (5GY6/1) mottles, wet, very silty CLAY, trace sand and gravel		592	
13A				20		1.75 *B*	26				
14A	24/24 *100%*	ss	*5-7* *8-9* N=15	17		3.30 *BSh*		Brown yellow (10YR5/4), wet, fine to coarse SAND, little gravel		590	
14B				18							
14C				15			28	Green gray (5GY6/1), moist, very silty CLAY, trace sand			
	24/24 *100%*	ss	*1-5* *6-9* N=11							588	
15A				19		4.07 *Sh*	30				
	24/24 *100%*	ss	*3-6* *5-8* N=11					Very dark gray (N3/1), moist, silty CLAY, trace sand and gravel		586	
16A				12		4.27 *Sh*	32				
	24/24 *100%*	ss	*6-8* *9-9* N=17							584	
17A				16		4.27 *BSh*	34				
18A	24/24 *100%*	ss	*4-8* *5-6* N=13	17		4.27 *Sh*				582	
18B				15			36				
	21/24 *88%*	ss	*4-4* *6-5* N=10					Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, clayey SILT, trace sand		580	
19A				37		0.81 *B*	38				
	22/24 *92%*	ss	*3-6* *8-9* N=14					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel		578	
20A				12		2.33					
20B				13		*BSh*		Dark gray (10YR4/1), wet, fine to coarse SAND, trace			
							40				

NOTE(S):

R002292

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/23/2008 **FIELD STAFF: Driller:** B. Williamson
Finish: 1/23/2008 **Helper:** R. Keedy
WEATHER: Overcast, windy, cold **Eng/Geo:** R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
20C				12		4.07 B		gravel			
	24/24 100%	ss	3-7 9-14 N=16							576	
21A				12		4.65 B	42				
	24/24 100%	ss	12-25 38-37 N=63					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel *[Continued from previous page]*		574	
22A				10		7.18 Sh	44				
	24/24 100%	ss	11-19 21-26 N=40							572	
23A				11		5.43 Sh	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

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FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/28/2008
Finish: 1/28/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG51
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG51a~~
Well ID: G51S
Surface Elev: 616.8 ft. MSL
Completion: 29.2 ft. BGS
Station: 15,405.35N
-75.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ = 10.41 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark gray (10YR4/2) silty CLAY, moist, trace sand		616	
							1	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand			
							2				
							3	Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		614	
							4				
							5			612	
							6				
							7			610	
							8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand			
							9	▼		608	
							10	▼			
							11			606	
							12				
							13	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand		604	
							14				
							15			602	
							16				
							17	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel		600	
							18				
							19			598	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/28/2008
Finish: 1/28/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG51
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51a
Well ID: G51S
Surface Elev: 616.8 ft. MSL
Completion: 29.2 ft. BGS
Station: 15,405.35N
-75.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ = 10.41 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		596	
								Olive yellow (2.5Y6/6) with 50% green gray (5GY6/1) mottles, wet, silty CLAY, trace sand and gravel		594	
							24	Olive (5Y5/3) with 50% green gray (5GY6/1) mottles, wet, very silty CLAY, trace sand and gravel		592	
							26	Brown yellow (10YR5/4), wet, fine to coarse SAND, little gravel		590	
								Green gray (5GY6/1), moist, very silty CLAY, trace sand			
							28	Very dark gray (N3/1), moist, silty CLAY, trace sand and gravel		588	

End of Boring = 29.16 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	4-5 5-6 N=10	21		1.05 Sh	0	Dark gray (10YR4/2) silty CLAY, moist, trace sand		616	
1B				31		0.81 Sh	2	Light brown gray (10YR6/2) with 25% brown yellow (10YR6/6) mottles, moist, silty CLAY, trace sand			
	23/24 96%	ss	2-3 3-5 N=6					Brown yellow (10YR6/6) with 50% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		614	
2A				23		1.24 Sh	4				
	21/24 88%	ss	1-3 2-3 N=5							612	
3A				27		0.74 BSh	6				
	24/24 100%	ss	2-3 1-3 N=4							610	
4A				29		0.74 BSh	8	Gray (10YR6/1) with 20% brown yellow (10YR6/6) mottles, moist, clayey SILT, trace sand			
	22/24 92%	ss	1-2 3-3 N=5				▼			608	
5A				30		0.78 B	10				
	24/24 100%	ss	0-2 1-2 N=3							606	
6A				28		0.62 Sh	12				
7A				28		0.81 BSh					
	24/24 100%	ss	0-2 2-3 N=4							604	
							14	Brown yellow (10YR5/4) with 30% yellow brown (10YR5/8) mottles, moist, clayey SILT, trace sand			
	24/24 100%	ss	0-1 2-2 N=3							602	
8A				27		0.81 BSh	16				
	23/24 96%	ss	1-2 3-4 N=5							600	
9A				26		1.09 BSh	18	Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
	24/24 100%	ss	2-2 4-4 N=6							598	
10A				25		1.09	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/23/2008
Finish: 1/23/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						BSh					
	24/24 *100%*	ss	*1-2* *2-3* N=4					Brown (10YR5/3) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		596	
11A				22			22				
12A	24/24 *100%*	ss	*3-4* *3-4* N=7	26		0.39 *B*		Olive yellow (2.5Y6/6) with 50% green gray (5GY6/1) mottles, wet, silty CLAY, trace sand and gravel		594	
12B				21		0.50 *B*	24				
	24/24 *100%*	ss	*0-2* *3-3* N=5					Olive (5Y5/3) with 50% green gray (5GY6/1) mottles, wet, very silty CLAY, trace sand and gravel		592	
13A				20		1.75 *B*	26				
14A	24/24 *100%*	ss	*5-7* *8-9* N=15	17		3.30 *BSh*		Brown yellow (10YR5/4), wet, fine to coarse SAND, little gravel		590	
14B				18							
14C				15			28	Green gray (5GY6/1), moist, very silty CLAY, trace sand			
	24/24 *100%*	ss	*1-5* *6-9* N=11							588	
15A				19		4.07 *Sh*	30				
	24/24 *100%*	ss	*3-6* *5-8* N=11					Very dark gray (N3/1), moist, silty CLAY, trace sand and gravel		586	
16A				12		4.27 *Sh*	32				
	24/24 *100%*	ss	*6-8* *9-9* N=17							584	
17A				16		4.27 *BSh*	34				
18A	24/24 *100%*	ss	*4-8* *5-6* N=13	17		4.27 *Sh*				582	
18B				15			36				
	21/24 *88%*	ss	*4-4* *6-5* N=10					Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, clayey SILT, trace sand		580	
19A				37		0.81 *B*	38				
	22/24 *92%*	ss	*3-6* *8-9* N=14					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel		578	
20A				12		2.33					
20B				13		*BSh*		Dark gray (10YR4/1), wet, fine to coarse SAND, trace			
							40				

NOTE(S):

R002297

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 3¼" hollow stem auger w/split spoon sampler
Project: 03S5010
DATES: Start: 1/23/2008 **FIELD STAFF: Driller:** B. Williamson
Finish: 1/23/2008 **Helper:** R. Keedy
WEATHER: Overcast, windy, cold **Eng/Geo:** R. Hasenyager

BOREHOLE ID: BG51
Well ID: hole abandoned
Surface Elev: 616.8 ft. MSL
Completion: 46.0 ft. BGS
Station: 15,400.00N
-75.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 9.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) / % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
20C				12		4.07 B		gravel			
	24/24 100%	ss	3-7 9-14 N=16							576	
21A				12		4.65 B	42				
	24/24 100%	ss	12-25 38-37 N=63					Dark gray (10YR4/1) silty CLAY, moist, trace sand and gravel *[Continued from previous page]*		574	
22A				10		7.18 Sh	44				
	24/24 100%	ss	11-19 21-26 N=40							572	
23A				11		5.43 Sh	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

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FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/22/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG52
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG52b~~
Well ID: G52L
Surface Elev: 616.7 ft. MSL
Completion: 34.2 ft. BGS
Station: 14,660.08N
-76.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 28.78 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Gray (10YR6/1) with 25% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand		616	
							6	FILL - Yellow brown (10YR5/4) with 25% very pale brown (10YR7/4) and 10% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand		610	
							8	FILL - Very dark green gray (10Y3/1) with 25% yellow brown (10YR5/4), mottles, moist, silty CLAY, trace sand and gravel		608	
							10	FILL - Yellow brown (10YR5/4) with 20% very pale brown (10YR7/4) and 15% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand and gravel		606	
							16	FILL - Dark gray (5Y4/1), moist, very silty CLAY, trace sand		600	
							18	FILL - Olive gray (5Y5/2), moist, very silty CLAY, trace sand		598	
							20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/22/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG52
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52b
Well ID: G52L
Surface Elev: 616.7 ft. MSL
Completion: 34.2 ft. BGS
Station: 14,660.08N
-76.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 28.78 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1), moist, clayey SILT, slight trace sand		596	
								Dark gray brown (10YR4/2) with 20% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand			
							22			594	
								Gray (10YR5/1) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
							24			592	
							26				
								Gray (10YR5/1) with 30% green gray (5GY5/1) mottle, moist, silty CLAY, trace sand and gravel		590	
							28				
							▼	Brown yellow (10YR6/8) with 20% green gray (5GY5/1) mottles, very moist, silty CLAY, trace sand and gravel		588	
							30				
								Brown yellow (10YR6/8) with 25% light gray (10YR7/2) mottle, very moist, very silty CLAY, little sand, trace gravel		586	
							32				
							▼			584	
								Dark gray brown (10YR4/2) with 25% dark yellow brown (10YR4/6) mottles, wet, clayey SILT, little sand, trace gravel			
							34	Dark gray (10YR4/1), very moist, silty CLAY, trace sand and gravel			

End of Boring = 34.17 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG52~~
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	20/24 83%	ss	3-3 2-4 N=5							616	
1A				23		1.28 BSh	2				
	24/24 100%	ss	3-3 4-4 N=7					FILL - Gray (10YR6/1) with 25% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand		614	
2A				16		2.13 Sh	4				
	21/24 88%	ss	6-6 9-13 N=15							612	
3A				19			6				
	21/24 88%	ss	6-5 8-8 N=13					FILL - Yellow brown (10YR5/4) with 25% very pale brown (10YR7/4) and 10% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand		610	
4A				14			8				
	23/24 96%	ss	5-7 9-10 N=16					FILL - Very dark green gray (10Y3/1) with 25% yellow brown (10YR5/4), mottles, moist, silty CLAY, trace sand and gravel		608	
5A				13			10				
	24/24 100%	ss	6-6 7-4 N=13							606	
6A				15			12				
	22/24 92%	ss	4-4 8-7 N=12					FILL - Yellow brown (10YR5/4) with 20% very pale brown (10YR7/4) and 15% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand and gravel		604	
7A				19			14				
	23/24 96%	ss	2-5 6-8 N=11							602	
8A				17		2.91 Sh	16				
	21/24 88%	ss	2-3 3-4 N=6					FILL - Dark gray (5Y4/1), moist, very silty CLAY, trace sand		600	
9A				25			18				
	24/24 100%	ss	2-5 5-5 N=10					FILL - Olive gray (5Y5/2), moist, very silty CLAY, trace sand		598	
10A				28		1.59	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1), moist, clayey SILT, slight trace sand			
11A	24/24 100%	ss	2-3 8-7 N=11	29		Sh				596	
								Dark gray brown (10YR4/2) with 20% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand			
11B				23		3.30 BSh	22				
	24/24 100%	ss	5-5 7-9 N=12							594	
12A				25		2.91 B	24	Gray (10YR5/1) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
	23/24 96%	ss	1-2 3-5 N=5							592	
13A				25		2.13 B	26				
	24/24 100%	ss	5-6 7-6 N=13					Gray (10YR5/1) with 30% green gray (5GY5/1) mottle, moist, silty CLAY, trace sand and gravel		590	
14A				19		2.33 B	28	Brown yellow (10YR6/8) with 20% green gray (5GY5/1) mottles, very moist, silty CLAY, trace sand and gravel			
15A	24/24 100%	ss	1-2 2-3 N=4	27		0.78 B				588	
15B				19		2.52 BSh	30				
	24/24 100%	ss	1-1 2-3 N=3					Brown yellow (10YR6/8) with 25% light gray (10YR7/2) mottle, very moist, very silty CLAY, little sand, trace gravel		586	
16A				22		1.24 B	32				
							▼ ▼			584	
17A	24/24 100%	ss	3-3 4-7 N=7	26		2.72 B		Dark gray brown (10YR4/2) with 25% dark yellow brown (10YR4/6) mottles, wet, clayey SILT, little sand, trace gravel			
17B				26							
17C				17			34				
	24/24 100%	ss	2-5 6-8 N=11							582	
18A				16		5.24 Sh	36	Dark gray (10YR4/1), very moist, silty CLAY, trace sand and gravel			
	24/24 100%	ss	9-10 10-11 N=20							580	
19A				17		4.46 Sh					
19B				25			38	Dark gray (10YR4/1), wet, sandy SILT			
								Gray (N6/1) with 30% gray (5Y5/1) mottles, wet, sandy SILT		578	
20A	24/24 100%	ss	5-7 5-6 N=12	25							
								Gray (10YR5/1), wet, sandy SILT			
20B				30		3.69	40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh					
	22/24 *92%*	ss	*2-3* *5-12* N=8					Gray (10YR5/1), wet, sandy SILT *[Continued from previous page]*		576	
21A				35		1.32					
21B				12		*Sh* 1.40 *Sh*	42	Dark gray (10YR4/1), wet, SAND and GRAVEL		574	
	24/24 *100%*	ss	*12-18* *18-8* N=36								
22A				13							
22B				13			44				
	24/24 *100%*	ss	*3-5* *8-11* N=13					Dark greenish gray (10Y4/1), moist, silty CLAY, trace sand and gravel		572	
23A				14		4.46 *B*	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG52~~
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	20/24 83%	ss	3-3 2-4 N=5				0			616	
1A				23		1.28 BSh	2				
	24/24 100%	ss	3-3 4-4 N=7					FILL - Gray (10YR6/1) with 25% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand		614	
2A				16		2.13 Sh	4				
	21/24 88%	ss	6-6 9-13 N=15							612	
3A				19			6				
	21/24 88%	ss	6-5 8-8 N=13					FILL - Yellow brown (10YR5/4) with 25% very pale brown (10YR7/4) and 10% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand		610	
4A				14			8				
	23/24 96%	ss	5-7 9-10 N=16					FILL - Very dark green gray (10Y3/1) with 25% yellow brown (10YR5/4), mottles, moist, silty CLAY, trace sand and gravel		608	
5A				13			10				
	24/24 100%	ss	6-6 7-4 N=13							606	
6A				15			12				
	22/24 92%	ss	4-4 8-7 N=12					FILL - Yellow brown (10YR5/4) with 20% very pale brown (10YR7/4) and 15% very dark green gray (10Y3/1) mottles, moist, silty CLAY, trace sand and gravel		604	
7A				19			14				
	23/24 96%	ss	2-5 6-8 N=11							602	
8A				17		2.91 Sh	16				
	21/24 88%	ss	2-3 3-4 N=6					FILL - Dark gray (5Y4/1), moist, very silty CLAY, trace sand		600	
9A				25			18				
	24/24 100%	ss	2-5 5-5 N=10					FILL - Olive gray (5Y5/2), moist, very silty CLAY, trace sand		598	
10A				28		1.59	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1), moist, clayey SILT, slight trace sand			
11A	24/24 100%	ss	2-3 8-7 N=11	29		Sh				596	
								Dark gray brown (10YR4/2) with 20% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand			
11B				23		3.30 BSh	22				
										594	
	24/24 100%	ss	5-5 7-9 N=12								
12A				25		2.91 B	24	Gray (10YR5/1) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
										592	
	23/24 96%	ss	1-2 3-5 N=5								
13A				25		2.13 B	26				
										590	
	24/24 100%	ss	5-6 7-6 N=13					Gray (10YR5/1) with 30% green gray (5GY5/1) mottle, moist, silty CLAY, trace sand and gravel			
14A				19		2.33 B	28				
								Brown yellow (10YR6/8) with 20% green gray (5GY5/1) mottles, very moist, silty CLAY, trace sand and gravel		588	
15A	24/24 100%	ss	1-2 2-3 N=4	27		0.78 B					
15B				19		2.52 BSh	30				
								Brown yellow (10YR6/8) with 25% light gray (10YR7/2) mottle, very moist, very silty CLAY, little sand, trace gravel		586	
	24/24 100%	ss	1-1 2-3 N=3								
16A				22		1.24 B	32				
							▼			584	
17A	24/24 100%	ss	3-3 4-7 N=7	26		2.72 B	▼	Dark gray brown (10YR4/2) with 25% dark yellow brown (10YR4/6) mottles, wet, clayey SILT, little sand, trace gravel			
17B				26							
17C				17			34				
										582	
	24/24 100%	ss	2-5 6-8 N=11					Dark gray (10YR4/1), very moist, silty CLAY, trace sand and gravel			
18A				16		5.24 Sh	36				
										580	
	24/24 100%	ss	9-10 10-11 N=20								
19A				17		4.46					
19B				25		Sh	38	Dark gray (10YR4/1), wet, sandy SILT			
								Gray (N6/1) with 30% gray (5Y5/1) mottles, wet, sandy SILT		578	
20A	24/24 100%	ss	5-7 5-6 N=12	25							
								Gray (10YR5/1), wet, sandy SILT			
20B				30		3.69	40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/21/2008
Finish: 1/22/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG52
Well ID: G52S
Surface Elev: 616.5 ft. MSL
Completion: 46.0 ft. BGS
Station: 14,655.26N
-76.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 32.80 - during drilling
▼ = 32.45 - 1/30/2008
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh					
	22/24 *92%*	ss	*2-3* *5-12* N=8					Gray (10YR5/1), wet, sandy SILT *[Continued from previous page]*		576	
21A				35		1.32					
						Sh					
21B				12		1.40	42				
						Sh		Dark gray (10YR4/1), wet, SAND and GRAVEL		574	
	24/24 *100%*	ss	*12-18* *18-8* N=36								
22A				13							
22B				13			44				
	24/24 *100%*	ss	*3-5* *8-11* N=13					Dark greenish gray (10Y4/1), moist, silty CLAY, trace sand and gravel		572	
23A				14		4.46 *B*	46				

End of Boring = 46.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G53a~~
Well ID: G53L
Surface Elev: 620.29 ft. MSL
Completion: 26.79 ft. BGS
Station: 16,199.98N
506.32E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		620	
							2	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand.		618	
							4	Dark gray (10YR4/1), moist, friable, clayey SILT with slight trace sand and gravel, trace roots.		616	
								Dark yellowish brown (10YR4/6) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.			
							6	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		614	
							8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		612	
							10			610	
							12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		608	
							14			606	
							16	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
								Dark gray (10YR4/1), moist, soft, clayey SILT.			
							18	Dark gray (10YR4/1) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.		602	
							20				

NOTE(S): See G53S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G53a
Well ID: G53L
Surface Elev: 620.29 ft. MSL
Completion: 26.79 ft. BGS
Station: 16,199.98N
506.32E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Dark gray (10YR4/1) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand. *[Continued from previous page]*		600	
							24	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		598	
							▼ 26	Greenish gray (5GY5/1), very moist, very soft, silty CLAY with sand and slight trace gravel.		596	
								Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		594	
								End of Boring = 26.79 ft bgs			

NOTE(S): See G53S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G53~~
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	20/24 *83%*	ss	*12-3* *4-3* N=7	21			0	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		620	
2A	22/24 *92%*	ss	*5-3* *3-6* N=6	22			2	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand.		618	
3A	18/24 *75%*	ss	*2-3* *6-7* N=9	27			4	Dark gray (10YR4/1), moist, friable, clayey SILT with slight trace sand and gravel, trace roots. Dark yellowish brown (10YR4/6) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		616	
4A	24/24 *100%*	ss	*5-4* *7-11* N=11	26			6	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		614	
5A	12/24 *50%*	ss	*1-2* *4-3* N=6	24			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		612	
6A	17/24 *71%*	ss	*1-2* *4-4* N=6	23			10			610	
7A	19/24 *79%*	ss	*6-5* *4-4* N=9	25			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		608	
8A	19/24 *79%*	ss	*1-2* *2-3* N=4	26			14			606	
9A	24/24 *100%*	ss	*3-6* *5-5* N=11	25			16	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
10A	19/24 *79%*	ss	*1-1* *3-4* N=4	24			18	Dark gray (10YR4/1), moist, soft, clayey SILT.		602	
							20	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G53
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	woh-1 2-2 N=3	25			22	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand. *[Continued from previous page]*	600	
12A	24/24 100%	ss	3-3 3-3 N=6	25					598	
12B				21			24	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		
13A	19/24 79%	ss	woh-1 1-1 N=2	23					596	
								Greenish gray (5GY5/1), very moist, very soft, silty CLAY with sand and slight trace gravel.		
							▼ 26		594	
	23/24 96%	ss	woh-woh 3-4							
14A				20			28	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.	592	
	22/24 92%	ss	1-3 6-8 N=9							
15A				16			30	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel.	590	
16A	18/24 75%	ss	woh-7 12-16 N=19	13			▼			
16B				19			32	Brown (10YR5/3), wet, dense, silty very fine- to coarse-grained SAND.	588	
17A				17						
	20/24 83%	ss	4-4 6-8 N=10							
17B				32			34	Gray (10YR5/1), very moist, soft, clayey SILT.	586	
18A	22/24 92%	ss	woh-3 3-9 N=6	30						
18B				20			36	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel. **End of Boring = 36.04 ft bgs**		

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G53~~
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	20/24 *83%*	ss	*12-3* *4-3* N=7	21			0	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		620	
2A	22/24 *92%*	ss	*5-3* *3-6* N=6	22			2	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand.		618	
3A	18/24 *75%*	ss	*2-3* *6-7* N=9	27			4	Dark gray (10YR4/1), moist, friable, clayey SILT with slight trace sand and gravel, trace roots. Dark yellowish brown (10YR4/6) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		616	
4A	24/24 *100%*	ss	*5-4* *7-11* N=11	26			6	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		614	
5A	12/24 *50%*	ss	*1-2* *4-3* N=6	24			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		612	
6A	17/24 *71%*	ss	*1-2* *4-4* N=6	23			10			610	
7A	19/24 *79%*	ss	*6-5* *4-4* N=9	25			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		608	
8A	19/24 *79%*	ss	*1-2* *2-3* N=4	26			14			606	
9A	24/24 *100%*	ss	*3-6* *5-5* N=11	25			16	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
10A	19/24 *79%*	ss	*1-1* *3-4* N=4	24			18	Dark gray (10YR4/1), moist, soft, clayey SILT.		602	
							20	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/5/2009
Finish: 2/5/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G53
Well ID: G53S
Surface Elev: 620.29 ft. MSL
Completion: 36.04 ft. BGS
Station: 16,199.56N
510.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 31.20 - 02/05/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	woh-1 2-2 N=3	25			22	Dark gray (10YR4/1) with 5% dak yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand. *[Continued from previous page]*		600	
12A	24/24 100%	ss	3-3 3-3 N=6	25						598	
12B				21			24	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		596	
13A	19/24 79%	ss	woh-1 1-1 N=2	23				Greenish gray (5GY5/1), very moist, very soft, silty CLAY with sand and slight trace gravel.			
							▼ 26			594	
14A	23/24 96%	ss	woh-woh 3-4	20			28	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	22/24 92%	ss	1-3 6-8 N=9	16			30	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel.		590	
16A	18/24 75%	ss	woh-7 12-16 N=19	13			▼				
16B				19			32	Brown (10YR5/3), wet, dense, silty very fine- to coarse-grained SAND.		588	
17A	20/24 83%	ss	4-4 6-8 N=10	17							
17B				32			34	Gray (10YR5/1), very moist, soft, clayey SILT.		586	
18A	22/24 92%	ss	woh-3 3-9 N=6	30							
18B				20			36	Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand and gravel. **End of Boring = 36.04 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S1	18/24 75%	SS	2-2 4-5 N=6			1.5	0	Fill - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% yellowish brown (10YR4/6) mottles, moist SILT with little clay, trace roots, and trace sand.		618	
S2	21/24 88%	SS	2-5 6-7 N=11			2.0	2	Fill - Yellowish brown (10YR5/6) with 30% light brownish gray (10YR6/2) mottles, moist, soft SILT with little clay, trace sand, and trace gravel.		616	
S3	22/24 92%	SS	2-7 10-12 N=17			2.5	4	Fill - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, firm SILT with little clay and trace sand.		614	
S4	19/24 79%	SS	3-7 9-11 N=16			4.5	6	Fill - Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		612	
S5	20/24 83%	SS	3-7 9-10 N=16			4.5	8	Grayish brown (10YR5/2) firm SILT with little clay, trace sand, and trace gravel.		610	
S6	21/24 88%	SS	3-4 7-10 N=11			4.5	10	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/6) mottles, firm SILT with little clay, trace sand, and trace gravel.		608	
S7	21/24 88%	SS	3-7 12-15 N=19			4.5	12	Yellowish brown (10YR5/4) firm SILT with little clay, trace sand, and trace gravel.		606	
ST8	20/24 83%	SH				4.0	14			604	
S9	18/24 75%	SS	1-4 4-5 N=8			0.5	16	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, soft SILT with little clay.		602	
S10	19/24 79%	SS	1-3 4-4 N=7			1.0	18			600	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S11	18/24 75%	SS	1-2 4-5 N=6			1.0	22	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft SILT with little clay.		598	
S12	20/24 83%	SS	1-3 4-7 N=7			1.0	24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft SILT with little clay.		596	
S13	19/24 79%	SS	1-3 3-4 N=6			1.5		Grayish brown (10YR5/2) moist, soft, CLAY with little silt.		594	
S14	22/24 92%	SS	woh-1 3-3 N=4			1.5	26	Gray (10YR5/1) moist, soft, CLAY with little silt.		592	
S15	21/24 88%	SS	1-2 3-4 N=5			1.0	28			590	
S16	22/24 92%	SS	1-3 5-5 N=8			2.0	30	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) soft CLAY with little silt.		588	
ST17	24/24 100%	SH				0.5	32			586	
S18	21/24 88%	SS	2-3 4-3 N=7			1.0	34			584	
S19	21/24 88%	SS	1-4 5-8 N=9			1.5	36	Gray (10YR6/1) wet, soft CLAY with little silt and trace sand.		582	
S20	20/24 83%	SS	woh-1 3-4 N=4			1.0	38	Dark gray (10YR4/1) wet, fine SAND with trace silt.		580	
							40	Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S21	4/24 17%	SS	1-2 5-10 N=7					Dark gray (10YR4/1) very moist, soft SILT with little clay and trace sand. *[Continued from previous page]*			
							42			578	
S22	23/24 96%	SS	2-6 12-11 N=18			3.0					
							44	Dark grayish brown (10YR4/2) moist, firm SILT with little clay, trace sand, and trace gravel.		576	
ST23	23/24 96%	SH				4.5					
							46			574	
S24	24/24 100%	SS	3-6 8-14 N=14			4.5					
							48			572	
S25	24/24 100%	SS	3-8 13-20 N=21			4.5					
							50	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.		570	
S26	24/24 100%	SS	3-10 14-19 N=24			4.5					
							52			568	
S27	24/24 100%	SS	6-9 15-16 N=24			4.5					
							54			566	
S28	24/24 100%	SS	4-10 28-50/3" N=38			4.5		Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.			
							56			564	
S29	24/24 100%	SS	10-47 50/3.25-50/1.25			2.5		Dark gray (10YR4/1) wet, soft SAND with little clay and trace silt.			
							58	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel.		562	
S30	24/24 100%	SS	19-29 44-72 N=73			4.5					
							60			560	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S31	24/24 100%	SS	14-29 42-54 N=71			4.5	62	Dark gray (10YR4/1) moist, firm SILT with little clay, trace sand, and trace gravel. *[Continued from previous page]*		558	
S32	23/24 96%	SS	12-14 30-48 N=44			4.5	64			556	
S33	23/24 96%	SS	10-22 25-34 N=47			4.5	66			554	
S34	24/24 100%	SS	10-19 26-34 N=45			4.5	68			552	
S35	24/24 100%	SS	11-19 24-33 N=43			4.5	70	Dark gray (10YR4/1) firm SILT with little clay, trace sand, and trace gravel.		550	
S36	23/24 96%	SS	11-22 22-34 N=44			4.5	72			548	
S37	24/24 100%	SS	9-13 20-22 N=33			4.5	74			546	
S38	24/24 100%	SS	6-8 12-15 N=20			4.5	76	Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt.		544	
ST39	11/24 46%	SH				4.5	78			542	
S40	14/24 58%	SS	7-10 17-20 N=27			4.5	80	Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel.		540	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
S41	24/24 100%	SS	6-8 11-15 N=19			4.5		Dark grayish olive (10Y4/2) firm, slick CLAY with trace silt and gravel. *[Continued from previous page]*			
							82			538	
S42	24/24 100%	SS	3-7 9-10 N=16			4.5		Dark gray (10YR4/1) firm CLAY with trace silt and gravel.			
							84			536	
S43	24/24 100%	SS	4-8 12-15 N=20			4.5		Dark gray (10YR4/1) with 5% gray (10YR5/1) mottles, firm, CLAY with little silt, trace sand, and trace gravel.			
							86			534	
S44	24/24 100%	SS	5-7 11-14 N=18			4.0					
							88	Dark gray (10YR4/1) CLAY with little silt, trace sand, and trace gravel.		532	
S45	24/24 100%	SS	5-8 11-14 N=19			4.5					
							90			530	
S46	24/24 100%	SS	5-9 13-15 N=22			4.5					
							92	Grayish green (5GY5/2) with 30% dark grayish green (5GY4/2) mottles, firm, CLAY with trace silt and gravel. (WEATHERED SHALE)		528	
S47	24/24 100%	SS	4-7 10-13 N=17			4.5					
							94			526	
S48	24/24 100%	SS	3-6 8-11 N=14			4.0					
							96	Very dark grayish green (5GY3/2) firm, CLAY with trace silt. (WEATHERED SHALE)		524	
S49	24/24 100%	SS	4-8 11-13 N=19			3.0					
							98			522	
S50	21/24 88%	SS	5-7 10-12 N=17			3.0		Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE)			
							100			520	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/3/2021
Finish: 2/5/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Al
Eng/Geo: T. Gass

BOREHOLE ID: G54C
Well ID: G54C
Surface Elev: 619.59 ft. MSL
Completion: 102.00 ft. BGS
Station: 1,384,885.21N
2,348,250.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks
S51	24/24 *100%*	SS	*3-7* *9-11* N=16			*2.5*		Very dark grayish green (5GY3/2) firm, CLAY with trace silt and gravel. (WEATHERED SHALE) *[Continued from previous page]*	518
							102	**End of boring = 102 feet**	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G54a~~
Well ID: G54L
Surface Elev: 620.28 ft. MSL
Completion: 37.22 ft. BGS
Station: 14,664.37N
463.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand, trace roots.		620	
							2			618	
							4	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		616	
							6	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand.		614	
							8			612	
							10	FILL - Yellowish brown (10YR5/4), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
							12			608	
							14			606	
							16	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		604	
							18			602	
							20	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, friable, clayey SILT.			

NOTE(S): See G54S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G54a
Well ID: G54L
Surface Elev: 620.28 ft. MSL
Completion: 37.22 ft. BGS
Station: 14,664.37N
463.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
							24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
							26	Gray (10YR5/1), moist, soft, silty CLAY.		596	
							28	Gray (10YR5/1), moist, soft, silty CLAY with trace sand.		594	
							30	Gray (10YR5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
							32	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		590	
							34	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
							36	Dark gray (10YR4/1), very moist, soft, clayey SILT with trace sand and slight trace gravel.		586	
								End of Boring = 37.22 ft bgs		584	

NOTE(S): See G54S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G54~~
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-2 2-2 N=4	25			0	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand, trace roots.		620	
2A	18/24 75%	ss	1-2 3-3 N=5	23			2			618	
3A	20/24 83%	ss	1-5 8-10 N=13	17			4	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		616	
4A	24/24 100%	ss	8-13 13-15 N=26	18			6	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand.		614	
5A	24/24 100%	ss	4-7 10-9 N=17	16			8			612	
6A	19/24 79%	ss	2-3 6-8 N=9	18			10	FILL - Yellowish brown (10YR5/4), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
7A	24/24 100%	ss	8-17 15-16 N=32	16			12			608	
8A	20/24 83%	ss	2-4 4-6 N=8	22			14	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		606	
9A	22/24 92%	ss	5-5 9-10 N=14	22			16			604	
10A	18/24 75%	ss	1-3 3-4 N=6	23			18	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, friable, clayey SILT.		602	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	1-2 1-3 N=3	28			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	600	
12A	20/24 83%	ss	4-5 5-4 N=10	25			24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.	598	
13A	19/24 79%	ss	2-2 3-4 N=5	23			26	Gray (10YR5/1), moist, soft, silty CLAY.	596	
13B				24			28	Gray (10YR5/1), moist, soft, silty CLAY with trace sand.	594	
14A	20/24 83%	ss	4-4 4-5 N=8	27			30	Gray (10YR5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.	592	
15A	14/24 58%	ss	woh-2 4-4 N=6	20			32	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.	590	
16A	22/24 92%	ss	1-2 4-8 N=6	24			34	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.	588	
17A	20/24 83%	ss	4-4 7-8 N=11	21			36		586	
18A	16/24 67%	ss	woh-1 2-3 N=3	14			38	Dark gray (10YR4/1), very moist, soft, clayey SILT with trace sand and slight trace gravel.	584	
19A	14/24 58%	ss	woh-3 3-6 N=6	15			40	Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel.	582	
20A	23/24 96%	ss	woh-3 4-5 N=7	13						

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
21A	20/24 83%	SS	1-3 5-7 N=8	14				Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel. *[Continued from previous page]*	580	
21B				32			42	Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, very moist, soft, clayey SILT.	578	
22A	20/24 83%	SS	5-7 7-9 N=14	28				Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, soft, clayey SILT.		
23A	20/24 83%	SS	2-4 8-7 N=12	16			▼ 44	Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.	576	
23B				12				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		
24A	22/24 92%	SS	7-10 13-17 N=23	19			46	Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.	574	
24B				13				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		
	0/5 0%	BD					48		572	

End of Boring = 48.41 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G54~~
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-2 2-2 N=4	25			0	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand, trace roots.		620	
2A	18/24 75%	ss	1-2 3-3 N=5	23			2			618	
3A	20/24 83%	ss	1-5 8-10 N=13	17			4	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		616	
4A	24/24 100%	ss	8-13 13-15 N=26	18			6	FILL - Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand.		614	
5A	24/24 100%	ss	4-7 10-9 N=17	16			8			612	
6A	19/24 79%	ss	2-3 6-8 N=9	18			10	FILL - Yellowish brown (10YR5/4), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
7A	24/24 100%	ss	8-17 15-16 N=32	16			12			608	
8A	20/24 83%	ss	2-4 4-6 N=8	22			14			606	
9A	22/24 92%	ss	5-5 9-10 N=14	22			16	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		604	
10A	18/24 75%	ss	1-3 3-4 N=6	23			18			602	
							20	Yellowish brown (10YR5/6) with 10% gray (10YR6/1) mottles, moist, friable, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 79%	ss	1-2 1-3 N=3	28			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
12A	20/24 83%	ss	4-5 5-4 N=10	25			24	Gray (10YR5/1) with 30% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
13A	19/24 79%	ss	2-2 3-4 N=5	23			26	Gray (10YR5/1), moist, soft, silty CLAY.		596	
13B				24			28	Gray (10YR5/1), moist, soft, silty CLAY with trace sand.		594	
14A	20/24 83%	ss	4-4 4-5 N=8	27			30	Gray (10YR5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	14/24 58%	ss	woh-2 4-4 N=6	20			32	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		590	
16A	22/24 92%	ss	1-2 4-8 N=6	24			34	Greenish gray (5GY6/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
17A	20/24 83%	ss	4-4 7-8 N=11	21			36			586	
18A	16/24 67%	ss	woh-1 2-3 N=3	14			38	Dark gray (10YR4/1), very moist, soft, clayey SILT with trace sand and slight trace gravel.		584	
19A	14/24 58%	ss	woh-3 3-6 N=6	15			40	Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel.		582	
20A	23/24 96%	ss	woh-3 4-5 N=7	13							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/12/2009
Finish: 2/12/2009
WEATHER: cold, sunny, windy, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G54
Well ID: G54S
Surface Elev: 620.28 ft. MSL
Completion: 48.41 ft. BGS
Station: 14,664.84N
460.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 44.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	20/24 83%	SS	1-3 5-7 N=8	14				Dark gray (10YR4/1), moist, soft, clayey SILT with trace sand and slight trace gravel. *[Continued from previous page]*		580	
21B				32			42	Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, very moist, soft, clayey SILT.		578	
22A	20/24 83%	SS	5-7 7-9 N=14	28				Dark gray (10YR4/1) with 20% gray (10YR5/1) mottles, moist, soft, clayey SILT.			
23A	20/24 83%	SS	2-4 8-7 N=12	16			▼ 44	Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.		576	
23B				12				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.			
24A	22/24 92%	SS	7-10 13-17 N=23	19			46	Dark gray (N4/1), wet, medium dense, silty fine- to coarse-grained SAND.		574	
24B				13				Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and slight trace gravel.			
	0/5 0%	BD					48			572	

End of Boring = 48.41 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G55a~~
Well ID: G55L
Surface Elev: 619.78 ft. MSL
Completion: 36.60 ft. BGS
Station: 14,667.70N
705.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand.		618	
							2				
							4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		616	
							6			614	
							8	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		612	
							10	FILL - Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		610	
							12	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand.		608	
							14	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		606	
							16	Very dark grayish brown (10YR3/2), slightly moist, hard, clayey SILT with slight trace sand and trace roots.		604	
							18	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, firm, silty CLAY.		602	
							20	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
								Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			

NOTE(S): See G55S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G55a
Well ID: G55L
Surface Elev: 619.78 ft. MSL
Completion: 36.60 ft. BGS
Station: 14,667.70N
705.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
							24	Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		596	
							26			594	
							28	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		592	
							30			590	
							32	Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
								Greenish gray (5GY6/1), moist, soft, sandy CLAY with slight trace gravel.			
								Medium light gray (N6/1), moist, soft, sandy CLAY with slight trace gravel.		586	
							34	Medium light gray (N6/1), wet, soft, silty, very fine- to medium-grained SAND.			
								Greenish gray (10Y6/1), very moist, soft, clayey SILT with slight trace sand and gravel.		584	
							36	Gray (N6/1), very moist, soft, sandy CLAY with slight trace gravel.			

End of Boring = 36.6 ft bgs

NOTE(S): See G55S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G55~~
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	2-3 4-3 N=7	19			0	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand.		618	
2A	17/24 71%	ss	2-3 2-2 N=5	20			2				
3A	12/24 50%	ss	woh-2 3-4 N=5	15			4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		616	
4A	24/24 100%	ss	6-8 12-11 N=20	15			6			614	
5A	24/24 100%	ss	4-3 3-5 N=6	18			8	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		612	
5B				17			10	FILL - Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		610	
6A	22/24 92%	ss	1-2 6-8 N=8	19			12	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand.		608	
7A	24/24 100%	ss	6-8 18-19 N=26	17			14	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		606	
8A	20/24 83%	ss	2-5 5-7 N=10	24			16	Very dark grayish brown (10YR3/2), slightly moist, hard, clayey SILT with slight trace sand and trace roots.		604	
9A	22/24 92%	ss	10-9 11-11 N=20	24			18	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, firm, silty CLAY.		602	
9B				23				Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
10A	18/24 75%	ss	2-4 4-5 N=8	22			20	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	1-2 2-4 N=4	25			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
12A	23/24 96%	ss	4-4 5-5 N=9	26			24			596	
13A	17/24 71%	ss	woh-2 3-3 N=5	21				Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.			
14A	22/24 92%	ss	3-3 4-5 N=7	25			26			594	
15A	24/24 100%	ss	woh-2 2-3 N=4	30			28	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		592	
16A	20/24 83%	ss	woh-1 3-4 N=4	25			30			590	
16B				22				Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.			
17A				24			32			588	
17B	12/24 50%	ss	2-3 4-4 N=7	16				Greenish gray (5GY6/1), moist, soft, sandy CLAY with slight trace gravel.			
								Medium light gray (N6/1), moist, soft, sandy CLAY with slight trace gravel.		586	
18A	11/24 46%	ss	1-3 5-4 N=8	16			34	Medium light gray (N6/1), wet, soft, silty, very fine- to medium-grained SAND.			
								Greenish gray (10Y6/1), very moist, soft, clayey SILT with slight trace sand and gravel.		584	
19A	17/24 71%	ss	2-5 6-7 N=11	14			36	Gray (N6/1), very moist, soft, sandy CLAY with slight trace gravel.			
20A				11			38			582	
20B	19/24 79%	ss	3-8 11-7 N=19	19				Gray (N5/1), slightly moist, firm, clayey SILT with slight trace sand and gravel.			
							▼	Gray (N5/1), moist, firm, SILT.		580	
							40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Gray (N5/1), moist, firm, SILT. *[Continued from previous page]*			
21A	18/24 *75%*	ss	*5-8* *10-19* N=18	36							
21B				16							
							42 ▼	Gray (N5/1), wet, dense, silty very fine- to medium-grained SAND.		578	
22A				11							
22B	18/24 *75%*	ss	*6-13* *21-15* N=34	10							
							44	Gray (N5/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	
23A	20/24 *83%*	ss	*6-9* *13-12* N=22	12							
										574	

End of Boring = 45.96 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G55~~
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	2-3 4-3 N=7	19			0	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand.		618	
2A	17/24 71%	ss	2-3 2-2 N=5	20			2				
3A	12/24 50%	ss	woh-2 3-4 N=5	15			4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		616	
4A	24/24 100%	ss	6-8 12-11 N=20	15			6			614	
5A	24/24 100%	ss	4-3 3-5 N=6	18			8	FILL - Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT.		612	
5B				17			10	FILL - Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		610	
6A	22/24 92%	ss	1-2 6-8 N=8	19			12	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand.		608	
7A	24/24 100%	ss	6-8 18-19 N=26	17			14	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		606	
8A	20/24 83%	ss	2-5 5-7 N=10	24			16	Very dark grayish brown (10YR3/2), slightly moist, hard, clayey SILT with slight trace sand and trace roots.		604	
9A	22/24 92%	ss	10-9 11-11 N=20	24			18	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, firm, silty CLAY.		602	
9B				23				Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
10A	18/24 75%	ss	2-4 4-5 N=8	22			20	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	1-2 2-4 N=4	25			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
12A	23/24 96%	ss	4-4 5-5 N=9	26			24			596	
13A	17/24 71%	ss	woh-2 3-3 N=5	21				Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.			
14A	22/24 92%	ss	3-3 4-5 N=7	25			26			594	
15A	24/24 100%	ss	woh-2 2-3 N=4	30			28	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		592	
16A	20/24 83%	ss	woh-1 3-4 N=4	25			30			590	
16B				22				Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand and slight trace gravel.			
17A				24			32			588	
17B	12/24 50%	ss	2-3 4-4 N=7	16				Greenish gray (5GY6/1), moist, soft, sandy CLAY with slight trace gravel.			
								Medium light gray (N6/1), moist, soft, sandy CLAY with slight trace gravel.		586	
18A	11/24 46%	ss	1-3 5-4 N=8	16			34	Medium light gray (N6/1), wet, soft, silty, very fine- to medium-grained SAND.			
								Greenish gray (10Y6/1), very moist, soft, clayey SILT with slight trace sand and gravel.		584	
19A	17/24 71%	ss	2-5 6-7 N=11	14			36	Gray (N6/1), very moist, soft, sandy CLAY with slight trace gravel.			
20A				11						582	
20B	19/24 79%	ss	3-8 11-7 N=19	19			38	Gray (N5/1), slightly moist, firm, clayey SILT with slight trace sand and gravel.			
							▼	Gray (N5/1), moist, firm, SILT.		580	
							40				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/19/2009
Finish: 2/19/2009
WEATHER: cold, sunny, windy, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G55
Well ID: G55S
Surface Elev: 619.78 ft. MSL
Completion: 45.96 ft. BGS
Station: 14,663.87N
705.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 41.80 - during drilling
▼ = 39.43 - 02/19/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	18/24 75%	ss	5-8 10-19 N=18	36				Gray (N5/1), moist, firm, SILT. *[Continued from previous page]*			
21B				16							
							▼ 42	Gray (N5/1), wet, dense, silty very fine- to medium-grained SAND.		578	
22A				11							
22B	18/24 75%	ss	6-13 21-15 N=34	10							
							44	Gray (N5/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	
23A	20/24 83%	ss	6-9 13-12 N=22	12							
										574	

End of Boring = 45.96 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G56a~~
Well ID: G56L
Surface Elev: 619.91 ft. MSL
Completion: 22.89 ft. BGS
Station: 14,708.56N
979.20E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0			620	
							2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand and gravel.		618	
							4			616	
							6	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		614	
							8			612	
							10			610	
							12	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		608	
							14	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
							16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		604	
							18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	

NOTE(S): See G56S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G56a
Well ID: G56L
Surface Elev: 619.91 ft. MSL
Completion: 22.89 ft. BGS
Station: 14,708.56N
979.20E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
								Dark grayish brown (10YR4/2), moist, soft, clayey SILT.			

End of Boring = 22.89 ft bgs

NOTE(S): See G56S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G56~~
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-3 4-6 N=7	20			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	6-6 6-7 N=12	16			4			616	
3A	20/24 83%	ss	1-4 7-7 N=11	15			6			614	
4A	22/24 92%	ss	9-10 11-13 N=21	19			8	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		612	
5A	20/24 83%	ss	1-4 6-8 N=10	19			10			610	
6A	22/24 92%	ss	2-4 8-8 N=12	27			12	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		608	
7A	24/24 100%	ss	9-15 13-13 N=28	26			14	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
8A	16/24 67%	ss	1-1 2-3 N=3	30			16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		604	
9A	22/24 92%	ss	3-3 5-6 N=8	23			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	19/24 79%	ss	1-3 3-2 N=6	24				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
	22/24		1-3				20	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G56
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	92%	ss	5-6 N=8	24			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		598	
12A	16/24 67%	ss	4-4 5-5 N=9	24			24	Dark grayish brown (10YR4/2), moist, soft, clayey SILT.		596	
13A	20/24 83%	ss	woh-2 2-3 N=4	23			26	Grayish brown (10YR5/2) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		594	
14A	18/24 75%	ss	woh-2 3-4 N=5	23			28	Dark greenish gray (5GY4/1), moist, soft, sandy CLAY with slight trace gravel.		592	
15A	19/24 79%	ss	woh-1 2-3 N=3	20			30	Greenish gray (5GY5/1), moist, soft, sandy CLAY with slight trace gravel.		590	
16A	18/24 75%	ss	woh-1 2-2 N=3	15			32			588	
17A	16/24 67%	ss	4-4 6-8 N=10	15			▼ 33.20	Gray (10YR5/1), wet, medium dense, silty fine- to coarse-grained SAND with slight trace gravel.		586	
18A	13/24 54%	ss	0-3 5-6 N=8	17			34	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		584	
19A	20/24 83%	ss	2-4 7-5 N=11	24			36	Greenish gray (10Y6/1), wet, medium dense, SILT with trace clay.		582	
20A	19/24 79%	ss	woh-4 7-7 N=11	11			38	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		580	
							40	Gray (10YR5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.			

End of Boring = 40.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G56
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	22/24 92%	ss	3-3 4-6 N=7	20			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	6-6 6-7 N=12	16			4			616	
3A	20/24 83%	ss	1-4 7-7 N=11	15			6			614	
4A	22/24 92%	ss	9-10 11-13 N=21	19			8	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		612	
5A	20/24 83%	ss	1-4 6-8 N=10	19			10			610	
6A	22/24 92%	ss	2-4 8-8 N=12	27			12	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		608	
7A	24/24 100%	ss	9-15 13-13 N=28	26			14			606	
8A	16/24 67%	ss	1-1 2-3 N=3	30			16	Light brownish gray (10YR6/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		604	
9A	22/24 92%	ss	3-3 5-6 N=8	23			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		602	
10A	19/24 79%	ss	1-3 3-2 N=6	24			20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		600	
	22/24		1-3					Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/16/2009
Finish: 2/16/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G56
Well ID: G56S
Surface Elev: 619.91 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,704.98N
978.76E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	92%	ss	5-6 N=8	24			22	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		598	
12A	16/24 67%	ss	4-4 5-5 N=9	24			24	Dark grayish brown (10YR4/2), moist, soft, clayey SILT.		596	
13A	20/24 83%	ss	woh-2 2-3 N=4	23			26	Grayish brown (10YR5/2) with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		594	
14A	18/24 75%	ss	woh-2 3-4 N=5	23			28	Dark greenish gray (5GY4/1), moist, soft, sandy CLAY with slight trace gravel.		592	
15A	19/24 79%	ss	woh-1 2-3 N=3	20			30	Greenish gray (5GY5/1), moist, soft, sandy CLAY with slight trace gravel.		590	
16A	18/24 75%	ss	woh-1 2-2 N=3	15			32			588	
17A	16/24 67%	ss	4-4 6-8 N=10	15			▼ 33.20	Gray (10YR5/1), wet, medium dense, silty fine- to coarse-grained SAND with slight trace gravel.		586	
18A	13/24 54%	ss	0-3 5-6 N=8	17			34	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		584	
19A	20/24 83%	ss	2-4 7-5 N=11	24			36	Greenish gray (10Y6/1), wet, medium dense, SILT with trace clay.		582	
20A	19/24 79%	ss	woh-4 7-7 N=11	11			38	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		580	
							40	Gray (10YR5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.			

End of Boring = 40.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G57a~~
Well ID: G57L
Surface Elev: 619.98 ft. MSL
Completion: 26.00 ft. BGS
Station: 15,064.65N
987.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							2	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, slightly moist, firm, clayey SILT.		618	
							4			616	
							6	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, moist, firm, clayey SILT with slight trace gravel, slight trace iron staining (10YR5/6) visible.		614	
							8			612	
							10	FILL - Dark yellowish brown (10YR4/6), moist, firm, silty CLAY.		610	
							12	Dark gray (10YR4/1), moist, firm, silty CLAY with trace gravel.		608	
							14	Dark grayish brown (10YR4/2) with gray (10YR5/1) mottles, moist, firm, clayey SILT with trace gravel.		606	
							16	Dark yellowish brown (10YR3/6), moist, firm, silty CLAY.		604	
							18	Light yellowish brown (10YR6/4), slightly moist, firm, clayey SILT, with trace iron staining (10YR4/6) visible.		602	
							20	Dark grayish brown (10YR4/2), moist, firm, clayey SILT.		600	

NOTE(S): See G57S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G57a
Well ID: G57L
Surface Elev: 619.98 ft. MSL
Completion: 26.00 ft. BGS
Station: 15,064.65N
987.47E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark grayish brown (10YR4/2), moist, firm, clayey SILT. *[Continued from previous page]*			
							22	Grayish brown (10YR5/2), moist, firm, clayey SILT, with trace iron staining (10YR5/6) visible.		598	
							24	Dark brown (10YR3/3), moist, firm, silty CLAY.		596	
							26	Dark yellowish brown (10YR3/6) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		594	

End of Boring = 26.00 ft bgs

NOTE(S): See G57S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G57~~
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-8 5-3 N=13	25			0			620	
2A	20/24 83%	ss	3-3 5-4 N=8	19			2	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, slightly moist, firm, clayey SILT.		618	
3A	24/24 100%	ss	3-3 4-5 N=7	17			4			616	
4A	24/24 100%	ss	8-5 5-8 N=10	20			6			614	
5A	22/24 92%	ss	1-3 3-3 N=6	22			8	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, moist, firm, clayey SILT with slight trace gravel, slight trace iron staining (10YR5/6) visible.		612	
6A	16/24 67%	ss	3-3 7-6 N=10	17			10	FILL - Dark yellowish brown (10YR4/6), moist, firm, silty CLAY.		610	
7A	24/24 100%	ss	5-6 7-6 N=13	22			12	Dark gray (10YR4/1), moist, firm, silty CLAY with trace gravel.		608	
7B				20			14	Dark grayish brown (10YR4/2) with gray (10YR5/1) mottles, moist, firm, clayey SILT with trace gravel.		606	
8A	22/24 92%	ss	5-5 7-5 N=12	22			16	Dark yellowish brown (10YR3/6), moist, firm, silty CLAY.		604	
9A	24/24 100%	ss	9-10 8-6 N=18	24			18	Light yellowish brown (10YR6/4), slightly moist, firm, clayey SILT, with trace iron staining (10YR4/6) visible.		602	
10A	24/24 100%	ss	1-2 4-4 N=6	27			20	Dark grayish brown (10YR4/2), moist, firm, clayey SILT.		600	

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G57
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
11A	24/24 100%	ss	1-3 5-3 N=8	25		
12A	24/24 100%	ss	1-3 5-4 N=8	25		
13A	23/24 96%	ss	0-2 2-3 N=4	26		
14A	24/24 100%	ss	2-3 3-6 N=6	26		
15A	24/24 100%	ss	1-2 3-5 N=5	23		
16A	24/24 100%	ss	1-2 5-3 N=7	14		
16B				18		
17A	23/24 96%	ss	6-8 10-4 N=18	16		
17B				14		
18A	22/24 92%	ss	1-3 5-8 N=8	11		
19A	18/24 75%	ss	5-13 17-15 N=30	11		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Dark grayish brown (10YR4/2), moist, firm, clayey SILT. *[Continued from previous page]*	
22	Grayish brown (10YR5/2), moist, firm, clayey SILT, with trace iron staining (10YR5/6) visible.	598
24	Dark brown (10YR3/3), moist, firm, silty CLAY.	596
26	Dark yellowish brown (10YR3/6) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.	594
28	Dark yellowish brown (10YR4/4) with 20% dark yellowish brown (10YR4/2) mottles, moist, firm, silty CLAY with slight trace sand and gravel.	592
30	Greenish gray (5G6/1), moist, soft, clayey SILT with trace sand and slight trace gravel.	590
	Greenish brown (10YR5/2), wet, soft, sandy CLAY.	
32	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.	588
	Gray (10YR5/1), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.	
34		586
36	Gray (N5/1), wet, firm, clayey SILT with slight trace sand and gravel.	584
38		582

End of Boring = 38.00 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G57~~
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-8 5-3 N=13	25			0			620	
2A	20/24 83%	ss	3-3 5-4 N=8	19			2	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, slightly moist, firm, clayey SILT.		618	
3A	24/24 100%	ss	3-3 4-5 N=7	17			4			616	
4A	24/24 100%	ss	8-5 5-8 N=10	20			6	FILL - Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% very dark brown (10YR2/2) mottles, moist, firm, clayey SILT with slight trace gravel, slight trace iron staining (10YR5/6) visible.		614	
5A	22/24 92%	ss	1-3 3-3 N=6	22			8			612	
6A	16/24 67%	ss	3-3 7-6 N=10	17			10	FILL - Dark yellowish brown (10YR4/6), moist, firm, silty CLAY.		610	
7A	24/24 100%	ss	5-6 7-6 N=13	22			12	Dark gray (10YR4/1), moist, firm, silty CLAY with trace gravel.		608	
7B				20			14	Dark grayish brown (10YR4/2) with gray (10YR5/1) mottles, moist, firm, clayey SILT with trace gravel.		606	
8A	22/24 92%	ss	5-5 7-5 N=12	22			16	Dark yellowish brown (10YR3/6), moist, firm, silty CLAY.		604	
9A	24/24 100%	ss	9-10 8-6 N=18	24			18	Light yellowish brown (10YR6/4), slightly moist, firm, clayey SILT, with trace iron staining (10YR4/6) visible.		602	
10A	24/24 100%	ss	1-2 4-4 N=6	27			20	Dark grayish brown (10YR4/2), moist, firm, clayey SILT.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/30/2009
Finish: 1/30/2009
WEATHER: cold, sunny, lo-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G57
Well ID: G57S
Surface Elev: 619.98 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,060.26N
987.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
11A	24/24 100%	ss	1-3 5-3 N=8	25		
12A	24/24 100%	ss	1-3 5-4 N=8	25		
13A	23/24 96%	ss	0-2 2-3 N=4	26		
14A	24/24 100%	ss	2-3 3-6 N=6	26		
15A	24/24 100%	ss	1-2 3-5 N=5	23		
16A	24/24 100%	ss	1-2 5-3 N=7	14		
16B				18		
17A	23/24 96%	ss	6-8 10-4 N=18	16		
17B				14		
18A	22/24 92%	ss	1-3 5-8 N=8	11		
19A	18/24 75%	ss	5-13 17-15 N=30	11		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Dark grayish brown (10YR4/2), moist, firm, clayey SILT. *[Continued from previous page]*	
22	Grayish brown (10YR5/2), moist, firm, clayey SILT, with trace iron staining (10YR5/6) visible.	598
24	Dark brown (10YR3/3), moist, firm, silty CLAY.	596
26	Dark yellowish brown (10YR3/6) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.	594
28	Dark yellowish brown (10YR4/4) with 20% dark yellowish brown (10YR4/2) mottles, moist, firm, silty CLAY with slight trace sand and gravel.	592
30	Greenish gray (5G6/1), moist, soft, clayey SILT with trace sand and slight trace gravel.	590
	Greenish brown (10YR5/2), wet, soft, sandy CLAY.	
32	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.	588
	Gray (10YR5/1), wet, medium dense, silty, fine- to coarse-grained SAND with trace gravel.	
34		586
36	Gray (N5/1), wet, firm, clayey SILT with slight trace sand and gravel.	584
38		582

End of Boring = 38.00 ft bgs

Borehole Detail

Remarks

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G58a~~
Well ID: G58L
Surface Elev: 620.04 ft. MSL
Completion: 30.56 ft. BGS
Station: 15,204.30N
989.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		620	
							2			618	
							4	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand.		616	
							6	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		614	
							8	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		612	
							10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, soft, clayey SILT.		610	
							12			608	
							14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
							16			604	
							18			602	
							20				

NOTE(S): See G58S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G58a
Well ID: G58L
Surface Elev: 620.04 ft. MSL
Completion: 30.56 ft. BGS
Station: 15,204.30N
989.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks
							22	Gray (10YR6/1) with 35% dark gray (10YR4/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	598
							24	Dark gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	596
							26	Dark gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.	594
							28	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.	592
							30	Greenish gray (5GY5/1) with 5% yellowish brown (10YR5/6) mottles, moist, soft, sandy CLAY with trace gravel.	590
								End of Boring = 30.56 ft bgs	

NOTE(S): See G58S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G58~~
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-11 7-5 N=18	23			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		620	
2A	24/24 100%	ss	7-8 10-12 N=18	23			2			618	
3A	24/24 100%	ss	4-4 6-9 N=10	20			4	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand.		616	
4A	23/24 96%	ss	8-12 14-19 N=26	19			6	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		614	
5A	24/24 100%	ss	2-3 7-7 N=10	20			8	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		612	
6A	20/24 83%	ss	2-3 5-8 N=8	22			10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, soft, clayey SILT.		610	
7A	24/24 100%	ss	7-7 7-6 N=14	25			12			608	
8A	17/24 71%	ss	1-3 5-7 N=8	23			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
9A	19/24 79%	ss	3-3 5-5 N=8	24			16			604	
10A	22/24 92%	ss	1-3 3-4 N=6	33			18			602	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G58
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	17/24 71%	ss	2-2 5-5 N=7	24				Gray (10YR6/1) with 35% dark gray (10YR4/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							22			598	
12A	24/24 100%	ss	5-5 6-8 N=11	22				Dark gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
13A				20			24			596	
13B	24/24 100%	ss	2-3 5-5 N=8	26				Dark gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
14A	24/24 100%	ss	5-9 6-7 N=15	30			26			594	
15A	23/24 96%	ss	woh-2 3-4 N=5	21			28	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
16A	24/24 100%	ss	6-8 11-7 N=19	18			30	Greenish gray (5GY5/1) with 5% yellowish brown (10YR5/6) mottles, moist, soft, sandy CLAY with trace gravel.		590	
16B				16				Greenish gray (5GY5/1), very moist, dense, silty, fine-to coarse-grained SAND with trace gravel.			
16C				20			32	Gray (10YR6/1), wet, firm, SILT.		588	
17A	20/24 83%	ss	3-6 10-3 N=16	13				Greenish gray (5GY5/1), moist, firm, clayey SILT with sand and trace gravel.			
								Gray (N5/1), wet, medium dense, silty very fine- to coarse-grained SAND with trace gravel.			
								Greenish gray (5GY5/1), moist, firm, sandy CLAY with trace gravel.			
18A				17			▼ 34			586	
18B	23/24 96%	ss	3-6 8-12 N=14	14				Gray (N5/1), wet, medium dense, silty fine- to coarse-grained SAND with trace gravel.			
								Greenish gray (5GY5/1), very moist, firm, sandy CLAY with trace gravel.			
18C				14			36	Dark gray (N4/1), slightly moist, hard, clayey SILT with sand and slight trace gravel.		584	

End of Boring = 36.43 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G58~~
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-11 7-5 N=18	23			2	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		618	
2A	24/24 100%	ss	7-8 10-12 N=18	23			4			616	
3A	24/24 100%	ss	4-4 6-9 N=10	20			6	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand.		614	
4A	23/24 96%	ss	8-12 14-19 N=26	19			8	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand.		612	
5A	24/24 100%	ss	2-3 7-7 N=10	20			10	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		610	
6A	20/24 83%	ss	2-3 5-8 N=8	22			12	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, moist, soft, clayey SILT.		608	
7A	24/24 100%	ss	7-7 7-6 N=14	25			14			606	
8A	17/24 71%	ss	1-3 5-7 N=8	23			16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		604	
9A	19/24 79%	ss	3-3 5-5 N=8	24			18			602	
10A	22/24 92%	ss	1-3 3-4 N=6	33			20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/26/2009
Finish: 1/26/2009
WEATHER: cold, overcast, mid-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G58
Well ID: G58S
Surface Elev: 620.04 ft. MSL
Completion: 36.43 ft. BGS
Station: 15,200.16N
989.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	17/24 71%	ss	2-2 5-5 N=7	24				Gray (10YR6/1) with 35% dark gray (10YR4/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							22			598	
12A	24/24 100%	ss	5-5 6-8 N=11	22				Dark gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
13A				20			24			596	
13B	24/24 100%	ss	2-3 5-5 N=8	26				Dark gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
14A	24/24 100%	ss	5-9 6-7 N=15	30			26			594	
15A	23/24 96%	ss	woh-2 3-4 N=5	21			28	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
							30	Greenish gray (5GY5/1) with 5% yellowish brown (10YR5/6) mottles, moist, soft, sandy CLAY with trace gravel.		590	
16A	24/24 100%	ss	6-8 11-7 N=19	18				Greenish gray (5GY5/1), very moist, dense, silty, fine-to coarse-grained SAND with trace gravel.			
16B				16				Gray (10YR6/1), wet, firm, SILT.			
16C				20			32	Greenish gray (5GY5/1), moist, firm, clayey SILT with sand and trace gravel.		588	
17A	20/24 83%	ss	3-6 10-3 N=16	13				Gray (N5/1), wet, medium dense, silty very fine- to coarse-grained SAND with trace gravel.			
								Greenish gray (5GY5/1), moist, firm, sandy CLAY with trace gravel.			
							▼ 34			586	
18A				17				Gray (N5/1), wet, medium dense, silty fine- to coarse-grained SAND with trace gravel.			
18B	23/24 96%	ss	3-6 8-12 N=14	14				Greenish gray (5GY5/1), very moist, firm, sandy CLAY with trace gravel.			
18C				14			36	Dark gray (N4/1), slightly moist, hard, clayey SILT with sand and slight trace gravel.		584	

End of Boring = 36.43 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G59a~~
Well ID: G59L
Surface Elev: 620.15 ft. MSL
Completion: 33.03 ft. BGS
Station: 15,343.87N
992.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Dark yellowish brown (10YR4/6) with 30% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
							4	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel		616	
							8	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, silty CLAY, trace roots.		612	
							12	FILL - Dark grayish brown (10YR4/2), slightly moist, firm, clayey SILT with slight trace sand.		608	
							14	Very dark grayish brown (10YR3/2), slightly moist, firm, clayey SILT, trace roots.		606	
							16	Dark grayish brown (10YR4/2), moist, firm, silty CLAY, slight trace roots.		604	
							18	Dark grayish brown (10YR4/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY, slight trace roots.		602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S): See G59S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G59a
Well ID: G59L
Surface Elev: 620.15 ft. MSL
Completion: 33.03 ft. BGS
Station: 15,343.87N
992.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		600	
							22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) and 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
							24	Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		596	
							26	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		594	
							28			592	
							30	Greenish gray (10GY6/1), moist, very soft, sandy CLAY with silt and trace gravel.		590	
							32			588	

End of Boring = 33.03 ft bgs

NOTE(S): See G59S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-15 20-19 N=35	17			0	FILL - Dark yellowish brown (10YR4/6) with 30% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
2A	24/24 100%	ss	26-10 15-17 N=25	19			2			618	
3A	24/24 100%	ss	6-6 10-6 N=16	19			4			616	
4A	24/24 100%	ss	10-10 9-7 N=19	23			6	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel		614	
5A	23/24 96%	ss	3-5 5-5 N=10	20			8			612	
6A	20/24 83%	ss	2-3 5-8 N=8	20			10	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, silty CLAY, trace roots.		610	
7A	24/24 100%	ss	10-14 12-11 N=26	17			12	FILL - Dark grayish brown (10YR4/2), slightly moist, firm, clayey SILT with slight trace sand.		608	
7B				30			14	Very dark grayish brown (10YR3/2), slightly moist, firm, clayey SILT, trace roots.		606	
8A	20/24 83%	ss	3-4 8-9 N=12	22			16	Dark grayish brown (10YR4/2), moist, firm, silty CLAY, slight trace roots.		604	
9A	24/24 100%	ss	8-11 11-11 N=22	25			18	Dark grayish brown (10YR4/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY, slight trace roots.		602	
10A	20/24 83%	ss	1-2 4-5 N=6	25			20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	woh-2 2-4 N=4	29				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		600	
							22			598	
12A	16/24 67%	ss	4-7 5-6 N=12	31				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) and 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.			
							24			596	
13A	22/24 92%	ss	1-2 3-4 N=5	24				Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.			
							26			594	
14A	17/24 71%	ss	4-7 7-6 N=14	23				Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							28			592	
15A	16/24 67%	ss	1-2 4-6 N=6	21							
							30			590	
16A	16/24 67%	ss	woh-2 2-2 N=4	17							
							32	Greenish gray (10GY6/1), moist, very soft, sandy CLAY with silt and trace gravel.		588	
17A	16/24 67%	ss	2-3 2-3 N=5	20							
							34			586	
18A	21/24 88%	ss	1-3 4-6 N=7	15							
							36	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
19A	24/24 100%	ss	6-9 11-9 N=20	15							
							38			582	
20A	24/24 100%	ss	15-22 24-17 N=46	12			▼				
20B				16			40	Gray (N5/1), wet, dense, silty, very fine- to coarse-grained SAND.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	24/24 *100%*	ss	*2-2* *4-5* N=6	16				Gray (10YR5/1) with 5% dark gray (10YR4/1), moist, soft, clayey SILT.		580	
21B				30			42			578	

End of Boring = 42.49 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	13-15 20-19 N=35	17			0	FILL - Dark yellowish brown (10YR4/6) with 30% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
2A	24/24 100%	ss	26-10 15-17 N=25	19			2			618	
3A	24/24 100%	ss	6-6 10-6 N=16	19			4			616	
4A	24/24 100%	ss	10-10 9-7 N=19	23			6	FILL - Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel		614	
5A	23/24 96%	ss	3-5 5-5 N=10	20			8			612	
6A	20/24 83%	ss	2-3 5-8 N=8	20			10	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, silty CLAY, trace roots.		610	
7A	24/24 100%	ss	10-14 12-11 N=26	17			12	FILL - Dark grayish brown (10YR4/2), slightly moist, firm, clayey SILT with slight trace sand.		608	
7B				30			14	Very dark grayish brown (10YR3/2), slightly moist, firm, clayey SILT, trace roots.		606	
8A	20/24 83%	ss	3-4 8-9 N=12	22			16	Dark grayish brown (10YR4/2), moist, firm, silty CLAY, slight trace roots.		604	
9A	24/24 100%	ss	8-11 11-11 N=22	25			18	Dark grayish brown (10YR4/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY, slight trace roots.		602	
10A	20/24 83%	ss	1-2 4-5 N=6	25			20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	ss	woh-2 2-4 N=4	29				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*		600	
							22			598	
12A	16/24 67%	ss	4-7 5-6 N=12	31				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) and 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.			
							24			596	
13A	22/24 92%	ss	1-2 3-4 N=5	24				Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.			
							26			594	
14A	17/24 71%	ss	4-7 7-6 N=14	23				Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							28			592	
15A	16/24 67%	ss	1-2 4-6 N=6	21							
							30			590	
16A	16/24 67%	ss	woh-2 2-2 N=4	17							
							32	Greenish gray (10GY6/1), moist, very soft, sandy CLAY with silt and trace gravel.		588	
17A	16/24 67%	ss	2-3 2-3 N=5	20							
							34			586	
18A	21/24 88%	ss	1-3 4-6 N=7	15							
							36	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
19A	24/24 100%	ss	6-9 11-9 N=20	15							
							38			582	
20A	24/24 100%	ss	15-22 24-17 N=46	12			▼				
20B				16			40	Gray (N5/1), wet, dense, silty, very fine- to coarse-grained SAND.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/23/2009
Finish: 1/23/2009
WEATHER: cold, overcast, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G59
Well ID: G59S
Surface Elev: 620.15 ft. MSL
Completion: 42.49 ft. BGS
Station: 15,339.79N
992.55E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 39.30 - during drilling
▼ =
▽ =

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	24/24 *100%*	SS	*2-2* *4-5* N=6	16				Gray (10YR5/1) with 5% dark gray (10YR4/1), moist, soft, clayey SILT.		580	
21B				30			42			578	

End of Boring = 42.49 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/17/2008
Finish: 1/17/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG60
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG60b~~
Well ID: G60L
Surface Elev: 612.5 ft. MSL
Completion: 25.3 ft. BGS
Station: 15,474.74N
1,049.75E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ = 21.02 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellow brown (10YR3/4), slightly moist, silty CLAY, trace sand		612	
							1	Light gray (10YR7/2) with 40% brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand			
							2	Brown yellow (10YR6/8) with 40% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand		610	
							4	Yellow brown (10YR5/8), moist, clayey SILT, trace sand		608	
							6	Light yellow brown (10YR6/4) with 30% brown yellow (10YR6/8) mottles, moist, clayey SILT, trace sand		606	
							8	Yellow brown (10YR5/8) with 20% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		604	
							10	Light brown gray (10YR6/2) with 10% brown yellow (10YR6/8) mottles, very moist, clayey SILT, trace sand		602	
							12	Gray brown (10YR5/2) with 30% very dark gray brown (10YR3/2) mottles, moist, clayey SILT, trace sand		600	
							14	Dark gray (10YR4/1), moist, clayey SILT, trace sand		598	
							16	Dark gray (10YR4/1) with 10% very dark gray (10YR3/1) mottles, moist, clayey SILT, trace sand		596	
							18	Black (10YR2/1), moist, very silty CLAY, trace sand		594	
								Dark gray (10YR4/1), moist, silty CLAY, trace sand			
								Dark green gray (10Y4/1) with 5% very dark gray (10YR3/1) mottles, moist, silty CLAY, trace sand, trace organics			
							20	Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel			

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/17/2008
Finish: 1/17/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG60
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG60b
Well ID: G60L
Surface Elev: 612.5 ft. MSL
Completion: 25.3 ft. BGS
Station: 15,474.74N
1,049.75E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ = 21.02 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL

▼ 22

Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel
[Continued from previous page]

592

Green gray (5GY5/1), very moist, silty CLAY, trace sand and gravel

590

24

Green gray (5GY5/1) with 5% yellow brown (10YR5/4) mottles, wet, very silty CLAY, trace sand and gravel

588

End of Boring = 25.28 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG60~~
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type
1A	19/24 79%	ss	4-6 6-7 N=12	24		
1B				19		4.27 Sh
	21/24 88%	ss	4-4 5-6 N=9			
2A				23		0.92
3A				23		Sh
	24/24 100%	ss	2-3 4-4 N=7			
3B				25		1.40 Sh
	21/24 88%	ss	3-4 6-5 N=10			
4A				24		
	22/24 92%	ss	2-2 3-4 N=5			
5A				27		0.78 Sh
	19/24 79%	ss	2-2 3-3 N=5			
6A				23		2.13 Sh
	21/24 88%	ss	2-2 2-3 N=4			
7A				27		2.33 Sh
8A	23/24 96%	ss	2-2 3-4 N=5	29		1.71 B
8B				33		1.82
9A				25		1.63 B
	24/24 100%	ss	2-3 3-5 N=6			
9B				23		1.67
9C				22		1.67
10A				27		0.97 B
	23/24 96%	ss	1-3 3-4 N=6			
10B				23		0.74

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
0	Dark yellow brown (10YR3/4), slightly moist, silty CLAY, trace sand		612	
	Light gray (10YR7/2) with 40% brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand			
2			610	
	Brown yellow (10YR6/8) with 40% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand			
4			608	
	Yellow brown (10YR5/8), moist, clayey SILT, trace sand			
	Light yellow brown (10YR6/4) with 30% brown yellow (10YR6/8) mottles, moist, clayey SILT, trace sand			
6			606	
8	Yellow brown (10YR5/8) with 20% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		604	
10	Light brown gray (10YR6/2) with 10% brown yellow (10YR6/8) mottles, very moist, clayey SILT, trace sand		602	
12	Gray brown (10YR5/2) with 30% very dark gray brown (10YR3/2) mottles, moist, clayey SILT, trace sand		600	
14	Dark gray (10YR4/1), moist, clayey SILT, trace sand		598	
	Dark gray (10YR4/1) with 10% very dark gray (10YR3/1) mottles, moist, clayey SILT, trace sand			
16			596	
	Black (10YR2/1), moist, very silty CLAY, trace sand			
18	Dark gray (10YR4/1), moist, silty CLAY, trace sand		594	
	Dark green gray (10Y4/1) with 5% very dark gray (10YR3/1) mottles, moist, silty CLAY, trace sand, trace organics			
	Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel			
20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG60
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	24/24 100%	ss	1-2 4-5 N=6					Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel *[Continued from previous page]*	592	
11A				18		1.32	22			
12A				18		0.47 B		Green gray (5GY5/1), very moist, silty CLAY, trace sand and gravel	590	
	24/24 100%	ss	4-4 4-4 N=8							
12B				20		0.04	24			
13A				19		B		Green gray (5GY5/1) with 5% yellow brown (10YR5/4) mottles, wet, very silty CLAY, trace sand and gravel	588	
	23/24 96%	ss	2-2 2-4 N=4			0.93 B				
13B				18		1.44 BSh	26	Green gray (5GY6/1), very moist, clayey SILT, trace sand	586	
14A	24/24 100%	ss	3-1 7-8 N=8	17		0.50 B		Green gray (5GY6/1), moist, very silty CLAY, trace sand and gravel		
14B				16		5.43 Sh				
	24/24 100%	ss	3-6 8-12 N=14				28	Dark gray (10YR4/1), moist, silty CLAY, trace sand and gravel	584	
15A				12		4.46 Sh	30	Dark gray (N4/1), very moist, sandy SILT	582	
16A	24/24 100%	ss	5-6 6-7 N=12	17			▼	Dark gray (N4/1), wet, fine to coarse SAND, trace gravel		
16B				16						
16C				20			32	Dark gray (N4/1), wet, fine to medium SAND	580	
	24/24 100%	ss	3-3 6-9 N=9					Gray (10YR5/1), very moist, clayey SILT, trace sand		
17A				35		1.44 Sh	34		578	
	22/24 92%	ss	3-6 14-17 N=20					Dark gray (N4/1), moist, clayey SILT, trace sand and gravel		
18A				16		3.93 Sh	36		576	
19A	24/24 100%	ss	11-13 14-13 N=27	12		4.46 Sh		Very dark green gray (10Y3/1), moist, silty CLAY, trace sand and gravel		
19B				18		6.21 Sh	38			

End of Boring = 38.0 ft. BGS

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG60~~
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellow brown (10YR3/4), slightly moist, silty CLAY, trace sand		612	
1A	19/24 79%	ss	4-6 6-7 N=12	24							
								Light gray (10YR7/2) with 40% brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand			
1B				19		4.27 Sh	2			610	
	21/24 88%	ss	4-4 5-6 N=9					Brown yellow (10YR6/8) with 40% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand			
2A				23		0.92	4				
3A				23		Sh				608	
								Yellow brown (10YR5/8), moist, clayey SILT, trace sand			
	24/24 100%	ss	2-3 4-4 N=7								
3B				25		1.40 Sh	6	Light yellow brown (10YR6/4) with 30% brown yellow (10YR6/8) mottles, moist, clayey SILT, trace sand		606	
	21/24 88%	ss	3-4 6-5 N=10								
4A				24			8			604	
	22/24 92%	ss	2-2 3-4 N=5					Yellow brown (10YR5/8) with 20% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand			
5A				27		0.78 Sh	10			602	
	19/24 79%	ss	2-2 3-3 N=5					Light brown gray (10YR6/2) with 10% brown yellow (10YR6/8) mottles, very moist, clayey SILT, trace sand			
6A				23		2.13 Sh	12			600	
	21/24 88%	ss	2-2 2-3 N=4					Gray brown (10YR5/2) with 30% very dark gray brown (10YR3/2) mottles, moist, clayey SILT, trace sand			
7A				27		2.33 Sh	14			598	
								Dark gray (10YR4/1), moist, clayey SILT, trace sand			
8A	23/24 96%	ss	2-2 3-4 N=5	29		1.71 B					
								Dark gray (10YR4/1) with 10% very dark gray (10YR3/1) mottles, moist, clayey SILT, trace sand			
8B				33		1.82	16			596	
9A				25		1.63 B					
	24/24 100%	ss	2-3 3-5 N=6					Black (10YR2/1), moist, very silty CLAY, trace sand			
9B				23		1.67					
9C				22		1.67	18	Dark gray (10YR4/1), moist, silty CLAY, trace sand			
10A				27		0.97 B				594	
	23/24 96%	ss	1-3 3-4 N=6					Dark green gray (10Y4/1) with 5% very dark gray (10YR3/1) mottles, moist, silty CLAY, trace sand, trace organics			
								Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel			
10B				23		0.74	20				

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/16/2008
Finish: 1/16/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG60
Well ID: G60S
Surface Elev: 612.2 ft. MSL
Completion: 38.0 ft. BGS
Station: 15,469.50N
1,050.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
								Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel *[Continued from previous page]*	592	
	24/24 100%	ss	*1-2* *4-5* N=6							
11A				18		1.32	22			
12A				18		0.47 *B*		Green gray (5GY5/1), very moist, silty CLAY, trace sand and gravel	590	
	24/24 100%	ss	*4-4* *4-4* N=8							
12B				20		0.04	24			
13A				19		*B* 0.93 *B*		Green gray (5GY5/1) with 5% yellow brown (10YR5/4) mottles, wet, very silty CLAY, trace sand and gravel	588	
	23/24 96%	ss	*2-2* *2-4* N=4							
13B				18		1.44 *BSh*	26	Green gray (5GY6/1), very moist, clayey SILT, trace sand	586	
14A				17		0.50 *B*		Green gray (5GY6/1), moist, very silty CLAY, trace sand and gravel		
	24/24 100%	ss	*3-1* *7-8* N=8							
14B				16		5.43 *Sh*	28	Dark gray (10YR4/1), moist, silty CLAY, trace sand and gravel	584	
	24/24 100%	ss	*3-6* *8-12* N=14							
15A				12		4.46 *Sh*	30	Dark gray (N4/1), very moist, sandy SILT	582	
16A				17			▼			
	24/24 100%	ss	*5-6* *6-7* N=12					Dark gray (N4/1), wet, fine to coarse SAND, trace gravel		
16B				16						
16C				20			32	Dark gray (N4/1), wet, fine to medium SAND	580	
	24/24 100%	ss	*3-3* *6-9* N=9					Gray (10YR5/1), very moist, clayey SILT, trace sand		
17A				35		1.44 *Sh*	34		578	
	22/24 92%	ss	*3-6* *14-17* N=20					Dark gray (N4/1), moist, clayey SILT, trace sand and gravel		
18A				16		3.93 *Sh*	36		576	
19A				12		4.46 *Sh*				
	24/24 100%	ss	*11-13* *14-13* N=27					Very dark green gray (10Y3/1), moist, silty CLAY, trace sand and gravel		
19B				18		6.21 *Sh*	38			

End of Boring = 38.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G61a~~
Well ID: G61L
Surface Elev: 620.00 ft. MSL
Completion: 19.90 ft. BGS
Station: 15,640.94N
994.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		618	
							4			616	
							6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		614	
							8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
								Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.			
							10			610	
							12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
							14			606	
							16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
								Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			
							18			602	
								Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							▼				
								Very dark gray (10YR3/1), slightly moist, friable, micaceous, clayey SILT.			
								End of Boring = 19.9 ft bgs			

NOTE(S): See G61S Boring log for sample and testing data.

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G61~~
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	18-12 9-8 N=21				2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		618	
2A	24/24 100%	ss	8-5 7-8 N=12	18			4			616	
3A	20/24 83%	ss	2-4 4-6 N=8	21			6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		614	
4A	24/24 100%	ss	7-9 10-11 N=19	20			8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
4B				21							
5A	19/24 79%	ss	2-3 6-7 N=9	26			10	Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		610	
6A	20/24 83%	ss	2-3 4-4 N=7	24			12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
7A	24/24 100%	ss	4-4 5-6 N=9	24			14			606	
8A	22/24 92%	ss	3-4 5-5 N=9	25			16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
9A	24/24 100%	ss	3-3 4-6 N=7	24			18	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	22/24 92%	ss	2-3 3-4 N=6	25			▼	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
10B				28			20	Very dark gray (10YR3/1), slightly moist, friable,		600	

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								micaceous, clayey SILT.			
11A	19/24 79%	ss	3-4 5-6 N=9	36							
11B				26			22	Dark gray (10YR4/1), moist, soft, clayey SILT.		598	
12A	24/24 100%	ss	4-3 6-9 N=9	25							
13A	20/24 83%	ss	woh-3 4-6 N=7	24			24			596	
14A	24/24 100%	ss	3-3 5-6 N=8	22			26	Greenish gray (5GY5/1), moist, soft, silty CLAY with slight trace sand.		594	
15A	22/24 92%	ss	woh-3 3-4 N=6	22			28			592	
16A	19/24 79%	ss	woh-1 3-3 N=4	17			30	Greenish gray (5GY5/1), very moist, very soft, sandy CLAY with slight trace gravel.		590	
17A	24/24 100%	ss	3-4 5-5 N=9	19			32			588	
17B				14			34	Greenish gray (10Y5/1), slightly moist, soft, clayey SILT with trace sand and slight trace gravel.		586	
18A	19/24 79%	ss	1-7 7-7 N=14	21			36	Medium light gray (N6/1), wet, firm, SILT with slight trace sand and gravel.		584	
19A	24/24 100%	ss	7-11 19-32 N=30	12			38	Greenish gray (10Y5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
								End of Boring = 38.0 ft bgs			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G61~~
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	ss	18-12 9-8 N=21				2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		618	
2A	24/24 100%	ss	8-5 7-8 N=12	18			4			616	
3A	20/24 83%	ss	2-4 4-6 N=8	21			6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		614	
4A	24/24 100%	ss	7-9 10-11 N=19	20			8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
4B				21							
5A	19/24 79%	ss	2-3 6-7 N=9	26			10	Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		610	
6A	20/24 83%	ss	2-3 4-4 N=7	24			12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
7A	24/24 100%	ss	4-4 5-6 N=9	24			14			606	
8A	22/24 92%	ss	3-4 5-5 N=9	25			16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
9A	24/24 100%	ss	3-3 4-6 N=7	24			18	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	22/24 92%	ss	2-3 3-4 N=6	25			▼	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
10B				28			20	Very dark gray (10YR3/1), slightly moist, friable,		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								micaceous, clayey SILT.			
11A	19/24 79%	ss	3-4 5-6 N=9	36							
11B				26			22	Dark gray (10YR4/1), moist, soft, clayey SILT.		598	
12A	24/24 100%	ss	4-3 6-9 N=9	25							
13A	20/24 83%	ss	woh-3 4-6 N=7	24			24			596	
14A	24/24 100%	ss	3-3 5-6 N=8	22			26	Greenish gray (5GY5/1), moist, soft, silty CLAY with slight trace sand.		594	
15A	22/24 92%	ss	woh-3 3-4 N=6	22			28			592	
16A	19/24 79%	ss	woh-1 3-3 N=4	17			30	Greenish gray (5GY5/1), very moist, very soft, sandy CLAY with slight trace gravel.		590	
17A	24/24 100%	ss	3-4 5-5 N=9	19			32			588	
17B				14			34	Greenish gray (10Y5/1), slightly moist, soft, clayey SILT with trace sand and slight trace gravel.		586	
18A	19/24 79%	ss	1-7 7-7 N=14	21			36	Medium light gray (N6/1), wet, firm, SILT with slight trace sand and gravel.		584	
19A	24/24 100%	ss	7-11 19-32 N=30	12			38	Greenish gray (10Y5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
								End of Boring = 38.0 ft bgs			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/22/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G62~~
Well ID: G62L
Surface Elev: 620.02 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,785.21N
994.71E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	13-9 5-5 N=14	25.8			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.			
2A	24/24 100%	SS	6-8 8-10 N=16	17.4			2			618	
3A	22/24 92%	SS	3-7 7-7 N=14	17.8			4	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		616	
4A	24/24 100%	SS	11-14 13-11 N=27	17.1			6			614	
5A	24/24 100%	SS	3-4 6-9 N=10	15.8			8	FILL - Yellowish brown (10YR5/4) with 5% medium dark gray (N4/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
6A	24/24 100%	SS	3-6 8-11 N=14	15.9			10			610	
7A	24/24 100%	SS	11-18 22-20 N=40	16.2			12	FILL - Yellowish brown (10YR5/4) with 5% medium dark gray (N4/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel and slight trace roots.		608	
8A	24/24 100%	SS	2-8 19-12 N=27	14.8			14	FILL - Yellowish brown (10YR5/4) with 5% medium dark gray (N4/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		606	
9A	24/24 100%	SS	12-13 18-15 N=31	23.1			16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		604	
10A	22/24 92%	SS	2-2 4-4 N=6	23.5			18			602	
							20	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/22/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G62
Well ID: G62L
Surface Elev: 620.02 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,785.21N
994.71E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	22/24 92%	SS	1-2 4-4 N=6	20.6			22	Gray (10YR5/1) with 10% dark gray (10YR4/1) mottles, moist, soft, clayey SILT.		598	
12A	24/24 100%	SS	2-3 3-4 N=6	23.5			24	Dark reddish gray (5YR4/2) with 5% dark reddish brown (5YR3/4) mottles, moist, soft, silty CLAY.		596	
12B				21.8							
13A	22/24 92%	SS	woh-2 3-3 N=5	20.9			26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	SS	4-5 5-8 N=10	20.3			28	Strong brown (7.5YR5/6), moist, hard, silty CLAY with trace sand and slight trace gravel.		592	
14B				22.0							
15A	24/24 100%	SS	1-2 3-3 N=5	18.7			30	Greenish gray (5GY5/1) with 10% dark yellowish brown (10YR4/6) and 5% olive gray (5Y4/2) mottles, moist, soft, silty CLAY with sand and trace gravel.		590	
16A	24/24 100%	SS	woh-1 2-4 N=3	18.2			32	Greenish gray (5GY5/1) with 5% olive gray (5Y4/2) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		588	
17A	17/24 71%	SS	4-3 5-7 N=8	19.4			34			586	
18A	22/24 92%	SS	1-4 4-6 N=8	14.7			36	Dark gray (N4/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
19A	24/24 100%	SS	6-13 13-13 N=26	13.2			38	End of Boring = 38.0 ft bgs			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G63a~~
Well ID: G63L
Surface Elev: 620.12 ft. MSL
Completion: 28.36 ft. BGS
Station: 15,928.37N
998.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		620	
							2			618	
							4			616	
							6			614	
							6	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.			
							8			612	
							8	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, soft, friable, clayey SILT with trace sand and slight trace gravel.			
							10			610	
							10	Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel, trace roots.			
							12			608	
							12	Gray (10YR5/1) with 10% yellowish brown (10YR5/4) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.			
							14			606	
							14	Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.			
							16			604	
							16	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.			
							18			602	
							18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
							20				

NOTE(S): See G63S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G63a
Well ID: G63L
Surface Elev: 620.12 ft. MSL
Completion: 28.36 ft. BGS
Station: 15,928.37N
998.01E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL	Remarks
							0	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.	600	
							22	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.	598	
							24		596	
							26		594	
							28		592	

End of Boring = 28.36 ft bgs

NOTE(S): See G63S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G63~~
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	3-3 3-6 N=6	21			0			620	
2A	24/24 100%	ss	2-3 4-5 N=7	22			2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		618	
3A	22/24 92%	ss	3-3 4-6 N=7	18			4			616	
4A	24/24 100%	ss	9-9 10-11 N=19	17			6	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		614	
5A	24/24 100%	ss	1-3 4-5 N=7	13			8	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, soft, friable, clayey SILT with trace sand and slight trace gravel.		612	
6A	23/24 96%	ss	1-3 3-6 N=6	15			10			610	
7A	24/24 100%	ss	8-9 12-12 N=21	15			12	Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		608	
8A	23/24 96%	ss	1-2 5-6 N=7	13			14	Gray (10YR5/1) with 10% yellowish brown (10YR5/4) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		606	
8B				18			16	Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		604	
9A	24/24 100%	ss	7-10 14-13 N=24	19							
9B				19			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		602	
10A	20/24 83%	ss	1-3 3-3 N=6	26				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
11A	22/24		1-4	21			20	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G63
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	92%	ss	4-3 N=8					Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							22	*[Continued from previous page]*		598	
12A	24/24 100%	ss	4-5 5-6 N=10	22							
							24			596	
13A	19/24 79%	ss	1-2 4-5 N=6	21							
							26	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 7-7 N=14	20							
							28			592	
15A	24/24 100%	ss	1-2 3-4 N=5	20							
							30			590	
16A	20/24 83%	ss	woh-1 2-3 N=3	22				Yellowish brown (10YR5/4) with 15% gray (10YR5/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							32			588	
17A	20/24 83%	ss	3-4 6-6 N=10	17							
17B				16				Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
							34			586	
18A	23/24 96%	ss	3-8 17-15 N=25	11				Dark gray (N4/1), slightly moist, hard, clayey SILT with trace sand and gravel.			
							36			584	
19A	23/24 96%	ss	10-18 25-9 N=43	11				Dark gray (N4/1), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.			
19B				26				Dark gray (N4/1), very moist, firm, SILT, trace organic material.			
							38			582	
20A	16/24 67%	ss	9-10 13-15 N=23	19				Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.			
							40	**End of Boring = 40.0 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G63~~
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	3-3 3-6 N=6	21			0			620	
2A	24/24 100%	ss	2-3 4-5 N=7	22			2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR4/6) and 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		618	
3A	22/24 92%	ss	3-3 4-6 N=7	18			4			616	
4A	24/24 100%	ss	9-9 10-11 N=19	17			6	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		614	
5A	24/24 100%	ss	1-3 4-5 N=7	13			8	FILL - Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, soft, friable, clayey SILT with trace sand and slight trace gravel.		612	
6A	23/24 96%	ss	1-3 3-6 N=6	15			10			610	
7A	24/24 100%	ss	8-9 12-12 N=21	15			12	Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		608	
8A	23/24 96%	ss	1-2 5-6 N=7	13			14	Gray (10YR5/1) with 10% yellowish brown (10YR5/4) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		606	
8B				18			16	Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		604	
9A	24/24 100%	ss	7-10 14-13 N=24	19							
9B				19			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		602	
10A	20/24 83%	ss	1-3 3-3 N=6	26				Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
11A	22/24		1-4	21			20	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/2/2009
Finish: 2/2/2009
WEATHER: cold, sunny, windy, hi-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G63
Well ID: G63S
Surface Elev: 620.12 ft. MSL
Completion: 40.00 ft. BGS
Station: 15,924.41N
998.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	92%	ss	4-3 N=8					Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							22	*[Continued from previous page]*		598	
12A	24/24 100%	ss	4-5 5-6 N=10	22							
							24			596	
13A	19/24 79%	ss	1-2 4-5 N=6	21							
							26	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 7-7 N=14	20							
							28			592	
15A	24/24 100%	ss	1-2 3-4 N=5	20							
							30			590	
16A	20/24 83%	ss	woh-1 2-3 N=3	22				Yellowish brown (10YR5/4) with 15% gray (10YR5/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.			
							32			588	
17A	20/24 83%	ss	3-4 6-6 N=10	17							
17B				16				Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
							34			586	
18A	23/24 96%	ss	3-8 17-15 N=25	11				Dark gray (N4/1), slightly moist, hard, clayey SILT with trace sand and gravel.			
							36			584	
19A	23/24 96%	ss	10-18 25-9 N=43	11				Dark gray (N4/1), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.			
19B				26							
							38	Dark gray (N4/1), very moist, firm, SILT, trace organic material.		582	
20A	16/24 67%	ss	9-10 13-15 N=23	19				Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.			
							40	**End of Boring = 40.0 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G64a~~
Well ID: G64L
Surface Elev: 620.02 ft. MSL
Completion: 27.95 ft. BGS
Station: 16,069.29N
995.70E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		620	
							6	Gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		614	
							8	Yellowish brown (10YR5/4) with 10% gray (10YR6/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		612	
							12	Yellowish brown (10YR5/4) with 10% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		608	
							14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
							18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
							20	Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	

NOTE(S): See G64S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G64a
Well ID: G64L
Surface Elev: 620.02 ft. MSL
Completion: 27.95 ft. BGS
Station: 16,069.29N
995.70E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks
								Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT. *[Continued from previous page]*	
							22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.	598
							24	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.	596
							26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with sand and slight trace gravel.	594
								End of Boring = 27.95 ft bgs	

NOTE(S): See G64S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G64~~
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	24-14 10-6 N=24	24			2	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	4-6 8-9 N=14	17			4			616	
3A	23/24 96%	ss	5-7 5-7 N=12	15			6			614	
4A	22/24 92%	ss	7-8 10-13 N=18	13			8	Gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		612	
5A	24/24 100%	ss	3-5 7-7 N=12	19			10	Yellowish brown (10YR5/4) with 10% gray (10YR6/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		610	
6A	22/24 92%	ss	3-3 5-8 N=8	24			12	Yellowish brown (10YR5/4) with 10% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		608	
7A 7B	22/24 92%	ss	8-8 6-7 N=14	25 25			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
8A	22/24 92%	ss	1-5 4-5 N=9	22			16			604	
9A	24/24 100%	ss	8-5 4-5 N=9	25			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	20/24 83%	ss	1-1 3-4 N=4	24			20	Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
11A	22/24		0-2	24							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G64
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	92%	ss	4-4 N=6	25			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		598	
12A	24/24 100%	ss	5-6 6-6 N=12	21			24	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		596	
13A	22/24 92%	ss	1-1 4-7 N=5	23			26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 8-6 N=15	20			28	Greenish gray (10GY6/1) with 10% olive (5Y5/3) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	24/24 100%	ss	1-2 2-3 N=4	18			30	Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		590	
16A	17/24 71%	ss	woh-2 4-6 N=6	17			32	Gray (N5/1), wet, medium dense, silty, very fine- to fine-grained SAND.		588	
17A				17			34	Gray (N5/1), very moist, firm, clayey SILT.		586	
17B	24/24 100%	ss	6-8 12-13 N=20	13			36	Gray (N5/1), wet, dense, silty, fine- to coarse-grained SAND with slight trace gravel.		584	
18A	19/24 79%	ss	7-8 9-13 N=17	14			38	Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		582	
19A				13			40	**End of Boring = 40.0 ft bgs**			
19B	24/24 100%	ss	7-10 12-13 N=22	22							
19C				33							
20A	20/24 83%	ss	3-6 10-14 N=16	14							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G64~~
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	24-14 10-6 N=24	24			2	FILL - Yellowish brown (10YR5/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		618	
2A	24/24 100%	ss	4-6 8-9 N=14	17			4			616	
3A	23/24 96%	ss	5-7 5-7 N=12	15			6	Gray (10YR5/1) mottles, moist, firm, clayey SILT with trace sand and slight trace gravel.		614	
4A	22/24 92%	ss	7-8 10-13 N=18	13			8	Yellowish brown (10YR5/4) with 10% gray (10YR6/1), moist, firm, clayey SILT with trace sand and slight trace gravel.		612	
5A	24/24 100%	ss	3-5 7-7 N=12	19			10			610	
6A	22/24 92%	ss	3-3 5-8 N=8	24			12	Yellowish brown (10YR5/4) with 10% gray (10YR6/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		608	
7A 7B	22/24 92%	ss	8-8 6-7 N=14	25 25			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
8A	22/24 92%	ss	1-5 4-5 N=9	22			16			604	
9A	24/24 100%	ss	8-5 4-5 N=9	25			18	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
10A	20/24 83%	ss	1-1 3-4 N=4	24			20	Dark gray (10YR4/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
11A	22/24		0-2	24							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/22/2009
Finish: 1/22/2009
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G64
Well ID: G64S
Surface Elev: 620.02 ft. MSL
Completion: 40.00 ft. BGS
Station: 16,064.64N
994.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 36.60 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	92%	ss	4-4 N=6	25			22	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY.		598	
12A	24/24 100%	ss	5-6 6-6 N=12	21			24	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		596	
13A	22/24 92%	ss	1-1 4-7 N=5	23			26	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with sand and slight trace gravel.		594	
14A	24/24 100%	ss	5-7 8-6 N=15	20			28	Greenish gray (10GY6/1) with 10% olive (5Y5/3) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		592	
15A	24/24 100%	ss	1-2 2-3 N=4	18			30	Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		590	
16A	17/24 71%	ss	woh-2 4-6 N=6	17			32	Gray (N5/1), wet, medium dense, silty, very fine- to fine-grained SAND.		588	
17A				17			34	Gray (N5/1), very moist, firm, clayey SILT.		586	
17B	24/24 100%	ss	6-8 12-13 N=20	13			36	Gray (N5/1), wet, dense, silty, fine- to coarse-grained SAND with slight trace gravel.		584	
18A	19/24 79%	ss	7-8 9-13 N=17	14			38	Greenish gray (10Y5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		582	
19A				13			40	**End of Boring = 40.0 ft bgs**			
19B	24/24 100%	ss	7-10 12-13 N=22	22							
19C				33							
20A	20/24 83%	ss	3-6 10-14 N=16	14							

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger - blind drilled within 10 ft of BG65
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG65b~~
Well ID: G65L
Surface Elev: 610.1 ft. MSL
Completion: 22.5 ft. BGS
Station: 13,986.12N
919.86E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 22.31 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) *% Recovery*	SAMPLE Type	TESTING *Blows / 6 in* N - Value **RQD**	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
							1	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand			
							2	Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand		608	
							4	Brown yellow (10YR6/6), moist, clayey SILT, trace sand		606	
							6	Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT		604	
							8	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand		602	
							10	Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand		600	
							12	Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel		598	
							14	Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel		596	
							16			594	
							18			592	
							20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger - blind drilled within 10 ft of BG65
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65b
Well ID: G65L
Surface Elev: 610.1 ft. MSL
Completion: 22.5 ft. BGS
Station: 13,986.12N
919.86E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 22.31 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
								Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
								Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND			
							▼ 22	Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel		588	
								Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
								End of Boring = 22.45 ft. BGS			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	ss	4-4 6-6 N=10	23			0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
1B				22		2.72 BSh	2	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand		608	
	24/24 100%	ss	6-6 8-10 N=14					Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
2A				19		4.15 Sh	4			606	
	20/24 83%	ss	4-4 7-7 N=11					Brown yellow (10YR6/6), moist, clayey SILT, trace sand			
3A				17		2.62 Sh	6			604	
	22/24 92%	ss	4-8 6-8 N=14								
4A											
4B				11			8			602	
	17/24 71%	ss	3-5 6-8 N=11					Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT			
5A				9			10			600	
	24/24 100%	ss	3-5 7-6 N=12								
6A				11						598	
7A				13			12				
	24/24 100%	ss	6-9 9-10 N=18								
7B				17			14	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand		596	
	17/24 71%	ss	2-3 5-6 N=8								
8A				18			16			594	
9A	21/24 88%	ss	5-8 10-10 N=18	17				Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand			
9B				17			18			592	
10A				20				Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
10B	19/24 79%	ss	1-3 4-7 N=7	18				Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel			
10C				22		1.44	20			590	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A				21		*Sh* 1.16 *BSh*		Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
	20/24 *83%*	ss	*4-4* *3-3* N=7					Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
11B											
11C				16			22	Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND		588	
								Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel			
12A	19/24 *79%*	ss	*3-5* *4-43* N=9	26				Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
12B				26			24			586	
	24/24 *100%*	ss	*1-3* *5-10* N=8					Yellow brown (10YR5/6) with 50% light brown gray (10YR6/2) mottles, moist, very silty CLAY, trace sand and gravel			
13A				19			26			584	
								Gray (10YR6/1) with 5% yellow brown (10YR5/4) mottles, moist, clayey SILT, trace sand and gravel			
14A	20/24 *83%*	ss	*10-8* *7-6* N=15	19			▼	Gray (10YR6/1) with 25% yellow brown (10YR5/4) mottles, wet, sandy SILT, trace gravel			
14B				14							
14C				22		1.09	28	Gray brown (10YR5/2), very moist, clayey SILT, trace sand		582	
15A				25		*B*					
								Yellow brown (10YR5/8), very moist to wet, fine to coarse SAND, trace gravel			
15B	24/24 *100%*	ss	*7-12* *11-17* N=23	21				Dark yellow brown (10YR4/6) with 40% yellow brown (10YR5/6) mottles, wet, sandy SILT, trace gravel			
15C				13							
15D				11			30	Gray brown (10YR5/2) with 40% yellow brown (10YR5/6) mottles, moist, very silty CLAY, trace sand and gravel		580	
16A				13							
								Dark yellow brown (10YR4/6) with 15% pale brown (10YR6/3) mottles, moist, very silty CLAY, little sand, trace gravel			
	20/24 *83%*	ss	*2-10* *9-14* N=19								
16B				12		5.82 *BSh*		Green gray (10Y5/1), moist, silty CLAY, trace sand and gravel		578	
	24/24 *100%*	ss	*11-15* *16-20* N=31				32				
17A				12		6.40 *Bh*				576	
	24/24 *100%*	ss	*7-16* *24-35* N=40				34	Gray (N5/1) with 30% gray brown (10YR5/2) mottles, moist, silty CLAY, little sand and gravel			
18A				11		7.62 *Sh*				574	
	24/24 *100%*	ss	*43-72* *75-97* N=147				36				
19A				10						572	
19B				11			38	Gray (N5), wet, fine to medium SAND			
	22/24 *92%*	ss	*11-27* *25-25* N=52					Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
20A				13		5.24	40			570	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh					
	24/24 *100%*	ss	*4-14* *17-24* N=31					Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*			
21A				10		10.86 *BSh*					
21B				11		6.98 *Sh*	42	Very dark green (10Y3/1) with 25% gray brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand and gravel		568	
22A				24		2.33 *Sh*		Green (5GY) with 10% gray brown (10YR4/3) mottles, moist, silty CLAY, trace sand and gravel			
22B	24/24 *100%*	ss	*27-41* *77-109* N=118	18				Dark green gray (10GY4/1), moist, silty CLAY, trace sand			
22C				14				Green (10Y5/1), wet, fine to medium SAND		566	
22D				11			44	CHERT			

End of Boring = 44.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger - blind drilled within 5 ft of BG65
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG65a~~
Well ID: G65S
Surface Elev: 609.9 ft. MSL
Completion: 32.7 ft. BGS
Station: 13,985.08N
914.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 25.28 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
							1	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand			
							2			608	
							3	Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
							4			606	
							5	Brown yellow (10YR6/6), moist, clayey SILT, trace sand			
							6			604	
							7				
							8			602	
							9	Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT			
							10			600	
							11				
							12			598	
							13	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand			
							14			596	
							15				
							16			594	
							17	Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand			
							18			592	
							19	Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
							20	Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel		590	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/15/2008
Finish: 1/15/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger - blind drilled within 5 ft of BG65
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65a
Well ID: G65S
Surface Elev: 609.9 ft. MSL
Completion: 32.7 ft. BGS
Station: 13,985.08N
914.07E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ = 25.28 - 1/30/2008
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
								Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
							22	Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND		588	
								Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel			
								Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
							24	Yellow brown (10YR5/6) with 50% light brown gray (10YR6/2) mottles, moist, very silty CLAY, trace sand and gravel		586	
								▼			
							26	Gray (10YR6/1) with 5% yellow brown (10YR5/4) mottles, moist, clayey SILT, trace sand and gravel		584	
								▼ Gray (10YR6/1) with 25% yellow brown (10YR5/4) mottles, wet, sandy SILT, trace gravel			
							28	Gray brown (10YR5/2), very moist, clayey SILT, trace sand		582	
								Yellow brown (10YR5/8), very moist to wet, fine to coarse SAND, trace gravel			
								Dark yellow brown (10YR4/6) with 40% yellow brown (10YR5/6) mottles, wet, sandy SILT, trace gravel			
							30	Gray brown (10YR5/2) with 40% yellow brown (10YR5/6) mottles, moist, very silty CLAY, trace sand and gravel		580	
								Dark yellow brown (10YR4/6) with 15% pale brown (10YR6/3) mottles, moist, very silty CLAY, little sand, trace gravel			
								Green gray (10Y5/1), moist, silty CLAY, trace sand and gravel			
							32	Gray (N5/1) with 30% gray brown (10YR5/2) mottles, moist, silty CLAY, little sand and gravel		578	
								End of Boring = 32.70 ft. BGS			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: Start: 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 *100%*	ss	*4-4* *6-6* N=10	23			0	Dark yellow brown (10YR4/4), slightly moist, silty CLAY, trace sand			
1B				22		2.72 *BSh*	2	Dark yellow brown (10YR4/6), moist, silty CLAY, trace sand		608	
	24/24 *100%*	ss	*6-6* *8-10* N=14					Yellow brown (10YR5/6) with 30% yellow brown (10YR5/4) mottles, moist, silty CLAY, trace sand			
2A				19		4.15 *Sh*	4			606	
	20/24 *83%*	ss	*4-4* *7-7* N=11					Brown yellow (10YR6/6), moist, clayey SILT, trace sand			
3A				17		2.62 *Sh*	6			604	
	22/24 *92%*	ss	*4-8* *6-8* N=14								
4A											
4B				11			8			602	
	17/24 *71%*	ss	*3-5* *6-8* N=11					Light gray (10YR7/2) with 5% brown yellow (10YR6/8) mottles, moist, sandy SILT			
5A				9			10			600	
	24/24 *100%*	ss	*3-5* *7-6* N=12								
6A				11							
7A				13			12			598	
	24/24 *100%*	ss	*6-9* *9-10* N=18								
7B				17			14	Brown (10YR5/3) with 40% brown yellow (10YR5/4) mottles, moist, clayey SILT, trace sand		596	
	17/24 *71%*	ss	*2-3* *5-6* N=8								
8A				18			16			594	
9A	21/24 *88%*	ss	*5-8* *10-10* N=18	17				Yellow brown (10YR5/8) with 35% brown (10YR5/3) and 10% very dark brown (10YR2/1) mottles, moist, very silty CLAY, trace sand			
9B				17			18			592	
10A				20				Black (10YR2/1) with 40% brown yellow (10YR6/6) and 5% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
10B	19/24 *79%*	ss	*1-3* *4-7* N=7	18				Dark yellow brown (10YR4/6) with 30% brown yellow (10YR6/6) and 5% black (10YR2/1) mottles, moist, sandy CLAY, trace gravel			
10C				22		1.44	20			590	

NOTE(S):

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A				21		*Sh* 1.16 *BSh*		Brown (10YR5/3) with 45% dark yellow brown (10YR4/6) mottles, moist, sandy CLAY, trace gravel			
	20/24 *83%*	ss	*4-4* *3-3* N=7					Gray brown (10YR5/2) with 30% yellow brown (10YR5/6) mottles, moist, silty CLAY, trace sand and gravel			
11B											
11C				16			22	Dark yellow (10YR4/6) with 10% brown (10YR3/4) mottles, moist, silty fine to medium SAND		588	
								Yellow brown (10YR5/6) with30% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand and gravel			
12A	19/24 *79%*	ss	*3-5* *4-43* N=9	26				Yellow brown (10YR5/8) with 20% gray (10YR6/1) and 15% dark brown (10YR3/3) mottles, very moist, very silty CLAY, trace sand and gravel			
12B				26			24			586	
	24/24 *100%*	ss	*1-3* *5-10* N=8					Yellow brown (10YR5/6) with 50% light brown gray (10YR6/2) mottles, moist, very silty CLAY, trace sand and gravel			
13A				19			26			584	
								Gray (10YR6/1) with 5% yellow brown (10YR5/4) mottles, moist, clayey SILT, trace sand and gravel			
14A	20/24 *83%*	ss	*10-8* *7-6* N=15	19			▼	Gray (10YR6/1) with 25% yellow brown (10YR5/4) mottles, wet, sandy SILT, trace gravel			
14B				14							
14C				22		1.09	28	Gray brown (10YR5/2), very moist, clayey SILT, trace sand		582	
15A				25		*B*					
								Yellow brown (10YR5/8), very moist to wet, fine to coarse SAND, trace gravel			
15B	24/24 *100%*	ss	*7-12* *11-17* N=23	21				Dark yellow brown (10YR4/6) with 40% yellow brown (10YR5/6) mottles, wet, sandy SILT, trace gravel			
15C				13							
15D				11			30	Gray brown (10YR5/2) with 40% yellow brown (10YR5/6) mottles, moist, very silty CLAY, trace sand and gravel		580	
16A				13							
								Dark yellow brown (10YR4/6) with 15% pale brown (10YR6/3) mottles, moist, very silty CLAY, little sand, trace gravel			
	20/24 *83%*	ss	*2-10* *9-14* N=19								
16B				12		5.82 *BSh*		Green gray (10Y5/1), moist, silty CLAY, trace sand and gravel		578	
	24/24 *100%*	ss	*11-15* *16-20* N=31				32				
17A				12		6.40 *Bh*				576	
	24/24 *100%*	ss	*7-16* *24-35* N=40				34	Gray (N5/1) with 30% gray brown (10YR5/2) mottles, moist, silty CLAY, little sand and gravel			
18A				11		7.62 *Sh*				574	
	24/24 *100%*	ss	*43-72* *75-97* N=147				36				
19A				10						572	
19B				11			38	Gray (N5), wet, fine to medium SAND			
	22/24 *92%*	ss	*11-27* *25-25* N=52					Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel			
20A				13		5.24	40			570	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Gypsum Managment Facility
Location: Canton, Fulton Co., Illinois
Project: 03S5010
DATES: **Start:** 1/14/2008
Finish: 1/14/2008
WEATHER: Overcast, windy, cold

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: BG65
Well ID: hole abandoned
Surface Elev: 609.7 ft. MSL
Completion: 44.0 ft. BGS
Station: 13,982.80N
909.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.80 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
						Sh					
	24/24 *100%*	ss	*4-14* *17-24* N=31					Gray (N5) with 10% gray brown (10YR5/2) mottles, moist, silty CLAY, trace sand and gravel *[Continued from previous page]*			
21A				10		10.86 *BSh*					
21B				11		6.98 *Sh*	42	Very dark green (10Y3/1) with 25% gray brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand and gravel		568	
22A				24		2.33 *Sh*		Green (5GY) with 10% gray brown (10YR4/3) mottles, moist, silty CLAY, trace sand and gravel			
22B	24/24 *100%*	ss	*27-41* *77-109* N=118	18				Dark green gray (10GY4/1), moist, silty CLAY, trace sand			
22C				14				Green (10Y5/1), wet, fine to medium SAND		566	
22D				11			44	CHERT			

End of Boring = 44.0 ft. BGS

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G66a~~
Well ID: G66L
Surface Elev: 614.86 ft. MSL
Completion: 19.74 ft. BGS
Station: 14,240.49N
965.72E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		614	
							2	FILL - Grayish brown (10YR5/2) with 10% dark yellowish brown (10YR4/6) and 10% yellowish brown (10YR5/4) mottles, slightly moist, hard, clayey SILT with slight trace sand.		612	
							4	FILL - Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT, slight trace roots.		610	
							6	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		608	
							8	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, firm, clayey SILT.		606	
							10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT.		604	
							12	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		602	
							14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		600	
							16			598	
							18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		596	
								End of Boring = 19.74 ft bgs			

NOTE(S): See G66S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G66~~
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	30-30 20-10 N=50	18.4			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		614	
2A				20.5			2	FILL - Grayish brown (10YR5/2) with 10% dark yellowish brown (10YR4/6) and 10% yellowish brown (10YR5/4) mottles, slightly moist, hard, clayey SILT with slight trace sand.			
2B	24/24 100%	SS	10-13 15-22 N=28	16.3			4	FILL - Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT, slight trace roots.		612	
3A	20/24 83%	SS	4-8 8-7 N=16	17.7			6	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		610	
4A	24/24 100%	SS	10-12 12-9 N=24	19.5			8	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, firm, clayey SILT.		608	
5A	19/24 79%	SS	3-6 8-10 N=14	22.8			10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT.		606	
6A	19/24 79%	SS	1-3 3-5 N=6	26.1			12	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		604	
7A	22/24 92%	SS	3-4 3-4 N=7	28.4			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 4-4 N=6	23.4			16			600	
9A	20/24 83%	SS	3-4 5-6 N=9	23.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		598	
10A	19/24 79%	SS	1-3 4-3 N=7	24.6			20			596	
11A	19/24		2-2	25.9						594	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G66
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	79%	SS	3-4 N=5	23.9			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		592	
12A	23/24 96%	SS	3-3 4-5 N=7	25.2			24				
13A	22/24 92%	SS	woh-2 2-3 N=4	22.7			26	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		590	
14A	23/24 96%	SS	4-7 7-8 N=14	18.8			28	Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		588	
15A	18/24 75%	SS	1-1 3-4 N=4	21.3				Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand.		586	
16A	19/24 79%	SS	1-3 4-5 N=7	17.2			30	Greenish gray (5GY6/1), moist, soft, clayey SILT with slight trace sand and gravel.		584	
17A	24/24 100%	SS	6-8 9-9 N=17	13.9			32	Dark gray (N4/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
17B				32.2			▼ 34	Dark gray (N4/1), very moist, firm, clayey SILT with slight trace sand.			
18A	22/24 92%	SS	4-10 16-13 N=26	15.6				Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand.		580	
19A	24/24 100%	SS	12-12 13-22 N=25	11.8			36	Dark gray (N4/1), moist, firm, clayey SILT with sand and slight trace gravel.		578	
20A	19/24 79%	SS	18-28 36-48 N=64	11.2			38	Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	Thin(<0.1'), wet, fine- to medium-grained sand seams near 36.0', 38.0', and 39.5'.
							40	**End of Boring = 40.09 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G66~~
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	30-30 20-10 N=50	18.4			0	FILL - Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		614	
2A				20.5			2	FILL - Grayish brown (10YR5/2) with 10% dark yellowish brown (10YR4/6) and 10% yellowish brown (10YR5/4) mottles, slightly moist, hard, clayey SILT with slight trace sand.			
2B	24/24 100%	SS	10-13 15-22 N=28	16.3			4	FILL - Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT, slight trace roots.		612	
3A	20/24 83%	SS	4-8 8-7 N=16	17.7			6	FILL - Yellowish brown (10YR5/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		610	
4A	24/24 100%	SS	10-12 12-9 N=24	19.5			8	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, firm, clayey SILT.		608	
5A	19/24 79%	SS	3-6 8-10 N=14	22.8			10	Yellowish brown (10YR5/4) with 20% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, moist, soft, clayey SILT.		606	
6A	19/24 79%	SS	1-3 3-5 N=6	26.1			12	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		604	
7A	22/24 92%	SS	3-4 3-4 N=7	28.4			14	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 4-4 N=6	23.4			16			600	
9A	20/24 83%	SS	3-4 5-6 N=9	23.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		598	
10A	19/24 79%	SS	1-3 4-3 N=7	24.6			20			596	
11A	19/24		2-2	25.9						594	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/4/2009
Finish: 2/4/2009
WEATHER: very cold, sunny, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G66
Well ID: G66S
Surface Elev: 614.86 ft. MSL
Completion: 40.09 ft. BGS
Station: 14,236.19N
964.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 34.20 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11B	79%	SS	3-4 N=5	23.9			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		592	
12A	23/24 96%	SS	3-3 4-5 N=7	25.2			24				
13A	22/24 92%	SS	woh-2 2-3 N=4	22.7			26	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		590	
14A	23/24 96%	SS	4-7 7-8 N=14	18.8			28	Greenish gray (5GY5/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		588	
15A	18/24 75%	SS	1-1 3-4 N=4	21.3				Greenish gray (5GY5/1), moist, soft, silty CLAY with trace sand.		586	
16A	19/24 79%	SS	1-3 4-5 N=7	17.2			30	Greenish gray (5GY6/1), moist, soft, clayey SILT with slight trace sand and gravel.		584	
17A	24/24 100%	SS	6-8 9-9 N=17	13.9			32	Dark gray (N4/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		582	
17B				32.2			▼ 34	Dark gray (N4/1), very moist, firm, clayey SILT with slight trace sand.			
18A	22/24 92%	SS	4-10 16-13 N=26	15.6				Dark gray (N4/1), moist, firm, clayey SILT with slight trace sand.		580	
19A	24/24 100%	SS	12-12 13-22 N=25	11.8			36	Dark gray (N4/1), moist, firm, clayey SILT with sand and slight trace gravel.		578	
20A	19/24 79%	SS	18-28 36-48 N=64	11.2			38	Dark gray (N4/1), slightly moist, hard, clayey SILT with slight trace sand and gravel.		576	Thin(<0.1'), wet, fine- to medium-grained sand seams near 36.0', 38.0', and 39.5'.
							40	**End of Boring = 40.09 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G67a~~
Well ID: G67L
Surface Elev: 614.64 ft. MSL
Completion: 17.18 ft. BGS
Station: 14,527.50N
928.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
							2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
							4	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		610	
							6	Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.		608	
							8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
							10	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
							12	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		602	
							14	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		600	
							16			598	

End of Boring = 17.18 ft bgs

NOTE(S): See G67S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G67~~
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	24-18 14-18 N=32	18.7			0	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	8-13 11-14 N=24	16.6			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
3A	24/24 100%	SS	4-4 7-8 N=11	18.0			4	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		610	
4A	24/24 100%	SS	8-8 14-15 N=22	25.8			6	Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.		608	
5A	19/24 79%	SS	1-3 3-3 N=6	25.5			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
6A	22/24 92%	SS	1-2 4-4 N=6	21.9			10			604	
7A	22/24 92%	SS	6-6 6-5 N=12	21.2			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 2-2 N=4	22.2			14	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		600	
9A	24/24 100%	SS	3-3 4-3 N=7	22.9			16	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
9B				25.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		596	
10A	19/24 79%	SS	1-2 1-2 N=3	25.4			20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G67
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	SS	1-2 2-2 N=4	25.5			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY. *[Continued from previous page]*		594	
12A	22/24 92%	SS	2-3 3-4 N=6	27.8			24	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.		592	
13A	24/24 100%	SS	woh-1 2-2 N=3	23.5			26	Grayish brown (10YR5/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, very soft, silty CLAY with trace sand.		590	
14A	16/24 67%	SS	2-2 3-3 N=5	19.2			28	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		588	
15A	17/24 71%	SS	woh-1 1-3 N=2	15.8			30			586	
16A	18/24 75%	SS	3-4 7-15 N=11	17.6			32	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
16B				12.3							
17A	24/24 100%	SS	14-21 25-22 N=46	11.6			34	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		582	
17B				13.6				Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.			
18A	18/24 75%	SS	1-8 12-11 N=20	11.9			36	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		580	
19A	22/24 92%	SS	14-22 23-25 N=45	12.5			38	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		578	

End of Boring = 38.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~G67~~
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	24-18 14-18 N=32	18.7			0	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	8-13 11-14 N=24	16.6			2	FILL - Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
3A	24/24 100%	SS	4-4 7-8 N=11	18.0			4	FILL - Yellowish brown (10YR5/4) with 10% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel, trace roots.		610	
4A	24/24 100%	SS	8-8 14-15 N=22	25.8			6	Gray (10YR5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.		608	
5A	19/24 79%	SS	1-3 3-3 N=6	25.5			8	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		606	
6A	22/24 92%	SS	1-2 4-4 N=6	21.9			10			604	
7A	22/24 92%	SS	6-6 6-5 N=12	21.2			12	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
8A	16/24 67%	SS	1-2 2-2 N=4	22.2			14	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		600	
9A	24/24 100%	SS	3-3 4-3 N=7	22.9			16	Gray (10YR6/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		598	
9B				25.5			18	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY.		596	
10A	19/24 79%	SS	1-2 1-2 N=3	25.4			20				

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/3/2009
Finish: 2/3/2009
WEATHER: very cold, partly cloudy, windy, lo-teen's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G67
Well ID: G67S
Surface Elev: 614.64 ft. MSL
Completion: 38.00 ft. BGS
Station: 14,530.27N
925.18E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 33.50 - during drilling
▼ = 31.71 - 02/03/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	SS	1-2 2-2 N=4	25.5			22	Gray (10YR5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY. *[Continued from previous page]*		594	
12A	22/24 92%	SS	2-3 3-4 N=6	27.8			24	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand.		592	
13A	24/24 100%	SS	woh-1 2-2 N=3	23.5			26	Grayish brown (10YR5/2) with 15% dark yellowish brown (10YR4/6) mottles, moist, very soft, silty CLAY with trace sand.		590	
14A	16/24 67%	SS	2-2 3-3 N=5	19.2			28	Greenish gray (5GY5/1), moist, very soft, silty CLAY with trace sand and slight trace gravel.		588	
15A	17/24 71%	SS	woh-1 1-3 N=2	15.8			30			586	
16A	18/24 75%	SS	3-4 7-15 N=11	17.6			32	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	
16B				12.3							
17A	24/24 100%	SS	14-21 25-22 N=46	11.6			34	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		582	
17B				13.6				Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.			
18A	18/24 75%	SS	1-8 12-11 N=20	11.9			36	Yellowish brown (10YR5/4), wet, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		580	
19A	22/24 92%	SS	14-22 23-25 N=45	12.5			38	Gray (N5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		578	

End of Boring = 38.0 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/18/2008
Finish: 11/18/2008
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: ~~G70a~~
Well ID: G70L
Surface Elev: 614.97 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,371.22N
156.88E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 27.00 - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0			614	
							2	FILL - Yellowish brown (10YR5/4), dry, firm, clayey SILT.			
										612	
							4				
								FILL - Brown (10YR5/3), dry, firm, silty CLAY.		610	
							6				
								FILL - Dark grayish brown (10YR4/2), slightly moist, firm, silty CLAY.		608	
								FILL - Brown (10YR5/3), slightly moist, firm, silty CLAY.			
							8				
										606	
								FILL - Yellowish brown (10YR5/6), moist, hard, silty CLAY, trace roots.			
							10			604	
							12				
								FILL - Yellowish brown (10YR5/6), very moist, hard, silty CLAY.		602	
							14				
										600	
							16	FILL - Dark yellowish brown (10YR3/6), very moist, hard, silty CLAY.			
										598	
							18	FILL - Yellowish brown (10YR5/6), very moist, hard, silty CLAY.			
										596	
								Brown (7.5YR4/4) with 50% strong brown (7.5YR4/6) mottles, moist, hard, silty CLAY.			
							20				

NOTE(S): See G70S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/18/2008
Finish: 11/18/2008
WEATHER: cold, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: .

BOREHOLE ID: G70a
Well ID: G70L
Surface Elev: 614.97 ft. MSL
Completion: 30.00 ft. BGS
Station: 14,371.22N
156.88E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 27.00 - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Brown (7.5YR4/4) with 50% strong brown (7.5YR4/6) mottles, moist, hard, silty CLAY. *[Continued from previous page]*			
							22	Brown (7.5YR4/3), moist, hard, silty CLAY with trace sand.		594	
							24	Brown (10YR5/3) with 50% dark yellowish brown (10YR4/6) mottles, moist, hard, silty CLAY with trace sand and slight trace gravel.		592	
							26	Dark yellowish brown (10YR4/4) with 30% grayish brown (10YR5/2) very moist to wet, soft, clayey SILT with trace sand and slight trace gravel.		590	
							▼			588	
							28	Yellowish brown (10YR5/4) with 50% pale brown (10YR6/3) mottles, very moist to wet, soft, clayey SILT with slight trace sand and gravel. *Silt content increases with depth.*		586	
							30	Yellowish brown (10YR5/4) with 20% light yellowish brown (10YR6/4) mottles, very moist, hard, clayey SILT with slight trace gravel.			
								End of Boring = 30.00 ft bgs			

NOTE(S): See G70S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G71a~~
Well ID: G71L
Surface Elev: 614.94 ft. MSL
Completion: 30.20 ft. BGS
Station: 14,106.39N
278.83E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/8), slightly moist, firm, clayey SILT with slight trace sand and gravel.		614	
							4	FILL - Yellowish brown (10YR5/8) with 20% gray (10YR6/1) mottles, moist, firm, silty CLAY with slight trace sand and gravel, trace roots.		610	
							8	Light yellowish brown (10YR6/4) with 30% brownish yellow (10YR6/8) mottles, moist, soft to friable, clayey SILT with slight trace sand.		606	
							12	Light gray (10YR7/1) with 20% yellowish brown (10YR5/8) mottles, slightly moist, friable, clayey SILT with slight trace sand.		602	
							16	Dark yellowish brown (10YR4/6), moist, friable, clayey SILT with slight trace sand.		598	
							18	Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		596	
							20				

NOTE(S): See G71S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G71a
Well ID: G71L
Surface Elev: 614.94 ft. MSL
Completion: 30.20 ft. BGS
Station: 14,106.39N
278.83E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, firm, clayey SILT with slight trace sand.		594	
							22	Yellowish brown (10YR5/8) with 25% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, moist, firm, silty CLAY with sand and slight trace gravel.		592	
							24	Brownish yellow (10YR6/6) with 20% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with trace sand and slight trace gravel.		590	
							26	Gray (10YR5/1) with 50% brownish yellow (10YR6/6) mottles, moist, soft, silty CLAY with sand and trace gravel.		588	
							28	Brownish yellow (10YR6/6) with 25% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.		586	
								Brownish yellow (10YR6/6), slightly moist, loose, silty, very fine- to medium-grained SAND with slight trace gravel.			
							30	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, friable, clayey SILT.			
								End of Boring = 30.20 ft bgs			

NOTE(S): See G71S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G71~~
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	6-9 9-5 N=18	15.5			0			614	
							2	FILL - Yellowish brown (10YR5/8), slightly moist, firm, clayey SILT with slight trace sand and gravel.			
2A	24/24 100%	SS	4-6 9-11 N=15	18.2						612	
							4				
3A	24/24 100%	SS	3-6 9-12 N=15	18.9				FILL - Yellowish brown (10YR5/8) with 20% gray (10YR6/1) mottles, moist, firm, silty CLAY with slight trace sand and gravel, trace roots.		610	
							6				
4A	24/24 100%	SS	10-15 17-13 N=32	18.4						608	
							8				
5A	24/24 100%	SS	2-4 6-7 N=10	17.0						606	
							10	Light yellowish brown (10YR6/4) with 30% brownish yellow (10YR6/8) mottles, moist, soft to friable, clayey SILT with slight trace sand.			
6A	20/24 83%	SS	1-4 5-6 N=9	9.0						604	
							12				
7A	24/24 100%	SS	7-10 12-12 N=22	8.0				Light gray (10YR7/1) with 20% yellowish brown (10YR5/8) mottles, slightly moist, friable, clayey SILT with slight trace sand.		602	
							14				
8A	24/24 100%	SS	3-5 6-7 N=11	10.3						600	
							16				
9A	24/24 100%	SS	6-8 10-9 N=18	15.4				Dark yellowish brown (10YR4/6), moist, friable, clayey SILT with slight trace sand.		598	
							18				
10A	24/24 100%	SS	2-4 6-6 N=10	15.8				Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		596	
							20	Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, firm, clayey SILT with slight		594	
	24/24		3-4								

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G71
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	100%	SS	6-9					trace sand.			
11A			N=10	18.0			22	Yellowish brown (10YR5/8) with 25% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, moist, firm, silty CLAY with sand and slight trace gravel.		592	
	24/24 100%	SS	6-13 15-14								
12A			N=28	20.6			24	Brownish yellow (10YR6/6) with 20% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with trace sand and slight trace gravel.		590	
	24/24 100%	SS	woh-2 4-6								
13A			N=6	18.0			26	Gray (10YR5/1) with 50% brownish yellow (10YR6/6) mottles, moist, soft, silty CLAY with sand and trace gravel.		588	
14A				17.8							
	24/24 100%	SS	6-16 14-16								
14B			N=30	11.5			28	Brownish yellow (10YR6/6) with 25% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.		586	
15A	24/24 100%	SS	2-12 14-50/5"	12.6				Brownish yellow (10YR6/6), slightly moist, loose, silty, very fine- to medium-grained SAND with slight trace gravel.			
			N=26				30	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, friable, clayey SILT.		584	
16A				13.5							
	24/24 100%	SS	3-14 10-11								
16B			N=24	13.3			32	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.		582	
	24/24 100%	SS	8-13 15-11								
17A			N=28	14.0			34				
	23/24 96%	SS	2-11 9-7				▼			580	
18A			N=20	13.0							
18B				28.0			36	Dark gray (10YR4/1), wet, soft, clayey SILT, trace wood fragments.		578	
	22/24 92%	SS	4-6 7-10								
19A			N=13	28.5			38	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.		576	
	24/24 100%	SS	10-13 15-26								
20A			N=28	12.0			40	**End of Boring = 40.00 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G71~~
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	6-9 9-5 N=18	15.5			0			614	
							2	FILL - Yellowish brown (10YR5/8), slightly moist, firm, clayey SILT with slight trace sand and gravel.			
2A	24/24 100%	SS	4-6 9-11 N=15	18.2						612	
							4				
3A	24/24 100%	SS	3-6 9-12 N=15	18.9						610	
							6	FILL - Yellowish brown (10YR5/8) with 20% gray (10YR6/1) mottles, moist, firm, silty CLAY with slight trace sand and gravel, trace roots.			
4A	24/24 100%	SS	10-15 17-13 N=32	18.4						608	
							8				
5A	24/24 100%	SS	2-4 6-7 N=10	17.0						606	
							10	Light yellowish brown (10YR6/4) with 30% brownish yellow (10YR6/8) mottles, moist, soft to friable, clayey SILT with slight trace sand.			
6A	20/24 83%	SS	1-4 5-6 N=9	9.0						604	
							12				
7A	24/24 100%	SS	7-10 12-12 N=22	8.0						602	
							14	Light gray (10YR7/1) with 20% yellowish brown (10YR5/8) mottles, slightly moist, friable, clayey SILT with slight trace sand.			
8A	24/24 100%	SS	3-5 6-7 N=11	10.3						600	
							16				
9A	24/24 100%	SS	6-8 10-9 N=18	15.4				Dark yellowish brown (10YR4/6), moist, friable, clayey SILT with slight trace sand.		598	
							18				
10A	24/24 100%	SS	2-4 6-6 N=10	15.8				Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		596	
							20	Dark yellowish brown (10YR4/4) with 30% very dark grayish brown (10YR3/2) and 10% yellowish brown (10YR5/8) mottles, moist, firm, clayey SILT with slight		594	
	24/24		3-4								

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 11/20/2008
Finish: 11/20/2008
WEATHER: cold, overcast, (30's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G71
Well ID: G71S
Surface Elev: 614.94 ft. MSL
Completion: 40.00 ft. BGS
Station: 14,110.54N
277.06E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	100%	SS	6-9					trace sand.			
11A			N=10	18.0			22	Yellowish brown (10YR5/8) with 25% very dark grayish brown (10YR3/2) and 10% gray (10YR5/1) mottles, moist, firm, silty CLAY with sand and slight trace gravel.		592	
	24/24 100%	SS	6-13 15-14								
12A			N=28	20.6			24	Brownish yellow (10YR6/6) with 20% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with trace sand and slight trace gravel.		590	
	24/24 100%	SS	woh-2 4-6								
13A			N=6	18.0			26	Gray (10YR5/1) with 50% brownish yellow (10YR6/6) mottles, moist, soft, silty CLAY with sand and trace gravel.		588	
14A				17.8							
	24/24 100%	SS	6-16 14-16								
14B			N=30	11.5			28	Brownish yellow (10YR6/6) with 25% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.		586	
15A	24/24 100%	SS	2-12 14-50/5"	12.6				Brownish yellow (10YR6/6), slightly moist, loose, silty, very fine- to medium-grained SAND with slight trace gravel.			
			N=26				30	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, friable, clayey SILT.		584	
16A				13.5							
	24/24 100%	SS	3-14 10-11								
16B			N=24	13.3			32	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.		582	
	24/24 100%	SS	8-13 15-11								
17A			N=28	14.0			34				
18A	23/24 96%	SS	2-11 9-7	13.0			▼			580	
			N=20				36	Dark gray (10YR4/1), wet, soft, clayey SILT, trace wood fragments.		578	
18B				28.0							
19A	22/24 92%	SS	4-6 7-10	28.5			38	Dark gray (10YR4/1), moist, firm, silty CLAY with sand and trace gravel.		576	
			N=13								
	24/24 100%	SS	10-13 15-26								
20A			N=28	12.0			40	**End of Boring = 40.00 ft bgs**			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72a~~
Well ID: G72L
Surface Elev: 615.01 ft. MSL
Completion: 24.79 ft. BGS
Station: 13,904.84N
509.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING					
Number	Recov / Total (in) % Recovery	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description
							0	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.
							6	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.
							8	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.
							12	Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.
							16	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.
							18	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.
							20	

Borehole Detail

Elevation ft. MSL: 614, 612, 610, 608, 606, 604, 602, 600, 598, 596

Remarks

NOTE(S): See G72S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72a
Well ID: G72L
Surface Elev: 615.01 ft. MSL
Completion: 24.79 ft. BGS
Station: 13,904.84N
509.93E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.	594	
							22	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.	592	
							24	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.		
								End of Boring = 24.79 ft bgs		

NOTE(S): See G72S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72~~
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	3-3 6-6 N=9	20.4			2	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.		614	
2A	24/24 100%	SS	3-5 6-6 N=11	18.3			4			612	
3A	24/24 100%	SS	3-5 6-9 N=11	15.7			6			610	
4A	24/24 100%	SS	10-14 16-16 N=30	21.3			8	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.		608	
5A	24/24 100%	SS	3-4 6-7 N=10	19.3			10			606	
6A	24/24 100%	SS	2-3 6-8 N=9	18.2			12	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.		604	
7A	20/24 83%	SS	5-7 12-13 N=19	9.2			14			602	
8A	24/24 100%	SS	1-3 4-6 N=7	11.1			16	Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		600	
9A	24/24 100%	SS	5-7 10-9 N=17	12.3			18	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.		598	
10A	24/24 100%	SS	1-3 4-7 N=7	17.5			20	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.		596	
	24/24		1-3					Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	100%	SS	4-8 N=7	16.6			22	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand. *[Continued from previous page]*			
12A	24/24 100%	SS	4-8 12-13 N=20	19.1			24	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		592	
13A	24/24 100%	SS	1-3 5-8 N=8	17.4			26	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.		590	
14A	24/24 100%	SS	5-6 8-8 N=14	21.2			28	Yellowish brown (10YR5/8) with 10% gray (10YR6/1) mottles, very moist, soft, silty CLAY with trace sand.		588	
15A	24/24 100%	SS	woh-1 2-3 N=3	26.5			30	Gray (10YR6/1) with 20% yellowish brown (10YR5/8) mottles, very moist to wet, very soft, silty CLAY with trace sand and slight trace gravel.		586	
16A	24/24 100%	SS	1-3 6-10 N=9	19.3				Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, wet, very soft, clayey SILT with some very fine-grained sand and slight trace gravel.		584	
16B				15.9			32	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
17A	20/24 83%	SS	5-10 13-11 N=23	24.9				Brownish yellow (10YR6/6), wet, soft, clayey SILT with trace very fine-grained sand.		582	
18A				27.8			34	Dark gray (10YR4/1), moist, firm, very silty CLAY with slight trace sand.			
18B	24/24 100%	SS	2-6 7-9 N=13	11.1				Dark gray (10YR4/1), moist, loose, SILT and very fine-grained SAND.		580	
19A	24/24 100%	SS	7-9 12-14 N=21	11.1			36	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		578	
20A	17/17 100%	SS	26-45 50/5"	9.4			38			576	

End of Boring = 39.40 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72~~
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	3-3 6-6 N=9	20.4			0			614	
2A	24/24 100%	SS	3-5 6-6 N=11	18.3			2	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.		612	
3A	24/24 100%	SS	3-5 6-9 N=11	15.7			4			610	
4A	24/24 100%	SS	10-14 16-16 N=30	21.3			6	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.		608	
5A	24/24 100%	SS	3-4 6-7 N=10	19.3			8			606	
6A	24/24 100%	SS	2-3 6-8 N=9	18.2			10	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.		604	
7A	20/24 83%	SS	5-7 12-13 N=19	9.2			12			602	
8A	24/24 100%	SS	1-3 4-6 N=7	11.1			14	Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		600	
9A	24/24 100%	SS	5-7 10-9 N=17	12.3			16			598	
10A	24/24 100%	SS	1-3 4-7 N=7	17.5			18	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.		596	
	24/24		1-3				20	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.			
								Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	100%	SS	4-8 N=7	16.6			22	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand. *[Continued from previous page]*			
12A	24/24 100%	SS	4-8 12-13 N=20	19.1			24	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		592	
13A	24/24 100%	SS	1-3 5-8 N=8	17.4			26	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.		590	
14A	24/24 100%	SS	5-6 8-8 N=14	21.2			28	Yellowish brown (10YR5/8) with 10% gray (10YR6/1) mottles, very moist, soft, silty CLAY with trace sand.		588	
15A	24/24 100%	SS	woh-1 2-3 N=3	26.5			30	Gray (10YR6/1) with 20% yellowish brown (10YR5/8) mottles, very moist to wet, very soft, silty CLAY with trace sand and slight trace gravel.		586	
16A	24/24 100%	SS	1-3 6-10 N=9	19.3				Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, wet, very soft, clayey SILT with some very fine-grained sand and slight trace gravel.		584	
16B				15.9			32	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
17A	20/24 83%	SS	5-10 13-11 N=23	24.9				Brownish yellow (10YR6/6), wet, soft, clayey SILT with trace very fine-grained sand.		582	
18A				27.8			34	Dark gray (10YR4/1), moist, firm, very silty CLAY with slight trace sand.			
18B	24/24 100%	SS	2-6 7-9 N=13	11.1				Dark gray (10YR4/1), moist, loose, SILT and very fine-grained SAND.		580	
19A	24/24 100%	SS	7-9 12-14 N=21	11.1			36	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		578	
20A	17/17 100%	SS	26-45 50/5"	9.4			38			576	

End of Boring = 39.40 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/6/2009
Finish: 2/6/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G73a
Well ID: G73L
Surface Elev: 614.64 ft. MSL
Completion: 34.76 ft. BGS
Station: 13,924.52N
799.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	FILL - Yellowish brown (10YR5/4) with 30% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		614	
							2	FILL - Dark yellowish brown (10YR4/4), slightly moist, firm, clayey SILT with slight trace sand and gravel.		612	
							4	FILL - Gray (10YR5/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		610	
							6	FILL - Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		608	
							8	FILL - Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, slightly moist, soft, clayey SILT with slight trace sand and gravel.		606	
							10	FILL - Dark yellowish brown (10YR4/4) with 5% gray (10YR6/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		604	
							12	FILL - Strong brown (7.5YR4/6), moist, firm, silty CLAY with slight trace sand, trace roots.		602	
							14	Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, moist, soft to friable, clayey SILT with slight trace sand.		600	
							16	Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) and 5% (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand, trace roots.		598	
							18	Brown (10YR4/3) with 5% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel.		596	
							20				

NOTE(S): See G73S Boring log for sample and testing data.

FIELD BORING LOG

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 2/6/2009
Finish: 2/6/2009
WEATHER: cool, sunny, lo-30's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G73a
Well ID: G73L
Surface Elev: 614.64 ft. MSL
Completion: 34.76 ft. BGS
Station: 13,924.52N
799.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ =
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22	Brown (10YR4/3) with 5% dark yellowish brown (10YR4/6) and 5% gray (10YR6/1) mottles, slightly moist, hard, clayey SILT with slight trace sand and gravel. *[Continued from previous page]*		594	
							24			592	
							26	Dark yellowish brown (10YR4/4) with 5% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with trace sand and slight trace gravel.		590	
								Dark gray (10YR4/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		588	
							28	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		586	
							30	Brown (10YR4/3) with 15% gray (10YR5/1) mottles, moist, firm, clayey SILT with slight trace sand and gravel.		584	
							32	Dark yellowish brown (10YR4/4) with 10% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		582	
								Dark yellowish brown (10YR4/4) with 30% gray (10YR6/1) mottles, very moist, soft, clayey SILT.			
							34	Gray (10YR6/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		580	
								Dark yellowish brown (10YR4/6) with 30% gray (10YR5/1) mottles, moist, soft, clayey SILT with slight trace sand and gravel.			
								End of Boring = 34.76 ft bgs			

NOTE(S): See G73S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01b~~
Well ID: P01L
Surface Elev: 622.00 ft. MSL
Completion: 20.35 ft. BGS
Station: 16,744.77N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 8.63 - 01/08/09
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.			
							2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
							4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
							6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
							8			614	
							▼				
							10	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		612	
							12			610	
							14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
							16			606	
							18	Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.		604	
							▼				
							20	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		602	
								Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.			
								End of Boring = 20.35 ft bgs			

NOTE(S): See P01I Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01~~
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	4-4 5-10 N=9	17.2			0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.		622	
1B				30.5							
2A	24/24 100%	SS	2-2 3-4 N=5	30.3			2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
2B				24.9							
3A	23/24 96%	SS	2-2 3-4 N=5	24.9			4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
4A	24/24 100%	SS	2-3 4-4 N=7	22.9			6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
5A	20/24 83%	SS	2-2 3-3 N=5	22.1			8			614	
6A	12/24 50%	SS	1-1 2-3 N=3	26.9			10 ▼	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		612	
7A	18/24 75%	SS	2-4 5-6 N=9	24.5			12			610	
7B				27.7			14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
8A	24/24 100%	SS	2-2 3-4 N=5	25.2							
8B				25.1			16			606	
9A	7/24 29%	SS	woh-woh woh-woh	24.9			18 ▼	Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.		604	
10A	24/24 100%	SS	2-3 4-5 N=7	22.5			20	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		602	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
11A	23/24 96%	SS	2-2 3-6 N=5	28.0				Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.		
11B				21.9				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.		
12A	24/24 100%	SS	0-0 3-5 N=3	24.5			22	Dark gray (10YR4/1), wet, soft, silty CLAY with little sand.	600	
12B				21.8				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.		
13A	24/24 100%	SS	1-2 2-4 N=4	20.3			24	Greenish gray (5GY6/1), wet, loose, clayey fine- to coarse-grained SAND with trace gravel.	598	
14A	24/24 100%	SS	0-3 3-3 N=6	19.9			26	Olive (5Y5/3), moist, soft, clayey SILT with slight trace sand.	596	
14B				16.4						
15A	24/24 100%	SS	4-5 7-10 N=12	16.5			28	Gray (N5/1), moist, firm, clayey SILT with slight trace sand and gravel.	594	
16A	24/24 100%	SS	2-3 4-5 N=7	16.4			30		592	
17A	18/24 75%	SS	3-3 4-5 N=7	30.6			32		590	
18A	24/24 100%	SS	7-9 14-21 N=23	23.5			34	Dark gray (10YR4/1), moist, firm, clayey SILT.	588	
18B				12.5			36	Greenish gray (5G5/1) with 30% reddish brown (5YR5/3) mottles, slightly moist, hard, clayey SILT with little sand and gravel.	586	
19A	24/24 100%	SS	8-10 15-20 N=25	12.4				Gray (N5/1), wet, silty fine- to coarse-grained SAND with trace gravel.		
19B				11.4			38	Gray (10YR5/1) slightly moist, hard, clayey SILT with trace sand and slight trace gravel.	584	
20A	12/16 75%	SS	16-26 50/4"	12.5			40		582	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
21A	24/24 100%	SS	7-15 18-21 N=33	11.5		
21B				15.2		
22A				14.3		
	24/24 100%	SS	8-6 17-21 N=23			
22B				13.0		
23A	13/24 54%	SS	24-22 20-22 N=42	13.7		

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	Dark greenish gray (10Y4/1), wet, silty fine- to coarse-grained SAND with trace gravel.			
	Dark gray (N4/1), moist, very hard, silty CLAY with some sand and gravel.			
42			580	
	Dark greenish gray (10Y4/1), wet, silty fine- to coarse-grained SAND with trace gravel.			
44	Dark gray (N4/1), slightly moist, very hard, clayey SILT with little sand and trace gravel.		578	
46			576	

End of Boring = 46.00 ft bgs

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA

FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01a~~
Well ID: P01S
Surface Elev: 622.00 ft. MSL
Completion: 27.74 ft. BGS
Station: 16,754.60N
-194.67E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 8.46 - 01/08/09
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.			
							2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
							4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
							6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
							8 ▼	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		614	
							10			612	
							12			610	
							14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
							16	Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.		606	
							18 ▼	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		604	
							20			602	

NOTE(S): See P01I Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: Start: 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01a
Well ID: P01S
Surface Elev: 622.00 ft. MSL
Completion: 27.74 ft. BGS
Station: 16,754.60N
-194.67E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 8.46 - 01/08/09
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.			
								Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
							22	Dark gray (10YR4/1), wet, soft, silty CLAY with little sand.		600	
								Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.			
							24	Greenish gray (5GY6/1), wet, loose, clayey fine- to coarse-grained SAND with trace gravel.		598	
							26	Olive (5Y5/3), moist, soft, clayey SILT with slight trace sand.		596	
								Gray (N5/1), moist, firm, clayey SILT with slight trace sand and gravel.			
								End of Boring = 27.74 ft bgs			

NOTE(S): See P01I Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: ~~P01~~
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	4-4 5-10 N=9	17.2			0	TOPSOIL - Black (10YR2/1), moist, friable, clayey SILT, roots.		622	
1B				30.5			2	Dark grayish brown (10YR4/2) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		620	
2A	24/24 100%	SS	2-2 3-4 N=5	30.3							
2B				24.9			4	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		618	
3A	23/24 96%	SS	2-2 3-4 N=5	24.9							
4A	24/24 100%	SS	2-3 4-4 N=7	22.9			6	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, very soft, clayey SILT.		616	
5A	20/24 83%	SS	2-2 3-3 N=5	22.1			8			614	
6A	12/24 50%	SS	1-1 2-3 N=3	26.9			▼ 10	Gray (10YR6/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very soft, SILT with trace sand.		612	
7A	18/24 75%	SS	2-4 5-6 N=9	24.5			12			610	
7B				27.7			14	Dark gray (10YR4/1), moist, very soft, silty CLAY with trace sand.		608	
8A	24/24 100%	SS	2-2 3-4 N=5	25.2							
8B				25.1			16			606	
9A	7/24 29%	SS	woh-woh woh-woh	24.9			▼ 18	Brown (10YR5/3), moist, very soft, silty CLAY with trace sand.		604	
10A	24/24 100%	SS	2-3 4-5 N=7	22.5			20	Brown (7.5YR5/3), wet, very soft, silty CLAY with slight trace sand.		602	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
11A				28.0				Dark gray (10YR4/1), wet, very soft, silty CLAY with slight trace sand.		
	23/24 96%	SS	2-2 3-6 N=5							
11B				21.9				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.		
							22		600	
12A				24.5				Dark gray (10YR4/1), wet, soft, silty CLAY with little sand.		
	24/24 100%	SS	0-0 3-5 N=3							
12B				21.8				Dark greenish gray (5GY4/1), moist, hard, silty CLAY with some sand and trace gravel.		
							24		598	
	24/24 100%	SS	1-2 2-4 N=4					Greenish gray (5GY6/1), wet, loose, clayey fine- to coarse-grained SAND with trace gravel.		
13A				20.3						
							26		596	
	24/24 100%	SS	0-3 3-3 N=6					Olive (5Y5/3), moist, soft, clayey SILT with slight trace sand.		
14A				19.9						
14B				16.4						
							28		594	
15A	24/24 100%	SS	4-5 7-10 N=12	16.5						
							30	Gray (N5/1), moist, firm, clayey SILT with slight trace sand and gravel.	592	
	24/24 100%	SS	2-3 4-5 N=7							
16A				16.4						
							32		590	
17A	18/24 75%	SS	3-3 4-5 N=7	30.6						
							34		588	
								Dark gray (10YR4/1), moist, firm, clayey SILT.		
18A	24/24 100%	SS	7-9 14-21 N=23	23.5						
								Greenish gray (5G5/1) with 30% reddish brown (5YR5/3) mottles, slightly moist, hard, clayey SILT with little sand and gravel.		
18B				12.5			36		586	
								Gray (N5/1), wet, silty fine- to coarse-grained SAND with trace gravel.		
19A	24/24 100%	SS	8-10 15-20 N=25	12.4						
19B				11.4			38		584	
	12/16 75%	SS	16-26 50/4"					Gray (10YR5/1) slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		
20A				12.5						
							40		582	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/10/2008
Finish: 11/10/2008
WEATHER: cool, sunny, lo-40's

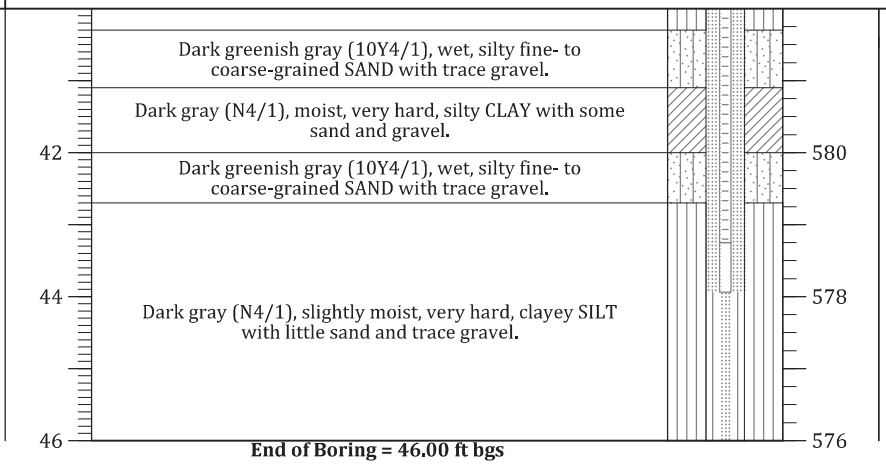
CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: P01
Well ID: P01I
Surface Elev: 622.00 ft. MSL
Completion: 46.00 ft. BGS
Station: 16,749.97N
-194.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 7, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 18.00 - during drilling
▼ = 9.58 - 01/08/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
21A	24/24 100%	SS	7-15 18-21 N=33	11.5		
21B				15.2		
22A				14.3		
	24/24 100%	SS	8-6 17-21 N=23			
22B				13.0		
23A	13/24 54%	SS	24-22 20-22 N=42	13.7		



End of Boring = 46.00 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

P41D (MW-5D)

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	~~B-14/MW-5~~
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	610.3
Foreman	Randy Howard CME 850	Drilling Method	HSA/ 2-3/4" Mud Rotary
Engineer/Geologist	ASY	Sampling Method	SS/Core
Weather & Temp.	82°, Sunny, Breezy	Hammer Type	Auto
Date: Start	9/17/2003 1250	Water Depth: DD	18'
Finish	9/19/2003 1255	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brn. silt loam, moist, topsoil.	SS-1	1.5	3.5	3-5-5-5 Rec = 18" Qp = 2.5
0.5	4.5	Lt. brn.-gray to yellow-brn. silt, tr.-so. clay, moist, mottled, iron staining, roots (loess).	SS-2	4.0	6.0	3-4-4-4 Rec = 20" Qp = 1.7
4.5	7.8	Gray silt, so. iron staining, v. moist @ 6' 7", occ. roots, moist (loess).	SS-3	6.5	8.5	2-2-3-3 Rec = 24" Qp = 1.6
7.8	9.0	Brn. and gray mottled silt, tr. clay, moist (locss).	SS-4	9.0	11.0	1-2-3-4 Rec = 20" Qp = 1.3
9.0	11.0	Yel.-brn. silt, tr. clay, moist (loess).	SS-5	11.5	13.5	1-2-3-3 Rec = 24" Qp = 1.3
11.0	14.5	Red-brn. and gray clayey silt, tr. f. sand, moist (till).	SS-6	14.0	16.0	2-3-3-3 Rec = 22" Qp = 1.4 to 2.4
14.5	18.0	As above, so. f.-m. sand, tr. coal frags and gravel (till).	SS-7	16.5	18.5	2-2-2-2 Rec = 24" Qp = -
18.0	20.8	Yellow-brn. sa. silt, so. clay, tr. gravel, v. moist to wet.	SS-8	19.0	21.0	1-1-2-2 Rec = 24" Qp = -
20.8	23.3	Red-brn and gray clayey silt, tr.-so. f. sand, tr. gravel and coal frags., moist (till).	SS-9	21.5	23.5	2-4-3-5 Rec = 19" Qp = 2.2
23.3	24.0	Brn-gray silty v.f. sand, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 19" Qp = -
24.0	26.0	Lt. gray to yellow-gray silt, v. moist-wet, laminated, so. dark gray laminae, occ. wood frags.	SS-11	26.5	28.5	4-9-17-25 Rec = 23" Qp = 3.2 (till)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.0	27.5	Gray cl. silt, so. sand (f.-m.), stiff, moist, occ. f. gravel (till).	SS-12	29.0	31.0	6-11-18-24 Rec = 24" Qp = 4.5+
27.5	28.4	Red brown to brn. f.-m. sand, wet.	SS-13	31.5	33.5	5-13-25-40 Rec = 21" Qp = 4.5+ to -
28.4	33.0	Gray sa. silt, so. clay, tr. gravel, moist, v. stiff (till).	SS-14	34.0	36.0	13-29-33-44 Rec = 19" Qp = -
33.0	38.4	Gray f.-m. sand, wet, tr. crs. sand (gravel @ base), dense.	SS-15	36.5	38.5	3-17-28-22 Rec = 18" Qp = -
38.4	46.0	Gray silty clay, tr.-so. gravel (f.-m.), tr. v.f.-f. sand, occ. coal fragments, dry to mst. v. stiff (till).	SS-16	39.0	41.0	5-11-16-23 Rec = 22" Qp = 4.5+
46.0	48.6	Brown to brn.-gray f.-m. sandy silt, so. clay, tr. gravel, stiff, moist (till).	SS-17	41.5	43.5	5-12-17-24 Rec = 24" Qp = 4.5+
48.6	50.0	Gray f.-crs. sand, dry, v. dense, tr.-so. gravel, v. moist @ base, methane production.	SS-18	44.0	46.0	6-10-17-21 Rec = 23" Qp = 4.5+
50.0	51.5	Lt. gray to yel-gray silt, v. moist-wet, iron staining, methane production.	SS-19	46.5	48.0	5-20-50/5" Rec = 15" Qp = 4.3 to 4.5+
51.5	55.8	Gray-brn. v.f. sa. silt, so. clay, tr. f. gravel, moist, v. stiff (till).	SS-20	49.0	51.0	35-40-47-50/5" Rec = 24" Qp = 1.0 (silt)
55.8	65.5	Gray f.-crs. sand, tr. f. gravel and silt, wet, partially cemented (calcareous), v. dense, more gravel 61.5' - 65.5'.	SS-21	51.5	53.0	14-34-50/4" (overpacked w/sand) Rec = 12" silt Qp = 1.0 (silt)
65.5	66.5	Gray silty v.f.-m. sand, tr. gravel, partially cemented, v. dense.	SS-22	54.0	55.0	14-50 Rec = 12" Qp = 4.5+
66.5	71.7	Gray clayey silt, so. v.f.-f. sand, tr. gravel (f.-m.), calcareous, sl. moist, v. stiff (till), so. shale frags.	SS-23	56.5	58.5	18-31-31-37 Rec = 21" Qp = -
71.7	80.8	Gray v.f.-f. sa. silt, tr.-so. clay, tr. f.-m. gravel, occ. coal frags., v. stiff, sl. moist, calcareous (till).	SS-24	59.0	61.0	16-27-32-41 Rec = 18" Qp = -
80.8	84.0	Gray to dk. gray silt, tr.-so. clay, tr. v.f.-f. sand and f.-m. gravel, occ. varves, wood frags., stiff, sl. calcareous (till).	SS-25	61.5	63.5	16-26-29-30 Rec = 19" Qp = -
84.0	89.6	Dk. gray silt, tr. clay, tr. v.f. sand, occ. zones of diss. carbonaceous material (m. sand sized), occ. coal frags., occ. varved zones, v. stiff.	SS-26	64.0	65.5	12-30-50/4" Rec = 14" Qp = -

General Remarks:

1640 Switch to mud rotary @ 55'.
1748 Begin mud rotary w/polymer.
1905 end drilling for today at 64.0'.
Methane produced from 49' - 53' inside borehole.

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
89.6	93.0	Gray wthrd. siltstone, thinly bedded, tr. clay.	SS-27	66.5	68.5	18-34-45-50/5" Rec = 24" Qp = 4.5++
			SS-28	69.0	71.0	15-29-32-45 Rec = 24" Qp = 4.5++
			SS-29	71.5	73.0	23-45-50/4" Rec = 15" Qp = 4.5+
			SS-30	74.0	75.5	24-36-37 Rec = 17" Qp = 4.5++
			SS-31	76.5	78.0	26-37-44 Rec = 18" Qp = 4.5+
			SS-32	79.0	81.0	Drop Rod-27-39-50 Rec = 22" Qp = 4.5+
			SS-33	81.5	83.5	13-23-33-44 Rec = 24" Qp = 4.5+
			SS-34	84.0	86.0	7-13-21-27 Rec = 24" Qp = 4.5+
			SS-35	87.5	89.5	8-16-32-50/3" Rec = 17" Qp = 4.5+
			SS-36	90.0	90.5	50/5-1/2" Rec = 6" Qp = 4.5+
		End SS @ 93.0'. Begin coring @ 93.7'.	SS-37	92.5	93.0	50/4"

General Remarks:

* 9-18-03 Resume B-14 @ 0800 @ 64.0'.
* Drilled much harder @ 89.6'.
* 9-18-03 1240 Stopped drilling @ 92.5'.

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 1 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC --- % RQD	Box Number	Time 8:35	DWR %	DWRC	Down Pressure	Depth In Feet
93.0	Start core 93.7'	1	Run 9.3'	1		100%	Gray	250#	
94.0	Loss 94.8'		Rec 8.15' 88%		1:53				
95.0	Gray silty shale, thinly bedded.		RQD 7.95'/ 9.3'		1:35				
96.0	95.6' High angle fracture 96.0'		85%		2:07		Lt. gray		
97.0					1:47				
98.0	98.3'				1:54	4'4" added 5.0'			
99.0	Gray shale, so. silt, thinly bedded.				1:35				
100.0					1:12		Dk. gray		
101.0					1:03				
102.0					0:53				
103.0									

Core barrel 13.0' - End Run 1 - 103.0

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 2 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
103.0	Dark gray shale, fissil.	2	Run 10.0'	1		100	Gray	450#	
104.0			Rec 8.6'		1:45				
				104.8'					
105.0					1:52				
				2					
106.0			RQD 7.5'/ 10.0'		1:58				
107.0					2:30				
108.0	108.0'				1:53				
	108.3' Gray shaley limestone.					sl. drop			
109.0	Loss 109.1'				1:50				
	Dark gray limey shale, fractured, near vert., open, clean. 109.7'					sl. drop			
110.0	Loss 110.1'				2:23				
	Gray shaley limestone, tr. fossils.								
111.0	Dark gray shale, fissil.				-			250#	
112.0					3:30				
	112.65'								
	112.75' Gray shaley limestone.								
113.0					3:02				

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 3 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
113.0	Dark gray limey shale.	2		2		100	Gray	250#	
	113.85'								
114.0	104.05' Dark gray shaley, limestone, fossiliferous.								
	Dk. gray to black shale, so. lime, scattered fossils.								
115.0									
	115.9'			115.9'					
116.0				3					
	Black shale, so. lime.								
	116.5'								
117.0	Dk. gray shaley limestone to limey shale, fossiliferous.								
	117.3'								
	Loss (in hole)								
118.0	118.0'								
	EOB @ 118.0'								

9-19-03 Coring completed 1255

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HANSON

RECORD OF SOIL EXPLORATION

P41I1 (MW-5I1)

Project Name	Ameren Duck Creek	Sheet	1 of 1
Job #	03S5010	Boring #	~~B-14A/P-5I1~~
Location	CCB Landfill - Phase III Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	609.9
Foreman	Randy Howard	Drilling Method	HSA CME 850 ATV
Engineer/Geologist	ASY	Sampling Method	SS
Weather & Temp.	35°, Sunny, Windy	Hammer Type	Auto
Date: Start	12/15/2003 1330	Water Depth: DD	-
Finish	12/15/2003 1600	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
		No sampling to 29' (see B-14)				
29.0	30.5	Brown-red f.-m. sand, wet.	SS-1	29.0	31.0	16-26-25-23 sand: - Rec = 24" Qp = till: 4.5+
30.5	32.5	Gray sandy clay, so. silt, tr. gravel, v. stiff, moist (till).	SS-2	31.5	33.5	8-18-26-46 sand: - Rec = 24" Qp = till: 4.5+
32.5	37.0	Gray f.-m. sand, wet.	SS-3	34.0	36.0	No sample. Sand blown-in inside auger. Rec = Qp =
37.0	38.5	Gray silty clay, tr. sand and gravel, tr.-so. coal frags., v. stiff, moist (till).	SS-4	36.5	38.5	14-10-11-14 Rec = 20" Qp = 4.5+
		EOB @ 38.5'				

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-14/MW-5
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	610.3
Foreman	Randy Howard CME 850	Drilling Method	HSA/ 2-3/4" Mud Rotary
Engineer/Geologist	ASY	Sampling Method	SS/Core
Weather & Temp.	82°, Sunny, Breezy	Hammer Type	Auto
Date: Start	9/17/2003 1250	Water Depth: DD	18'
Finish	9/19/2003 1255	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brn. silt loam, moist, topsoil.	SS-1	1.5	3.5	3-5-5-5 Rec = 18" Qp = 2.5
0.5	4.5	Lt. brn.-gray to yellow-brn. silt, tr.-so. clay, moist, mottled, iron staining, roots (loess).	SS-2	4.0	6.0	3-4-4-4 Rec = 20" Qp = 1.7
4.5	7.8	Gray silt, so. iron staining, v. moist @ 6' 7", occ. roots, moist (loess).	SS-3	6.5	8.5	2-2-3-3 Rec = 24" Qp = 1.6
7.8	9.0	Brn. and gray mottled silt, tr. clay, moist (locss).	SS-4	9.0	11.0	1-2-3-4 Rec = 20" Qp = 1.3
9.0	11.0	Yel.-brn. silt, tr. clay, moist (loess).	SS-5	11.5	13.5	1-2-3-3 Rec = 24" Qp = 1.3
11.0	14.5	Red-brn. and gray clayey silt, tr. f. sand, moist (till).	SS-6	14.0	16.0	2-3-3-3 Rec = 22" Qp = 1.4 to 2.4
14.5	18.0	As above, so. f.-m. sand, tr. coal frags and gravel (till).	SS-7	16.5	18.5	2-2-2-2 Rec = 24" Qp = -
18.0	20.8	Yellow-brn. sa. silt, so. clay, tr. gravel, v. moist to wet.	SS-8	19.0	21.0	1-1-2-2 Rec = 24" Qp = -
20.8	23.3	Red-brn and gray clayey silt, tr.-so. f. sand, tr. gravel and coal frags., moist (till).	SS-9	21.5	23.5	2-4-3-5 Rec = 19" Qp = 2.2
23.3	24.0	Brn-gray silty v.f. sand, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 19" Qp = -
24.0	26.0	Lt. gray to yellow-gray silt, v. moist-wet, laminated, so. dark gray laminae, occ. wood frags.	SS-11	26.5	28.5	4-9-17-25 Rec = 23" Qp = 3.2 (till)

General Remarks:

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.0	27.5	Gray cl. silt, so. sand (f.-m.), stiff, moist, occ. f. gravel (till).	SS-12	29.0	31.0	6-11-18-24 Rec = 24" Qp = 4.5+
27.5	28.4	Red brown to brn. f.-m. sand, wet.	SS-13	31.5	33.5	5-13-25-40 Rec = 21" Qp = 4.5+ to -
28.4	33.0	Gray sa. silt, so. clay, tr. gravel, moist, v. stiff (till).	SS-14	34.0	36.0	13-29-33-44 Rec = 19" Qp = -
33.0	38.4	Gray f.-m. sand, wet, tr. crs. sand (gravel @ base), dense.	SS-15	36.5	38.5	3-17-28-22 Rec = 18" Qp = -
38.4	46.0	Gray silty clay, tr.-so. gravel (f.-m.), tr. v.f.-f. sand, occ. coal fragments, dry to mst. v. stiff (till).	SS-16	39.0	41.0	5-11-16-23 Rec = 22" Qp = 4.5+
46.0	48.6	Brown to brn.-gray f.-m. sandy silt, so. clay, tr. gravel, stiff, moist (till).	SS-17	41.5	43.5	5-12-17-24 Rec = 24" Qp = 4.5+
48.6	50.0	Gray f.-crs. sand, dry, v. dense, tr.-so. gravel, v. moist @ base, methane production.	SS-18	44.0	46.0	6-10-17-21 Rec = 23" Qp = 4.5+
50.0	51.5	Lt. gray to yel-gray silt, v. moist-wet, iron staining, methane production.	SS-19	46.5	48.0	5-20-50/5" Rec = 15" Qp = 4.3 to 4.5+
51.5	55.8	Gray-brn. v.f. sa. silt, so. clay, tr. f. gravel, moist, v. stiff (till).	SS-20	49.0	51.0	35-40-47-50/5" Rec = 24" Qp = 1.0 (silt)
55.8	65.5	Gray f.-crs. sand, tr. f. gravel and silt, wet, partially cemented (calcareous), v. dense, more gravel 61.5' - 65.5'.	SS-21	51.5	53.0	14-34-50/4" (overpacked w/sand) Rec = 12" silt Qp = 1.0 (silt)
65.5	66.5	Gray silty v.f.-m. sand, tr. gravel, partially cemented, v. dense.	SS-22	54.0	55.0	14-50 Rec = 12" Qp = 4.5+
66.5	71.7	Gray clayey silt, so. v.f.-f. sand, tr. gravel (f.-m.), calcareous, sl. moist, v. stiff (till), so. shale frags.	SS-23	56.5	58.5	18-31-31-37 Rec = 21" Qp = -
71.7	80.8	Gray v.f.-f. sa. silt, tr.-so. clay, tr. f.-m. gravel, occ. coal frags., v. stiff, sl. moist, calcareous (till).	SS-24	59.0	61.0	16-27-32-41 Rec = 18" Qp = -
80.8	84.0	Gray to dk. gray silt, tr.-so. clay, tr. v.f.-f. sand and f.-m. gravel, occ. varves, wood frags., stiff, sl. calcareous (till).	SS-25	61.5	63.5	16-26-29-30 Rec = 19" Qp = -
84.0	89.6	Dk. gray silt, tr. clay, tr. v.f. sand, occ. zones of diss. carbonaceous material (m. sand sized), occ. coal frags., occ. varved zones, v. stiff.	SS-26	64.0	65.5	12-30-50/4" Rec = 14" Qp = -

General Remarks:

1640 Switch to mud rotary @ 55'.
1748 Begin mud rotary w/polymer.
1905 end drilling for today at 64.0'.
Methane produced from 49' - 53' inside borehole.

Electronic Filing: Received, Clerk's Office 06/20/2024

Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
89.6	93.0	Gray wthrd. siltstone, thinly bedded, tr. clay.	SS-27	66.5	68.5	18-34-45-50/5" Rec = 24" Qp = 4.5++
			SS-28	69.0	71.0	15-29-32-45 Rec = 24" Qp = 4.5++
			SS-29	71.5	73.0	23-45-50/4" Rec = 15" Qp = 4.5+
			SS-30	74.0	75.5	24-36-37 Rec = 17" Qp = 4.5++
			SS-31	76.5	78.0	26-37-44 Rec = 18" Qp = 4.5+
			SS-32	79.0	81.0	Drop Rod-27-39-50 Rec = 22" Qp = 4.5+
			SS-33	81.5	83.5	13-23-33-44 Rec = 24" Qp = 4.5+
			SS-34	84.0	86.0	7-13-21-27 Rec = 24" Qp = 4.5+
			SS-35	87.5	89.5	8-16-32-50/3" Rec = 17" Qp = 4.5+
			SS-36	90.0	90.5	50/5-1/2" Rec = 6" Qp = 4.5+
		End SS @ 93.0'. Begin coring @ 93.7'.	SS-37	92.5	93.0	50/4"

General Remarks:

* 9-18-03 Resume B-14 @ 0800 @ 64.0'.
* Drilled much harder @ 89.6'.
* 9-18-03 1240 Stopped drilling @ 92.5'.

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 1 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time (8:35)	DWR %	DWRC	Down Pressure	Depth In Feet
93.0	Start core 93.7'	1	Run 9.3'	1		100%	Gray	250#	
94.0	Loss 94.8'		Rec 8.15'		1:53				
95.0	Gray silty shale, thinly bedded.		88%		1:35				
96.0	95.6' High angle fracture 96.0'		RQD 7.95'/ 9.3'		2:07				
97.0			85%		1:47		Lt. gray		
98.0	98.3'				1:54	4'4" added 5.0'			
99.0	Gray shale, so. silt, thinly bedded.				1:35				
100.0					1:12		Dk. gray		
101.0					1:03				
102.0					0:53				
103.0									

Core barrel 13.0' - End Run 1 - 103.0

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 2 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
103.0	Dark gray shale, fissil.	2	Run 10.0'	1		100	Gray	450#	
104.0			Rec 8.6'		1:45				
				104.8'					
105.0					1:52				
				2					
106.0			RQD 7.5'/ 10.0'		1:58				
107.0					2:30				
108.0	108.0'				1:53				
	108.3' Gray shaley limestone.					sl. drop			
109.0	Loss 109.1'				1:50				
	Dark gray limey shale, fractured, near vert., open, clean. 109.7'					sl. drop			
110.0	Loss 110.1'				2:23				
	Gray shaley limestone, tr. fossils.								
111.0	Dark gray shale, fissil.				-			250#	
112.0					3:30				
	112.65'								
	112.75' Gray shaley limestone.								
113.0					3:02				

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 3 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
113.0	Dark gray limey shale.	2		2		100	Gray	250#	
	113.85'								
114.0	104.05' Dark gray shaley, limestone, fossiliferous.								
	Dk. gray to black shale, so. lime, scattered fossils.								
115.0									
	115.9'			115.9'					
116.0				3					
	Black shale, so. lime.								
	116.5'								
117.0	Dk. gray shaley limestone to limey shale, fossiliferous.								
	117.3'								
	Loss (in hole)								
118.0	118.0'								
	EOB @ 118.0'								

9-19-03 Coring completed 1255

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P41I2 (MW-5I2)

HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 1
Job #	03S5010	Boring #	~~B-14B/P-5I2~~
Location	CCB Landfill - Phase III Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	609.8
Foreman	Randy Howard	Drilling Method	HSA CME 850 ATV
Engineer/Geologist	ASY	Sampling Method	SS
Weather & Temp.		Hammer Type	Auto

Date:	Start	12/16/2003 0805	Water Depth: DD	-
	Finish	12/16/2003 1230	AAR	-
			Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
		No sampling to 44' (see B-14)				
44.0	47.0	Gray to brown-gray silty clay, tr. sand and gravel, occ. coal frags., v. stiff, sl. moist (till).	SS-1	44.0	46.0	5-10-15-24 Rec = 24" Qp = 4.5+
47.0	49.0	Gray f.-crs. sand, so. gravel, partially cemented, wet, methane production.	SS-2	46.5	47.3	12-50/4" till: 4.5+ Rec = 10" Qp = sand: -
49.0	50.3	Gray-brown silt, partially cemented, wet, methane production.	SS-3	49.0	51.0	8-18-28-32 silt: - to 0.5 Rec = 10" Qp = till: 4.5+
50.3	51.0	Gray-brown clayey silt, so. v.f. sand, tr. gravel, v. stiff, moist (till).				
		EOB @ 51.0'				

General Remarks:

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HANSON

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 3
Job #	03S5010	Boring #	B-14/MW-5
Location	CCB Landfill - Phase II Site Invest.	Station	-
Driller	Western Environmental Drilling Inc.	Surface Elevation	610.3
Foreman	Randy Howard CME 850	Drilling Method	HSA/ 2-3/4" Mud Rotary
Engineer/Geologist	ASY	Sampling Method	SS/Core
Weather & Temp.	82°, Sunny, Breezy	Hammer Type	Auto
Date: Start	9/17/2003 1250	Water Depth: DD	18'
Finish	9/19/2003 1255	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brn. silt loam, moist, topsoil.	SS-1	1.5	3.5	3-5-5-5 Rec = 18" Qp = 2.5
0.5	4.5	Lt. brn.-gray to yellow-brn. silt, tr.-so. clay, moist, mottled, iron staining, roots (loess).	SS-2	4.0	6.0	3-4-4-4 Rec = 20" Qp = 1.7
4.5	7.8	Gray silt, so. iron staining, v. moist @ 6' 7", occ. roots, moist (loess).	SS-3	6.5	8.5	2-2-3-3 Rec = 24" Qp = 1.6
7.8	9.0	Brn. and gray mottled silt, tr. clay, moist (locss).	SS-4	9.0	11.0	1-2-3-4 Rec = 20" Qp = 1.3
9.0	11.0	Yel.-brn. silt, tr. clay, moist (loess).	SS-5	11.5	13.5	1-2-3-3 Rec = 24" Qp = 1.3
11.0	14.5	Red-brn. and gray clayey silt, tr. f. sand, moist (till).	SS-6	14.0	16.0	2-3-3-3 Rec = 22" Qp = 1.4 to 2.4
14.5	18.0	As above, so. f.-m. sand, tr. coal frags and gravel (till).	SS-7	16.5	18.5	2-2-2-2 Rec = 24" Qp = -
18.0	20.8	Yellow-brn. sa. silt, so. clay, tr. gravel, v. moist to wet.	SS-8	19.0	21.0	1-1-2-2 Rec = 24" Qp = -
20.8	23.3	Red-brn and gray clayey silt, tr.-so. f. sand, tr. gravel and coal frags., moist (till).	SS-9	21.5	23.5	2-4-3-5 Rec = 19" Qp = 2.2
23.3	24.0	Brn-gray silty v.f. sand, wet.	SS-10	24.0	26.0	1-2-2-3 Rec = 19" Qp = -
24.0	26.0	Lt. gray to yellow-gray silt, v. moist-wet, laminated, so. dark gray laminae, occ. wood frags.	SS-11	26.5	28.5	4-9-17-25 Rec = 23" Qp = 3.2 (till)

General Remarks:

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Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 2 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
26.0	27.5	Gray cl. silt, so. sand (f.-m.), stiff, moist, occ. f. gravel (till).	SS-12	29.0	31.0	6-11-18-24 Rec = 24" Qp = 4.5+
27.5	28.4	Red brown to brn. f.-m. sand, wet.	SS-13	31.5	33.5	5-13-25-40 Rec = 21" Qp = 4.5+ to -
28.4	33.0	Gray sa. silt, so. clay, tr. gravel, moist, v. stiff (till).	SS-14	34.0	36.0	13-29-33-44 Rec = 19" Qp = -
33.0	38.4	Gray f.-m. sand, wet, tr. crs. sand (gravel @ base), dense.	SS-15	36.5	38.5	3-17-28-22 Rec = 18" Qp = -
38.4	46.0	Gray silty clay, tr.-so. gravel (f.-m.), tr. v.f.-f. sand, occ. coal fragments, dry to mst. v. stiff (till).	SS-16	39.0	41.0	5-11-16-23 Rec = 22" Qp = 4.5+
46.0	48.6	Brown to brn.-gray f.-m. sandy silt, so. clay, tr. gravel, stiff, moist (till).	SS-17	41.5	43.5	5-12-17-24 Rec = 24" Qp = 4.5+
48.6	50.0	Gray f.-crs. sand, dry, v. dense, tr.-so. gravel, v. moist @ base, methane production.	SS-18	44.0	46.0	6-10-17-21 Rec = 23" Qp = 4.5+
50.0	51.5	Lt. gray to yel-gray silt, v. moist-wet, iron staining, methane production.	SS-19	46.5	48.0	5-20-50/5" Rec = 15" Qp = 4.3 to 4.5+
51.5	55.8	Gray-brn. v.f. sa. silt, so. clay, tr. f. gravel, moist, v. stiff (till).	SS-20	49.0	51.0	35-40-47-50/5" Rec = 24" Qp = 1.0 (silt)
55.8	65.5	Gray f.-crs. sand, tr. f. gravel and silt, wet, partially cemented (calcareous), v. dense, more gravel 61.5' - 65.5'.	SS-21	51.5	53.0	14-34-50/4" (overpacked w/sand) Rec = 12" silt Qp = 1.0 (silt)
65.5	66.5	Gray silty v.f.-m. sand, tr. gravel, partially cemented, v. dense.	SS-22	54.0	55.0	14-50 Rec = 12" Qp = 4.5+
66.5	71.7	Gray clayey silt, so. v.f.-f. sand, tr. gravel (f.-m.), calcareous, sl. moist, v. stiff (till), so. shale frags.	SS-23	56.5	58.5	18-31-31-37 Rec = 21" Qp = -
71.7	80.8	Gray v.f.-f. sa. silt, tr.-so. clay, tr. f.-m. gravel, occ. coal frags., v. stiff, sl. moist, calcareous (till).	SS-24	59.0	61.0	16-27-32-41 Rec = 18" Qp = -
80.8	84.0	Gray to dk. gray silt, tr.-so. clay, tr. v.f.-f. sand and f.-m. gravel, occ. varves, wood frags., stiff, sl. calcareous (till).	SS-25	61.5	63.5	16-26-29-30 Rec = 19" Qp = -
84.0	89.6	Dk. gray silt, tr. clay, tr. v.f. sand, occ. zones of diss. carbonaceous material (m. sand sized), occ. coal frags., occ. varved zones, v. stiff.	SS-26	64.0	65.5	12-30-50/4" Rec = 14" Qp = -

General Remarks:

1640 Switch to mud rotary @ 55'.
1748 Begin mud rotary w/polymer.
1905 end drilling for today at 64.0'.
Methane produced from 49' - 53' inside borehole.

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Project Name Ameren Duck Creek - Phase II Site Invest. **Boring #** B-14/MW-5

Sheet 3 of 3

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
89.6	93.0	Gray wthrd. siltstone, thinly bedded, tr. clay.	SS-27	66.5	68.5	18-34-45-50/5" Rec = 24" Qp = 4.5++
			SS-28	69.0	71.0	15-29-32-45 Rec = 24" Qp = 4.5++
			SS-29	71.5	73.0	23-45-50/4" Rec = 15" Qp = 4.5+
			SS-30	74.0	75.5	24-36-37 Rec = 17" Qp = 4.5++
			SS-31	76.5	78.0	26-37-44 Rec = 18" Qp = 4.5+
			SS-32	79.0	81.0	Drop Rod-27-39-50 Rec = 22" Qp = 4.5+
			SS-33	81.5	83.5	13-23-33-44 Rec = 24" Qp = 4.5+
			SS-34	84.0	86.0	7-13-21-27 Rec = 24" Qp = 4.5+
			SS-35	87.5	89.5	8-16-32-50/3" Rec = 17" Qp = 4.5+
			SS-36	90.0	90.5	50/5-1/2" Rec = 6" Qp = 4.5+
		End SS @ 93.0'. Begin coring @ 93.7'.	SS-37	92.5	93.0	50/4"

General Remarks:

* 9-18-03 Resume B-14 @ 0800 @ 64.0'.
* Drilled much harder @ 89.6'.
* 9-18-03 1240 Stopped drilling @ 92.5'.

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 1 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time (8:35)	DWR %	DWRC	Down Pressure	Depth In Feet
93.0	Start core 93.7'	1	Run 9.3'	1		100%	Gray	250#	
94.0	Loss 94.8'		Rec 8.15'		1:53				
95.0	Gray silty shale, thinly bedded.		88%		1:35				
96.0	95.6' High angle fracture 96.0'		RQD 7.95'/ 9.3'		2:07				
97.0			85%		1:47		Lt. gray		
98.0	98.3'				1:54	4'4" added 5.0'			
99.0	Gray shale, so. silt, thinly bedded.				1:35				
100.0					1:12		Dk. gray		
101.0					1:03				
102.0					0:53				
103.0									

Core barrel 13.0' - End Run 1 - 103.0

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 2 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
103.0	Dark gray shale, fissil.	2	Run 10.0'	1		100	Gray	450#	
104.0			Rec 8.6'		1:45				
				104.8'					
105.0					1:52				
				2					
106.0			RQD 7.5'/ 10.0'		1:58				
107.0					2:30				
108.0	108.0'				1:53				
	108.3' Gray shaley limestone.					sl. drop			
109.0	Loss 109.1'				1:50				
	Dark gray limey shale, fractured, near vert., open, clean. 109.7'					sl. drop			
110.0	Loss 110.1'				2:23				
	Gray shaley limestone, tr. fossils.								
111.0	Dark gray shale, fissil.				-			250#	
112.0					3:30				
	112.65'								
	112.75' Gray shaley limestone.								
113.0					3:02				

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HANSON

BORING NO. B-14/MW-5

PROJECT No. 03S5010

SHEET 3 OF 3

PROJECT NAME: Ameren Duck Creek

DATE 9/19/2003

Engineer/Geologist: Scott Yankey

Depth In Feet	ROCK, COLOR, HARDNESS, WEATHERING, GRAIN OR CRYSTALLINITY, BEDDING, VOIDS (OTHER: THICKNESS & LOCATION OF CLAY/SHALE SEAMS)	Sample or Run Number	% REC / % RQD	Box Number	Time	DWR %	DWRC	Down Pressure	Depth In Feet
113.0	Dark gray limey shale.	2		2		100	Gray	250#	
	113.85'								
114.0	104.05' Dark gray shaley, limestone, fossiliferous.								
	Dk. gray to black shale, so. lime, scattered fossils.								
115.0									
	115.9'			115.9'					
116.0				3					
	Black shale, so. lime.								
	116.5'								
117.0	Dk. gray shaley limestone to limey shale, fossiliferous.								
	117.3'								
	Loss (in hole)								
118.0	118.0'								
	EOB @ 118.0'								

9-19-03 Coring completed 1255

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HANSON

P42D (MW-9D)

RECORD OF SOIL EXPLORATION

Project Name	Ameren Duck Creek	Sheet	1 of 2
Job #	03S5010	Boring #	~~B-22 / MW-9~~
Location	CCB Landfill - Phase IV Site Invest.	Station	-
Driller	Testing Service Corporation	Surface Elevation	615.7
Foreman	Bruno Williamson	Drilling Method	HSA 3 1/4" I.D.
Engineer/Geologist	Scott Yankey	Sampling Method	SB/SS
Weather & Temp.	32°, Sunny, Calm	Hammer Type	Auto
Date: Start	12/8/2004	Water Depth: DD	8.5'
Finish	12/8/2004	AAR	-
		Delayed	-

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
0.0	0.5	Brown silt loam (topsoil).	SB-1	0.0	4.5	Rec = 4' Qp = 0.6
0.5	8.0	Yellow-brown silt, so. gray mottling, so. clay, iron staining, concretions, soft, moist (loess).	SB-2	4.5	9.5	Rec = 4' Qp = 0.8
8.0	11.2	Gray silt, tr. clay and v.f. sand, so. brown mottling, iron staining, concretions, moist, wet at 8.5' (loess).	SB-3	9.5	14.5	Rec = 5' Qp = 2.4
11.2	17.0	Dark gray and brown mottled clayey silt, so. v.f. sand, iron staining, stiff, moist (paleosol?).	SB-4	14.5	19.5	Rec = 5' Qp = 2.0
17.0	23.0	Brown and gray mottled silty clay, tr. v.f. sand and f. gravel, stiff, moist (till).	SB-5	19.5	24.5	Rec = 5' Qp = 2.0
23.0	24.5	Gray silt, so. v.f.-f. sand, soft v. moist.	SB-6	24.5	29.5	Rec = 2.0' Qp = -
24.5	29.5	Brown-gray f.-med. sand, wet.	SB-7	29.5	34.5	Rec = 5' Qp = 1.5-4.0
29.5	30.5	Gray clayey silt, so. sand and gravel, stiff, moist (till).	SB-8	34.5	39.5	Rec = 3' Qp = 1.7-4.5+
30.5	31.7	Gray silt, so. v.f.-f. sand, tr. gravel, wet.	SB-9	39.5	44.5	Rec = 5' Qp = 4.5+
31.7	32.2	Brown med. sand, wet.	SB-10	44.5	49.5	Rec = 5' Qp = 4.5+
32.2	35.0	Brown clayey silt, so. sand, tr.-so. gravel, v. stiff, moist (till).	SB-11	49.5	54.5	Rec = 1.0' Qp = -

General Remarks:

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Project Name Ameren Duck Creek - Phase IV Site Invest. **Boring #** B-22 / MW-9

Sheet 2 of 2

STRATUM DEPTH From	STRATUM DEPTH To	SOIL CLASSIFICATION	SAMPLE NUMBER	SAMPLE DEPTH From	SAMPLE DEPTH To	STD. PENETRATION TEST BLOWS / 6 INCHES P=Penetrometer
35.0	39.0	Gray silt, with some sand seams, wet.	SB-12	54.5	59.5	Rec = 5' Qp = 4.5+
39.0	47.0	Gray silty clay, so. v.f.-f. sand, tr.-so. gravel, occ. coal and wood fragments, v. stiff (till).	SB-13	59.5	64.5	Rec = 5' Qp = 4.5+
47.0	48.0	Gray clayey sand. so. silt and gravel, so. thin sand partings.	SB-14	64.5	69.5	Rec = 5' Qp = 4.5+
48.0	49.5	Gray silty clay, so. v.f.-f. sand, tr.-so. gravel, occ. coal and wood fragments, v. stiff, organic zone 49.1-49.2' (till).	SB-15	69.5	74.5	Rec = 2.5' Qp = -
49.5	54.5	Gray f.-v.crs. sand, partially cemented, calcareous, wet.	SB-16	74.5	79.5	Rec = 5' Qp = 4.5+
54.5	67.0	Gray clayey silt, so. v.f.-f. sand, tr.-so. gravel, calcareous (till).	SB-17	79.5	84.5	Rec = 5' Qp = 4.5+
67.0	67.5	Gray silt, wet.	SB-18	84.5	85.5	Refusal Rec = 1' Qp = 4.5+
67.5	69.5	Gray sandy silt, partially cemented, wet.	SS-1	85.5	87.0	28-50-100/3" Rec = 16" Qp = 4.5+
69.5	73.8	Gray f.-v.crs. sand, partially cemented, calcareous, wet.	SS-2	89.5	89.7	100/3" Rec = 2.5" Qp = 4.5+
73.8	74.5	Gray silt, so. v.f. sand, partially cemented, calcareous.				
74.5	79.5	Gray clayey silt, so. v.f. sand, tr.-so. gravel, occ. coal and wood fragments, v. stiff, abund. wood frags. and organics 79-79.5' (till).				
79.5	83.0	Darh gray clayey silt, so. v.f. sand, tr. gravel, v. stiff (till).				
83.0	85.5	Gray silty sand, so. silt and clay, cemented, calcareous, so. v. thin sand partings.				
85.5	89.5	Dark gray-brown sandy silt, tr. clay and gravel, cemented, calcareous.				
89.5	89.7	Dark gray weathered shale.				

General Remarks:

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	14/24 58%	SS	2-3 3-4 N=6				0			620	
2A	18/24 75%	SS	3-6 8-11 N=14	17.5			2			618	
3A	15/24 63%	SS	3-4 6-7 N=10	19.6			4	FILL - Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		616	
4A	20/24 83%	SS	6-8 11-14 N=19	18.5			6			614	
5A	22/24 92%	SS	3-5 6-7 N=11	26.8			8			612	
6A	21/24 88%	SS	2-4 5-5 N=9	23.8			10	Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.		610	
7A	20/24 83%	SS	4-4 6-7 N=10	22.8			12	Yellowish brown (10YR5/8) with 30% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		608	
8A	21/24 88%	SS	5-6 7-7 N=13	22.1			14	Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, moist, medium, SILT with few clay and trace sand.		606	
9A	21/24 88%	SS	5-5 6-6 N=11	21.0			16			604	
10A	24/24 100%	SS	2-3 4-7 N=7	28.1			18	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, medium, SILT with few clay and trace sand.		602	
10B				61.7			20	Dark yellowish brown (10YR3/4), moist, medium, SILT with few clay and trace sand, trace organics. Dark brown (10YR3/3), moist, medium, PEAT.			

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark brown (10YR3/3), moist, medium, PEAT. *[Continued from previous page]*		600	
11A	20/24 *83%*	SS	*2-5* *6-7* N=11	31.4			22	Very dark gray (10YR3/1), moist, medium, SILT with some clay and trace sand, trace organics.		598	
12A	24/24 *100%*	SS	*9-8* *7-6* N=15	33.7			24	Very dark gray (10YR3/1), wet, medium, SILT with some clay and trace sand, trace organics.		596	
								Dark brown (10YR3/3), moist, medium, PEAT.			
13A	20/24 *83%*	SS	*4-3* *4-4* N=7	23.0			26	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand and gravel.		594	
14A	22/24 *92%*	SS	*4-5* *6-6* N=11	20.6			28			592	
15A	24/24 *100%*	SS	*3-3* *4-5* N=7	17.5			30	Greenish gray (5G6/1), moist, medium, CLAY with some silt and trace sand and gravel.		590	
16A	24/24 *100%*	SS	*1-3* *3-3* N=6	20.2			32			588	
17A	24/24 *100%*	SS	*5-6* *6-7* N=12	15.9			34	Greenish gray (5G6/1), wet, soft, SILT with few clay, little sand, and trace gravel.		586	
	0/7 *0%*	BD									

End of Boring = 34.62 ft bgs

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P61
Well ID: P61
Surface Elev: 611.09 ft. MSL
Completion: 20.00 ft. BGS
Station: 1,398,670.81N
2,346,779.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	ss	--- ---				0	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		610	
2A	19/24 79%	ss	1-3 3-3 N=6				2	Yellowish brown (10YR5/6) with 5% gray (10YR5/1) mottles, moist, medium CLAY with some silt and trace sand.		608	
3A	21/24 88%	ss	2-4 4-5 N=8				4	Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		606	
4A	19/24 79%	ss	woh-2 4-4 N=6				6	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, soft, SILT with few clay and trace sand.		604	
5A	10/24 42%	ss	1-2 2-3 N=4				▼ 8	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.		602	
6A	17/24 71%	ss	2-2 3-3 N=5				10	Yellowish brown (10YR5/8), moist, soft, SILT with few clay and trace sand.		600	
								Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, soft, SILT with few clay and trace sand.			
7A	24/24 100%	ss	woh-1 2-2 N=3				12	Brown (10YR4/3), wet, soft, SILT with few clay and trace sand.		598	
8A	24/24 100%	ss	1-2 3-3 N=5				14	Black (10YR2/1), moist, medium, CLAY with few silt and trace sand.		596	
9A	24/24 100%	ss	1-3 3-4 N=6				16	Gray (10YR5/1), moist, medium CLAY with some silt and trace sand.		594	
10A	24/24 100%	ss	1-1 3-3 N=4				18			592	
							20	End of boring = 20 ft.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P62
Well ID: P62
Surface Elev: 610.81 ft. MSL
Completion: 16.30 ft. BGS
Station: 1,398,887.32N
2,346,602.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = Dry - durring drilling
▽ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---				0	Yellowish brown (10YR5/6), moist, medium, SILT with some clay and trace sand.		610	
2A	23/24 96%	SS	1-7 9-9 N=16				2	Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.		608	
3A	24/24 100%	SS	2-5 5-6 N=10				4	Yellowish brown (10YR5/6), moist, hard, SILT with few clay, trace sand, and trace gravel.		606	
4A	24/24 100%	SS	4-4 7-8 N=11				6	Gray (10YR5/1), moist, medium, SILT with few clay, trace sand, and trace gravel.		604	
5A	24/24 100%	SS	2-5 5-6 N=10				8	Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.		602	
6A	24/24 100%	SS	3-4 6-10 N=10				10	Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		600	
7A	23/24 96%	SS	2-3 5-6 N=8				12	Dark yellowish brown (10YR4/6), moist, medium, SILT with few clay and trace sand.		598	
8A	24/24 100%	SS	1-2 3-4 N=5				14	Gray (10YR5/1) with 5% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand, and trace gravel		596	
	0/4 0%	BD					16				

End of boring = 16.3 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/24/2021
Finish: 2/24/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P63
Well ID: P63
Surface Elev: 612.33 ft. MSL
Completion: 18.25 ft. BGS
Station: 1,399,026.62N
2,346,605.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---				0	Grayish brown (10R5/2), moist, medium, CLAY with some silt, trace sand, and trace gravel.		612	
2A	24/24 100%	SS	3-7 7-10 N=14				2			610	
							4	Yellowish brown (10YR5/6), moist, hard, CLAY with some silt, trace sand, and trace gravel.		608	
3A	24/24 100%	SS	2-4 4-4 N=8				6	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.		606	
4A	22/24 92%	SS	1-1 4-5 N=5				8	Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, moist, soft, SILT with few clay and trace sand.		604	
5A	21/24 88%	SS	2-2 3-4 N=5				10	Yellowish brown (10YR5/8) with 25% gray (10YR5/1) mottles, wet, soft, SILT with few clay and trace sand.		602	
6A	23/24 96%	SS	2-3 3-5 N=6				12			600	
7A	20/24 83%	SS	2-2 3-4 N=5				14	Dark yellowish brown (10YR3/4), moist, medium SILT with few clay and trace sand.		598	
8A	24/24 100%	SS	2-2 3-3 N=5				16	Gray (10YR5/1) with 35% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.		596	
9A	24/24 100%	SS	1-2 3-3 N=5				18	Yellowish brown(10YR5/6), moist, soft, CLAY with some silt, trace sand, and trace gravel.			
	0/4 0%	BD						**End of boring = 18.25 ft.**			

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: **Start:** 2/25/2021
Finish: 2/25/2021
WEATHER: Sunny, cool (lo-40's)

CONTRACTOR: Geotechnics
Rig mfg/model: CME-750X ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: **Driller:** Matt
Helper: Doug
Eng/Geo: R. Hasenyager

BOREHOLE ID: P64
Well ID: P64
Surface Elev: 614.04 ft. MSL
Completion: 16.47 ft. BGS
Station: 1,399,305.91N
2,346,597.96E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 6.70 - durring drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/24 0%	SS	--- ---					Yellowish brown (10YR5/6), medium CLAY with some silt and trace sand.			
							2			612	
2A	23/24 96%	SS	2-4 4-5 N=8					Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace sand.			
							4			610	
3A	23/24 96%	SS	2-2 2-3 N=4					Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, soft, SILT with few clay, trace sand, and trace wood fragments.			
							6			608	
4A	20/24 83%	SS	1-2 4-4 N=6				▼				
							8			606	
5A	15/24 63%	SS	1-2 2-3 N=4					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, soft, SILT with few clay and trace sand.			
							10			604	
6A	19/24 79%	SS	1-2 2-3 N=4								
							12			602	
7A	24/24 100%	SS	1-1 2-3 N=3					Yellowish brown (10YR5/6), moist, soft, SILT with some clay and trace sand.			
							14			600	
8A	24/24 100%	SS	1-2 2-3 N=4					Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, soft, CLAY with some silt and trace sand.			
	0/6 0%	BD					16			598	

End of boring = 16.5 ft.

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/14/2017
Finish: 3/14/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: R61L
Well ID: R61L
Surface Elev: 619.96 ft. MSL
Completion: 28.67 ft. BGS
Station: 15,649.93N
994.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - At completion
▼ =
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail / Elevation ft. MSL / Remarks

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, moist, firm, clayey SILT.	618
4		616
6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, moist, firm, clayey SILT.	614
8	Grayish brown (10YR5/2), moist, hard, clayey SILT.	612
	Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, moist, hard, clayey SILT.	
10		610
12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	608
14		606
16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	604
	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	
18		602
	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.	
20	Very dark gray (10YR3/1), moist, friable, micaceous,	600

NOTE(S): R61L installed in blind drilled boring approximately 10 ft. west of G61L. Lithologies from boring G61L, except as indicated.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/14/2017
Finish: 3/14/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: R61L
Well ID: R61L
Surface Elev: 619.96 ft. MSL
Completion: 28.67 ft. BGS
Station: 15,649.93N
994.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - At completion
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								clayey SILT.			
1A	13/24 54%	SS	2-2 2-3 N=4	23.1				Very dark grayish brown (10YR3/2), moist, soft, CLAY with some silt and trace sand and gravel.			
							22			598	
2A	24/24 100%	SS	5-5 6-6 N=11	23.9				Very dark grayish brown (10YR3/2), moist, medium, CLAY with some silt and trace sand.			
							24			596	
3A	20/24 83%	SS	2-3 4-5 N=7	22.5							
							26	Dark gray (10YR4/1), moist, medium, CLAY with some silt and trace sand.		594	
4A	24/24 100%	SS	5-5 6-6 N=11	22.1							
							28			592	
	0/8 0%	BD									

End of Boring = 28.67 ft bgs

NOTE(S): R61L installed in blind drilled boring approximately 10 ft. west of G61L. Lithologies from boring G61L, except as indicated.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	24/24 100%	SS	18-12 9-8 N=21				0	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		620	
2A	24/24 100%	SS	8-5 7-8 N=12	18.4			2			618	
3A	20/24 83%	SS	2-4 4-6 N=8	20.9			4	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		616	
4A	24/24 100%	SS	7-9 10-11 N=19	20.1			6			614	
4B				20.5			8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
5A	19/24 79%	SS	2-3 6-7 N=9	26.5				Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.			
6A	20/24 83%	SS	2-3 4-4 N=7	24.4			10			610	
7A	24/24 100%	SS	4-4 5-6 N=9	24.0			12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
8A	22/24 92%	SS	3-4 5-5 N=9	25.0			14			606	
9A	24/24 100%	SS	3-3 4-6 N=7	23.9			16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
10A	22/24 92%	SS	2-3 3-4 N=6	25.0				Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.			
10B				28.2			18	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		602	
							20	Very dark gray (10YR3/1), slightly moist, friable,		600	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/20/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G61
Well ID: G61S
Surface Elev: 620.00 ft. MSL
Completion: 38.00 ft. BGS
Station: 15,644.94N
994.79E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								micaceous, clayey SILT.			
11A	19/24 79%	SS	3-4 5-6 N=9	35.8							
11B				26.0			22	Dark gray (10YR4/1), moist, soft, clayey SILT.		598	
12A	24/24 100%	SS	4-3 6-9 N=9	25.3							
13A	20/24 83%	SS	woh-3 4-6 N=7	24.4			24			596	
14A	24/24 100%	SS	3-3 5-6 N=8	22.4			26	Greenish gray (5GY5/1), moist, soft, silty CLAY with slight trace sand.		594	
15A	22/24 92%	SS	woh-3 3-4 N=6	21.5			28			592	
16A	19/24 79%	SS	woh-1 3-3 N=4	16.7			30	Greenish gray (5GY5/1), very moist, very soft, sandy CLAY with slight trace gravel.		590	
17A	24/24 100%	SS	3-4 5-5 N=9	18.8			32			588	
17B				13.6				Greenish gray (10Y5/1), slightly moist, soft, clayey SILT with trace sand and slight trace gravel.			
18A	19/24 79%	SS	1-7 7-7 N=14	20.7			34			586	
								Medium light gray (N6/1), wet, firm, SILT with slight trace sand and gravel.			
19A	24/24 100%	SS	7-11 19-32 N=30	12.4			36			584	
								Greenish gray (10Y5/1), slightly moist, firm, clayey SILT with trace sand and slight trace gravel.			
							38	**End of Boring = 38.0 ft bgs**		582	

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 1/21/2009
Finish: 1/21/2009
WEATHER: cold, sunny, windy, mid-20's

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: S. Suzanna Simpson

BOREHOLE ID: G61a
Well ID: G61L
Surface Elev: 620.00 ft. MSL
Completion: 19.90 ft. BGS
Station: 15,640.94N
994.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 19.50 - 01/21/09
▽ =

SAMPLE			TESTING						
Number	Recov / Total (in) % Recovery	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0			620	
							2	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) mottles, slightly moist, firm, clayey SILT.		618	
							4			616	
							6	FILL - Yellowish brown (10YR5/4) with 15% yellowish brown (10YR5/6) and 15% gray (10YR6/1) mottles, slightly moist, firm, clayey SILT.		614	
							8	Grayish brown (10YR5/2), slightly moist, hard, clayey SILT.		612	
							10	Light brownish gray (10YR6/2) with 35% dark yellowish brown (10YR4/6) mottles, slightly moist, hard, clayey SILT.		610	
							12	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.		608	
							14			606	
							16	Gray (10YR6/1) with 40% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		604	
							18	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT.		602	
							▼	Gray (10YR6/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT.			
								Very dark gray (10YR3/1), slightly moist, friable, micaceous, clayey SILT.			
								End of Boring = 19.9 ft bgs			

NOTE(S): See G61S Boring log for sample and testing data.

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

~~R72S~~

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~G72~~
Well ID: ~~G72S~~
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	24/24 100%	SS	3-3 6-6 N=9	20.4			0			614	
2A	24/24 100%	SS	3-5 6-6 N=11	18.3			2	FILL - Yellowish brown (10YR5/8), moist, firm, clayey SILT with slight trace sand and gravel.		612	
3A	24/24 100%	SS	3-5 6-9 N=11	15.7			4			610	
4A	24/24 100%	SS	10-14 16-16 N=30	21.3			6	Yellowish brown (10YR5/8), moist, firm, silty CLAY with slight trace sand and gravel.		608	
5A	24/24 100%	SS	3-4 6-7 N=10	19.3			8			606	
6A	24/24 100%	SS	2-3 6-8 N=9	18.2			10	Yellowish brown (10YR5/8), moist, soft, silty CLAY with slight trace sand.		604	
7A	20/24 83%	SS	5-7 12-13 N=19	9.2			12			602	
8A	24/24 100%	SS	1-3 4-6 N=7	11.1			14	Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, moist, friable, clayey SILT with slight trace sand.		600	
9A	24/24 100%	SS	5-7 10-9 N=17	12.3			16	Light gray (10YR7/1) with 10% yellowish brown (10YR5/8) mottles, moist, friable, SILT with some clay and slight trace sand.		598	
10A	24/24 100%	SS	1-3 4-7 N=7	17.5			18	Dark gray (10YR4/1) with 80% dark yellowish brown (10YR4/4) mottles, moist, friable, clayey SILT with slight trace sand.		596	
	24/24		1-3				20	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand.			

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

FIELD BORING LOG

HANSON

CLIENT: AERG Duck Creek Power Generating Station
Site: Gypsum Management Facility
Location: Canton, Illinois
Project: 03S5010D 1000
DATES: **Start:** 11/19/2008
Finish: 11/19/2008
WEATHER: sunny, cold, (40's)

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: G72
Well ID: G72S
Surface Elev: 615.01 ft. MSL
Completion: 39.40 ft. BGS
Station: 13,905.05N
504.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 28.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	100%	SS	4-8 N=7	16.6			22	Dark yellowish brown (10YR4/8), moist, friable, very clayey SILT with trace sand. *[Continued from previous page]*			
12A	24/24 100%	SS	4-8 12-13 N=20	19.1			24	Dark yellowish brown (10YR4/6) with 40% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		592	
13A	24/24 100%	SS	1-3 5-8 N=8	17.4			26	Grayish brown (10YR5/2) with 30% yellowish brown (10YR5/8) mottles, moist, soft, clayey SILT with trace sand.		590	
14A	24/24 100%	SS	5-6 8-8 N=14	21.2			28 ▼	Yellowish brown (10YR5/8) with 10% gray (10YR6/1) mottles, very moist, soft, silty CLAY with trace sand.		588	
15A	24/24 100%	SS	woh-1 2-3 N=3	26.5			30	Gray (10YR6/1) with 20% yellowish brown (10YR5/8) mottles, very moist to wet, very soft, silty CLAY with trace sand and slight trace gravel.		586	
16A	24/24 100%	SS	1-3 6-10 N=9	19.3				Light gray (10YR7/1) with 30% yellowish brown (10YR5/8) mottles, wet, very soft, clayey SILT with some very fine-grained sand and slight trace gravel.		584	
16B				15.9			32	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.			
17A	20/24 83%	SS	5-10 13-11 N=23	24.9				Brownish yellow (10YR6/6), wet, soft, clayey SILT with trace very fine-grained sand.		582	
18A				27.8			34	Dark gray (10YR4/1), moist, firm, very silty CLAY with slight trace sand.			
18B	24/24 100%	SS	2-6 7-9 N=13	11.1				Dark gray (10YR4/1), moist, loose, SILT and very fine-grained SAND.		580	
19A	24/24 100%	SS	7-9 12-14 N=21	11.1			36	Dark gray (10YR4/1), moist, firm, silty CLAY with trace sand and slight trace gravel.		578	
20A	17/17 100%	SS	26-45 50/5"	9.4			38			576	

End of Boring = 39.40 ft bgs

NOTE(S):

Electronic Filing: Received, Clerk's Office 06/20/2024

WELL CONSTRUCTION LOGS

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: G54C

Site Name: Duck Creek Part 845 Groundwater Borehole #: G54C

State Plane Coordinate: X 2,348,250.1 Y 1,384,885.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Tad A. Gass Date Started: 2/3/2021 Date Finished: 2/5/2021

Report Form Completed By: Tad A. Gass Date: 2/23/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: tremie

Setting Time: 45 min.

Type of Bentonite Seal -- Granular (Pellet) Slurry (choose one)

Installation Method: gravity

Setting Time: 25 min.

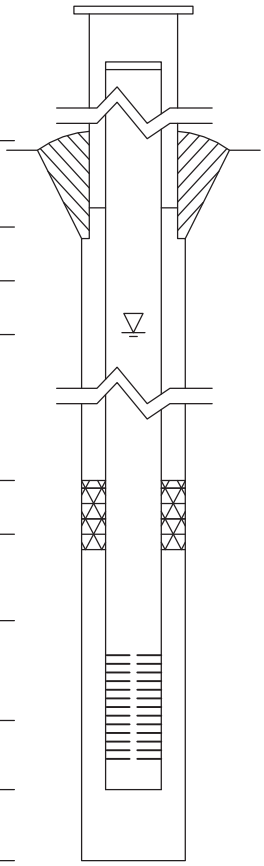
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.03	-3.43	Top of Protective Casing
622.72	-3.13	Top of Riser Pipe
619.59	0.00	Ground Surface
615.59	4.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
530.00	89.59	Top of Sand Pack
528.00	91.59	Top of Screen
518.09	101.50	Bottom of Screen
517.59	102.00	Bottom of Well
517.59	102.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	95.56
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.07
Total Length of Casing	(feet)	105.13
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P61

Site Name: Duck Creek Part 845 Groundwater Borehole #: P61

State Plane Coordinate: X 2,346,779.3 Y 1,398,670.8 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

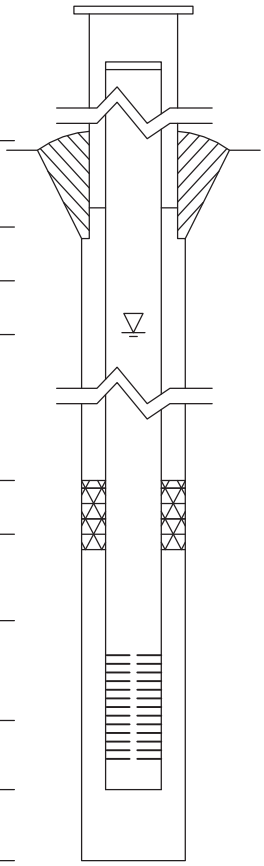
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.31	-3.21	Top of Protective Casing
613.96	-2.87	Top of Riser Pipe
611.09	0.00	Ground Surface
607.58	3.51	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
603.54	7.55	Top of Sand Pack
602.38	8.71	Top of Screen
592.72	18.37	Bottom of Screen
592.33	18.76	Bottom of Well
591.09	20.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	11.58
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	9.66
Total Length of Casing	(feet)	21.63
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P62

Site Name: Duck Creek Part 845 Groundwater Borehole #: P62

State Plane Coordinate: X 2,346,602.3 Y 1,398,887.3 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

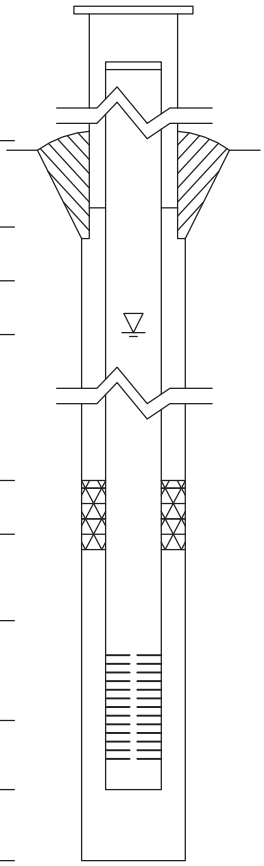
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.96	-3.15	Top of Protective Casing
613.54	-2.73	Top of Riser Pipe
610.81	0.00	Ground Surface
607.89	2.92	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
601.33	9.48	Top of Sand Pack
599.63	11.18	Top of Screen
595.03	15.78	Bottom of Screen
594.51	16.30	Bottom of Well
594.51	16.30	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	16.30
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	4.60
Total Length of Casing	(feet)	21.42
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P63

Site Name: Duck Creek Part 845 Groundwater Borehole #: P63

State Plane Coordinate: X 2,346,605.9 Y 1,399,026.6 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

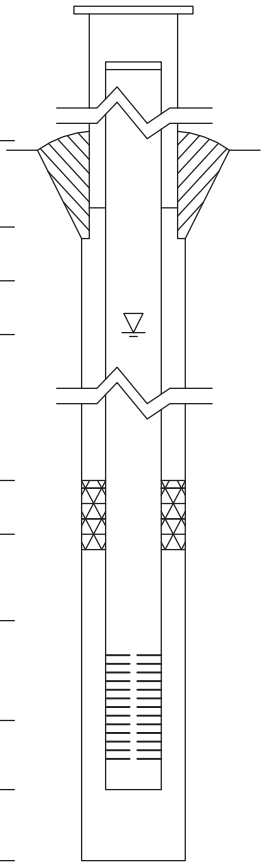
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.85	-2.52	Top of Protective Casing
614.47	-2.15	Top of Riser Pipe
612.33	0.00	Ground Surface
609.23	3.10	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
600.98	11.35	Top of Sand Pack
599.29	13.04	Top of Screen
594.70	17.63	Bottom of Screen
594.08	18.25	Bottom of Well
594.08	18.25	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.19
Bottom of Screen to End Cap	(feet)	0.62
Screen Length (1st slot to last slot)	(feet)	4.59
Total Length of Casing	(feet)	20.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P64

Site Name: Duck Creek Part 845 Groundwater Borehole #: P64

State Plane Coordinate: X 2,346,598.0 Y 1,399,305.9 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/25/2021 Date Finished: 2/25/2021

Report Form Completed By: Tad A. Gass Date: 2/25/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

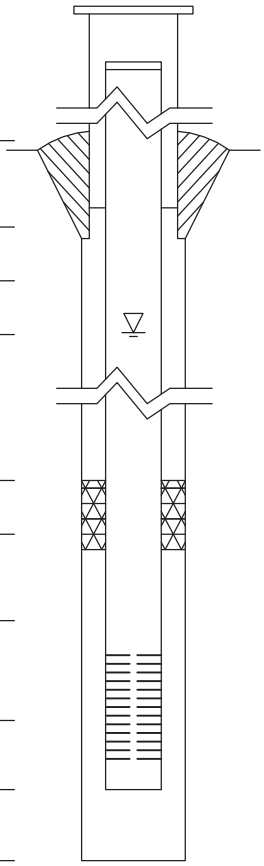
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
616.83	-2.78	Top of Protective Casing
616.47	-2.43	Top of Riser Pipe
614.04	0.00	Ground Surface
611.04	3.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
608.96	5.08	Top of Sand Pack
607.87	6.17	Top of Screen
598.08	15.96	Bottom of Screen
597.57	16.47	Bottom of Well
597.57	16.47	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

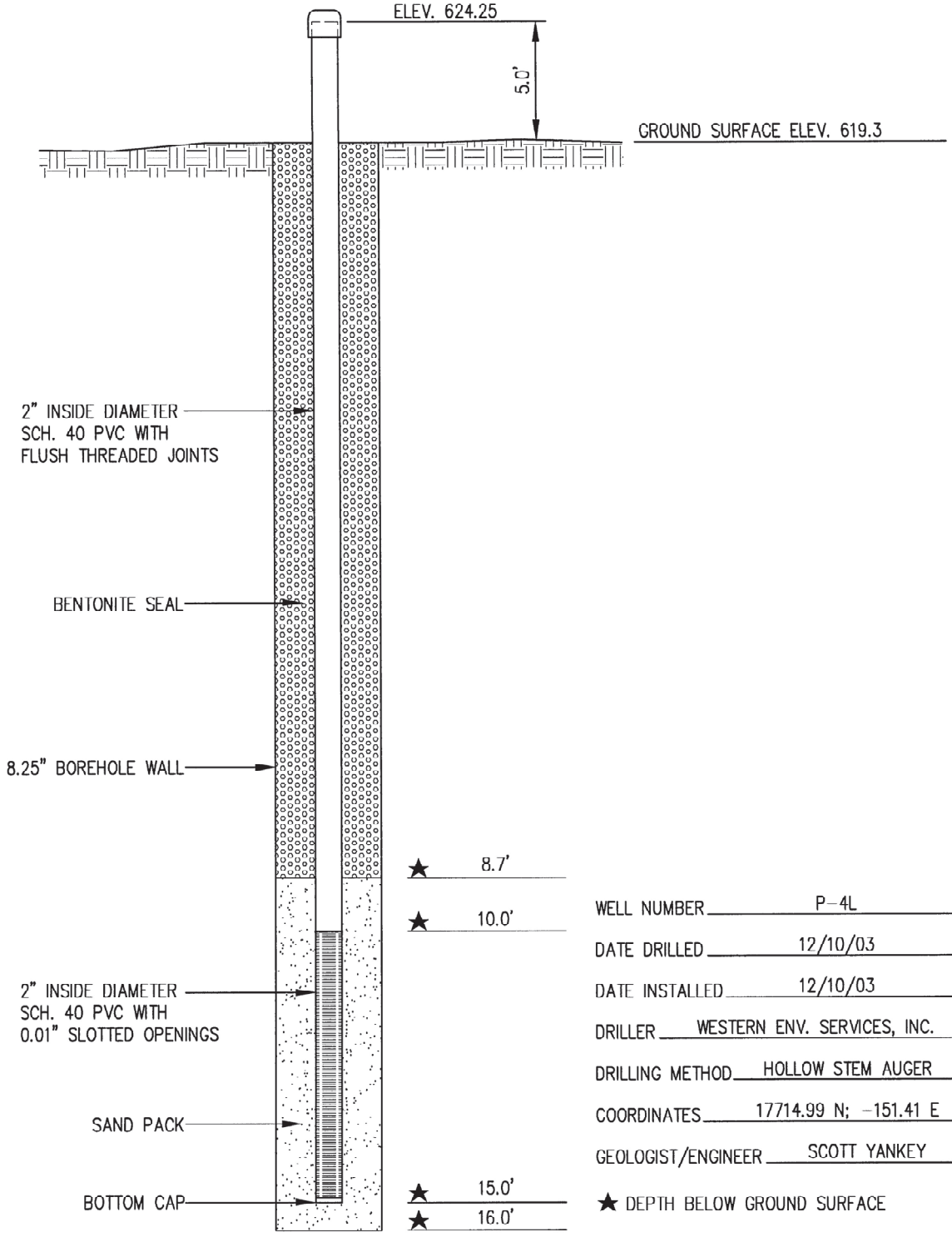
CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	9.19
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	9.19
Total Length of Casing	(feet)	18.90
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

G02L (MW-4L)



WELL NUMBER P-4L

DATE DRILLED 12/10/03

DATE INSTALLED 12/10/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 17714.99 N; -151.41 E

GEOLOGIST/ENGINEER SCOTT YANKEY

★ DEPTH BELOW GROUND SURFACE

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PIEZOMETER P-4L CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 24, 2004 3:13 PM KDE
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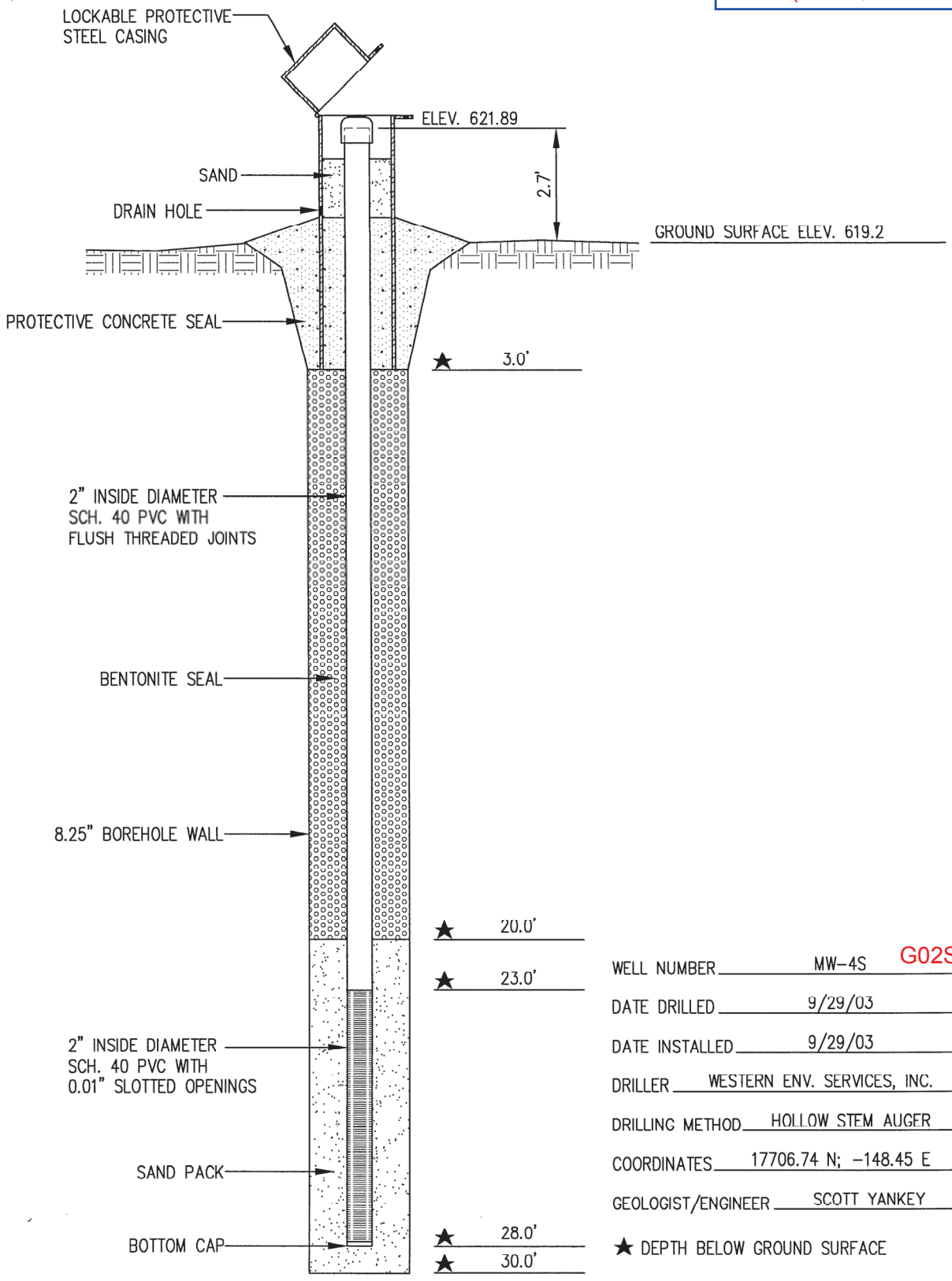
Electronic Filing: Received, Clerk's Office 06/20/2024

G02S (P02S, MW-4S)



WELL NUMBER MW-4S G02S

DATE DRILLED 9/29/03

DATE INSTALLED 9/29/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 17706.74 N; -148.45 E

GEOLOGIST/ENGINEER SCOTT YANKEY

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MONITORING WELL MW-4S CONSTRUCTION DETAIL

PHASE II HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 23, 2004 1:50 PM KDE
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Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50L (MW51L)

Site #: _____ County: Fulton Well #: ~~MW51L~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51a~~

State Plane Coordinate: X 16,174.9 Y -5.3 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: gravity

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hr

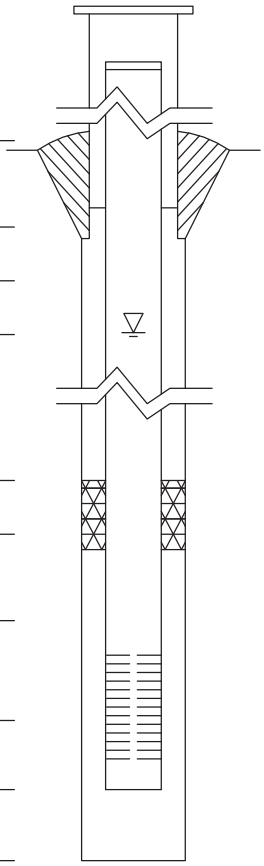
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.31	-3.47	Top of Protective Casing
623.83	-2.99	Top of Riser Pipe
620.84	0.00	Ground Surface
620.54	0.30	Top of Annular Sealant
615.27	5.57	Static Water Level (After Completion) 3/29/2007
620.54	0.30	Top of Seal
610.81	10.03	Top of Sand Pack
609.23	11.61	Top of Screen
604.52	16.32	Bottom of Screen
604.13	16.71	Bottom of Well
604.13	16.71	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	14.60
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	19.70
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50S (MW51S)

Site #: _____ County: Fulton Well #: ~~MW51S~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51b~~

State Plane Coordinate: X 16,180.8 Y -5.1 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- [Granular] Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

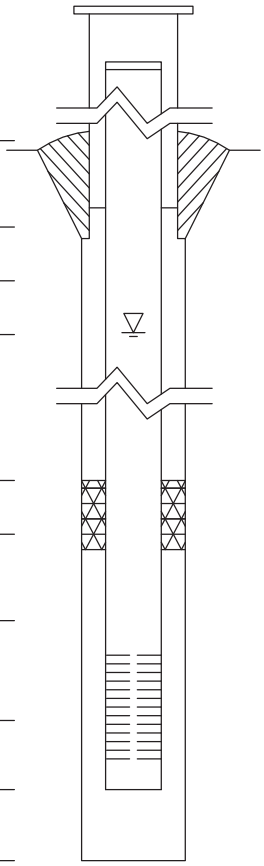
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.22	-3.38	Top of Protective Casing
623.82	-2.98	Top of Riser Pipe
620.84	0.00	Ground Surface
620.54	0.30	Top of Annular Sealant
614.98	5.86	Static Water Level (After Completion) 3/29/2007
597.42	23.42	Top of Seal
593.80	27.04	Top of Sand Pack
591.67	29.17	Top of Screen
586.86	33.98	Bottom of Screen
586.52	34.32	Bottom of Well
586.52	34.32	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: [Steel]
Riser Pipe Above W.T.	SS304	SS316	PTFE	[PVC]	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	[PVC]	OTHER:
Screen	SS304	SS316	PTFE	[PVC]	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.25
Bottom of Screen to End Cap	(feet)	0.34
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	37.30
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.7 Y 15,409.7 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time:

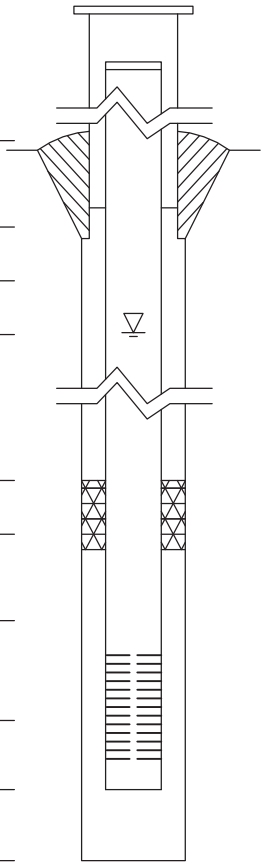
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand
(if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.35	-3.44	Top of Protective Casing
619.91	-3.00	Top of Riser Pipe
616.91	0.00	Ground Surface
614.81	2.10	Top of Annular Sealant
606.34	10.57	Static Water Level (After Completion) 1/30/2008
614.81	2.10	Top of Seal
606.77	10.14	Top of Sand Pack
604.87	12.04	Top of Screen
600.08	16.83	Bottom of Screen
599.70	17.21	Bottom of Well
599.19	17.72	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.15
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	20.32
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51a~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.3 Y 15,405.4 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

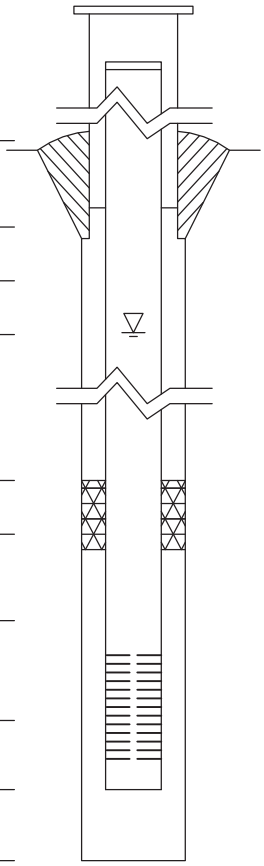
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.32	-3.52	Top of Protective Casing
619.81	-3.01	Top of Riser Pipe
616.80	0.00	Ground Surface
614.50	2.30	Top of Annular Sealant
606.39	10.41	Static Water Level (After Completion) 1/30/2008
597.05	19.75	Top of Seal
594.58	22.22	Top of Sand Pack
592.79	24.01	Top of Screen
588.01	28.79	Bottom of Screen
587.64	29.16	Bottom of Well
587.64	29.16	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	27.02
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	32.17
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.5 Y 14,660.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/22/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method:

Setting Time: 12 hrs

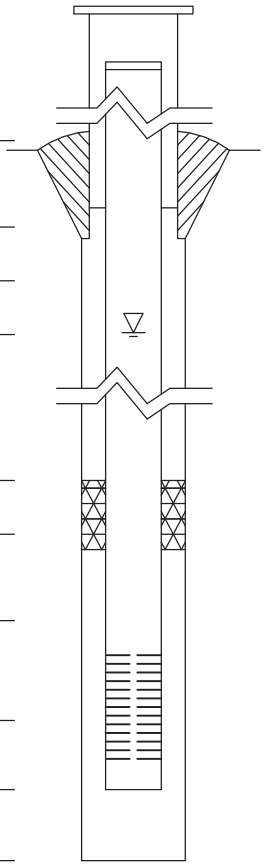
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.10	-3.40	Top of Protective Casing
619.64	-2.94	Top of Riser Pipe
616.70	0.00	Ground Surface
614.50	2.20	Top of Annular Sealant
587.92	28.78	Static Water Level (After Completion) 1/30/2008
591.25	25.45	Top of Seal
588.79	27.91	Top of Sand Pack
587.49	29.21	Top of Screen
582.90	33.80	Bottom of Screen
582.53	34.17	Bottom of Well
582.53	34.17	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.15
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	37.31
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.1 Y 14,655.3 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/21/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 min

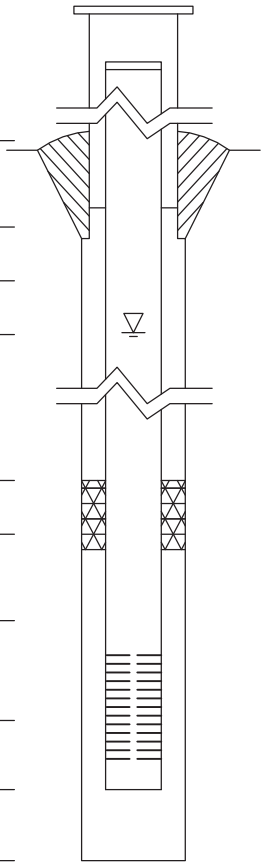
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.19	-3.66	Top of Protective Casing
619.64	-3.11	Top of Riser Pipe
616.53	0.00	Ground Surface
613.33	3.20	Top of Annular Sealant
584.08	32.45	Static Water Level (After Completion) 1/30/2008
582.26	34.27	Top of Seal
579.31	37.22	Top of Sand Pack
577.38	39.15	Top of Screen
572.60	43.93	Bottom of Screen
572.33	44.20	Bottom of Well
570.53	46.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	42.29
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	47.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53L

Site Name: Gypsum Management Facility Borehole #: ~~G53a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 506.3 Y 16,200.0 (or) Latitude: _____ Longitude: _____

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

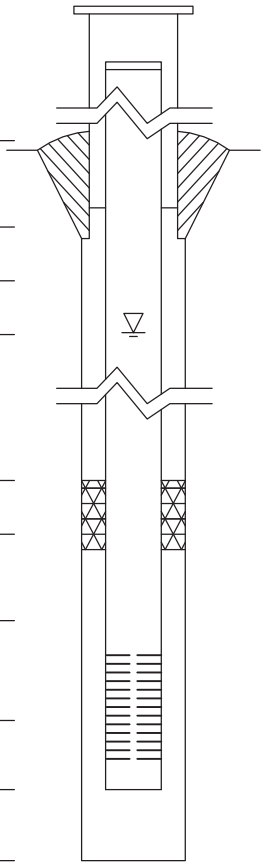
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.61	-3.32	Top of Protective Casing
623.28	-2.99	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
600.45	19.84	Static Water Level (After Completion) 3/4/2009
607.79	12.50	Top of Seal
605.67	14.62	Top of Sand Pack
603.32	16.97	Top of Screen
593.97	26.32	Bottom of Screen
593.50	26.79	Bottom of Well
593.50	26.79	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.96
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	29.78
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53S

Site Name: Gypsum Management Facility Borehole #: ~~G53~~

~~State~~ Plant ~~Plane~~ Coordinate: X 510.5 Y 16,199.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

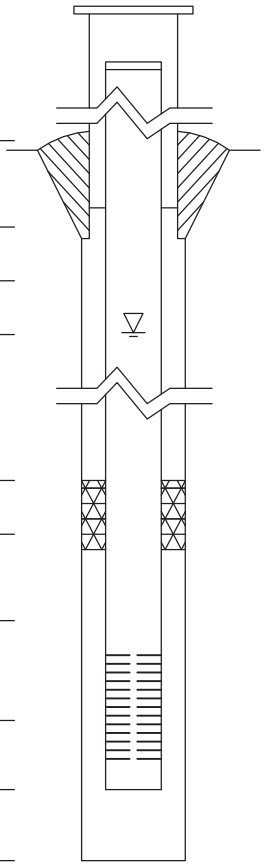
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.33	-3.04	Top of Protective Casing
623.17	-2.88	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
599.63	20.66	Static Water Level (After Completion) 3/4/2009
595.29	25.00	Top of Seal
592.29	28.00	Top of Sand Pack
589.65	30.64	Top of Screen
585.16	35.13	Bottom of Screen
584.73	35.56	Bottom of Well
584.25	36.04	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	33.52
Bottom of Screen to End Cap	(feet)	0.43
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	38.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: G54C

Site Name: Duck Creek Part 845 Groundwater Borehole #: G54C

State Plane Coordinate: X 2,348,250.1 Y 1,384,885.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Tad A. Gass Date Started: 2/3/2021 Date Finished: 2/5/2021

Report Form Completed By: Tad A. Gass Date: 2/23/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: tremie

Setting Time: 45 min.

Type of Bentonite Seal -- Granular (Pellet) Slurry (choose one)

Installation Method: gravity

Setting Time: 25 min.

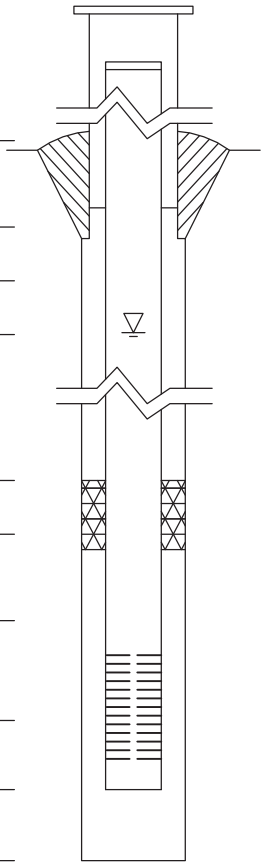
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.03	-3.43	Top of Protective Casing
622.72	-3.13	Top of Riser Pipe
619.59	0.00	Ground Surface
615.59	4.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
530.00	89.59	Top of Sand Pack
528.00	91.59	Top of Screen
518.09	101.50	Bottom of Screen
517.59	102.00	Bottom of Well
517.59	102.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	95.56
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.07
Total Length of Casing	(feet)	105.13
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54L

Site Name: Gypsum Management Facility Borehole #: ~~G54a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 463.8 Y 14,664.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

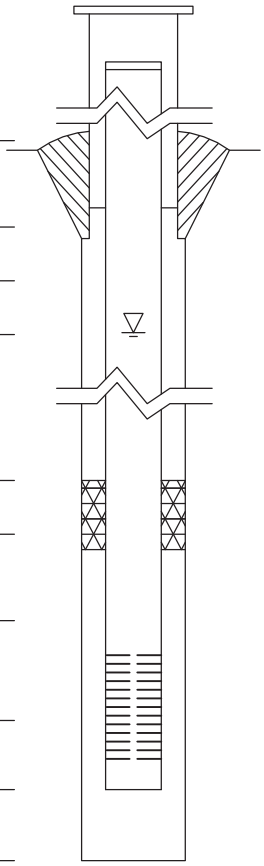
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.37	-3.09	Top of Protective Casing
623.00	-2.72	Top of Riser Pipe
620.28	0.00	Ground Surface
618.48	1.80	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
597.78	22.50	Top of Seal
595.28	25.00	Top of Sand Pack
592.96	27.32	Top of Screen
583.53	36.75	Bottom of Screen
583.06	37.22	Bottom of Well
583.06	37.22	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.04
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.43
Total Length of Casing	(feet)	39.94
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54S

Site Name: Gypsum Management Facility Borehole #: ~~G54~~

~~State~~ Plant ~~Plane~~ Coordinate: X 460.5 Y 14,664.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

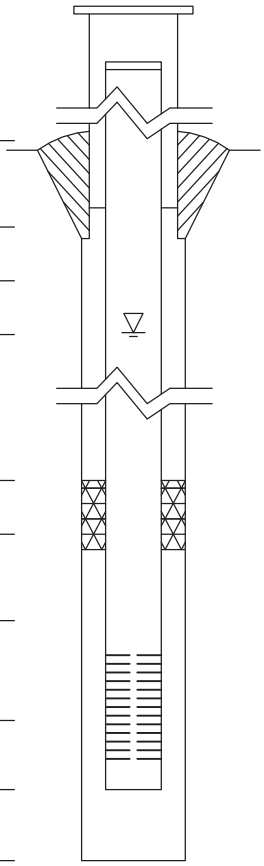
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.54	-3.26	Top of Protective Casing
623.13	-2.85	Top of Riser Pipe
620.28	0.00	Ground Surface
618.38	1.90	Top of Annular Sealant
580.98	39.30	Static Water Level (After Completion) 3/4/2009
580.78	39.50	Top of Seal
578.61	41.67	Top of Sand Pack
576.78	43.50	Top of Screen
572.31	47.97	Bottom of Screen
571.87	48.41	Bottom of Well
571.87	48.41	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	46.50
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.47
Total Length of Casing	(feet)	51.41
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55L

Site Name: Gypsum Management Facility Borehole #: ~~G55a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.1 Y 14,667.7 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 22 minutes

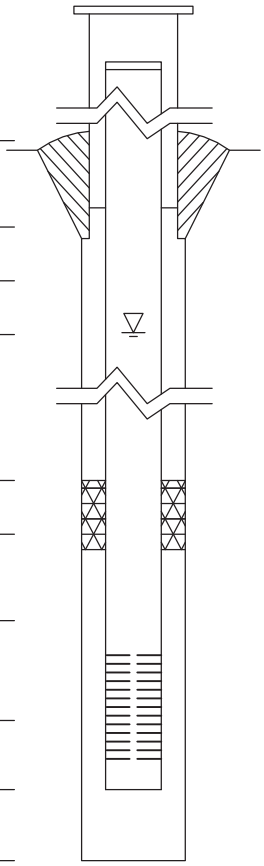
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.47	-3.69	Top of Protective Casing
623.28	-3.50	Top of Riser Pipe
619.78	0.00	Ground Surface
617.78	2.00	Top of Annular Sealant
585.79	33.99	Static Water Level (After Completion) 3/4/2009
597.95	21.83	Top of Seal
596.28	23.50	Top of Sand Pack
593.02	26.76	Top of Screen
583.66	36.12	Bottom of Screen
583.18	36.60	Bottom of Well
583.18	36.60	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.26
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	40.10
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55S

Site Name: Gypsum Management Facility Borehole #: ~~G55~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.0 Y 14,663.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 55 minutes

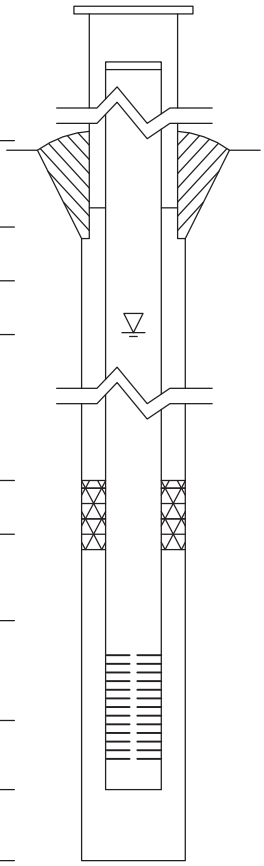
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.21	-3.43	Top of Protective Casing
622.91	-3.13	Top of Riser Pipe
619.78	0.00	Ground Surface
617.95	1.83	Top of Annular Sealant
586.49	33.29	Static Water Level (After Completion) 3/4/2009
582.78	37.00	Top of Seal
580.95	38.83	Top of Sand Pack
578.74	41.04	Top of Screen
574.29	45.49	Bottom of Screen
573.82	45.96	Bottom of Well
573.82	45.96	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

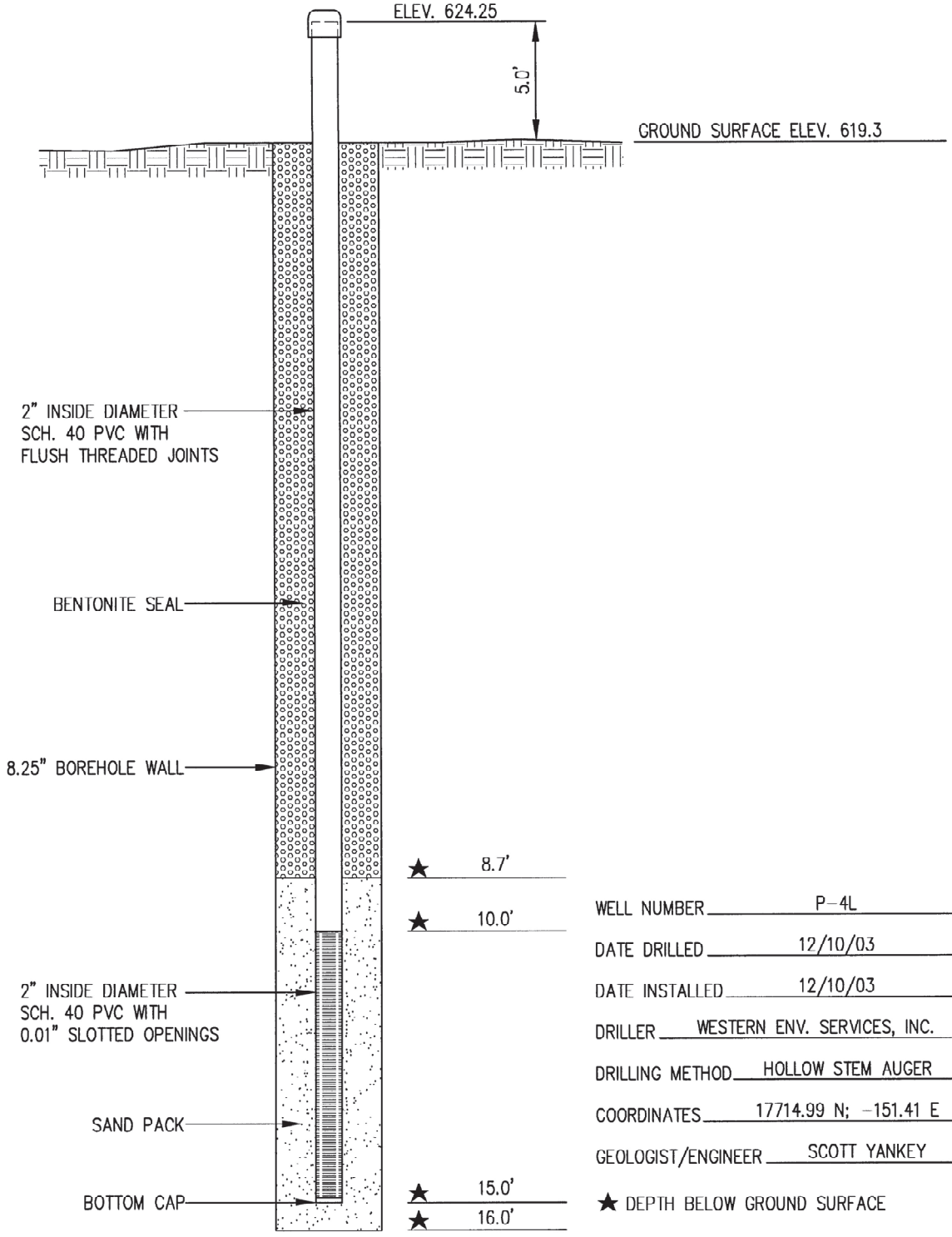
CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	44.17
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	4.45
Total Length of Casing	(feet)	49.09
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

G02L (MW-4L)



WELL NUMBER P-4L

DATE DRILLED 12/10/03

DATE INSTALLED 12/10/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 17714.99 N; -151.41 E

GEOLOGIST/ENGINEER SCOTT YANKEY

★ DEPTH BELOW GROUND SURFACE

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PIEZOMETER P-4L CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 24, 2004 3:13 PM KDE
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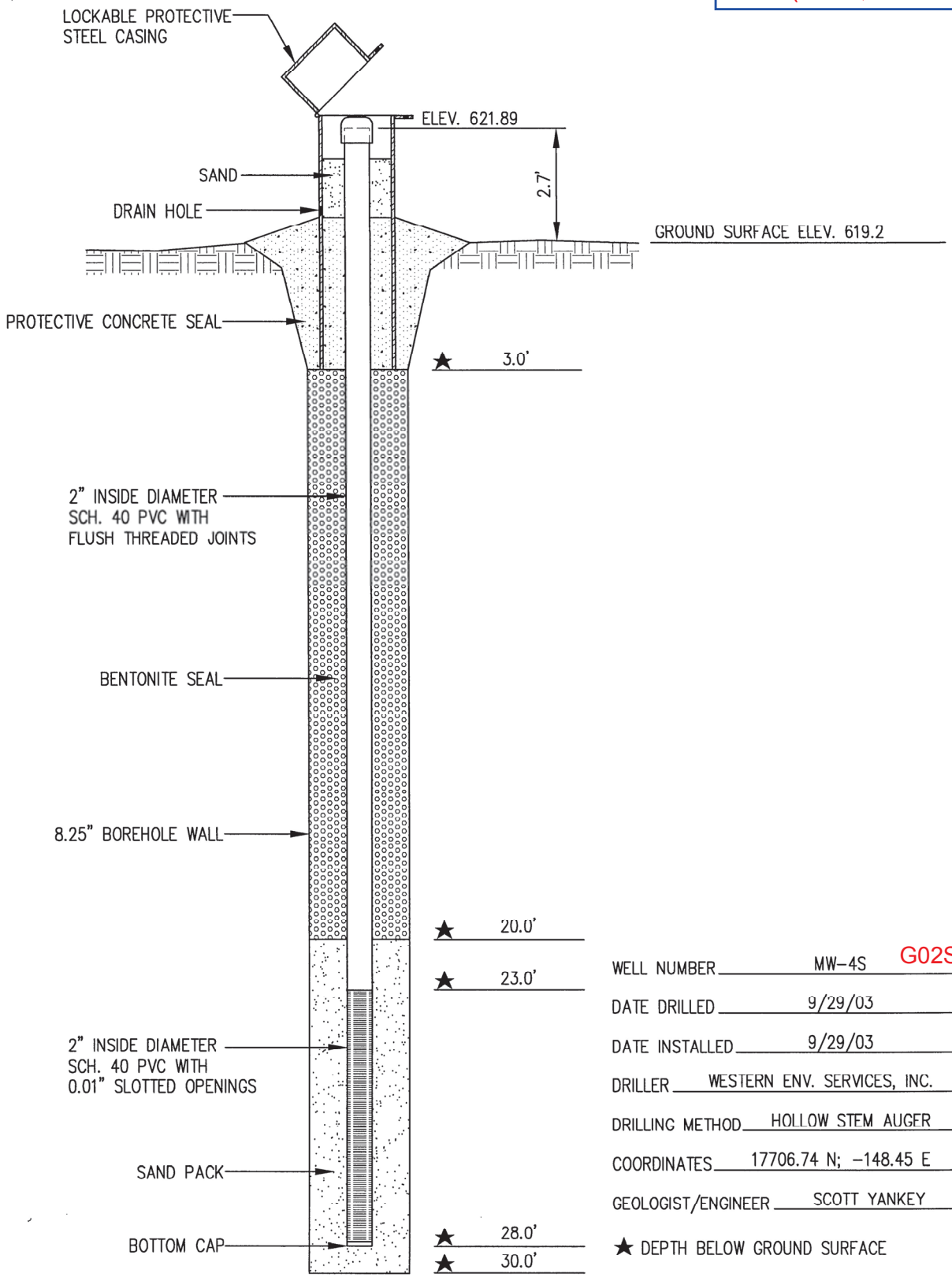
Electronic Filing: Received, Clerk's Office 06/20/2024

G02S (P02S, MW-4S)



G02S

WELL NUMBER MW-4S

DATE DRILLED 9/29/03

DATE INSTALLED 9/29/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 17706.74 N; -148.45 E

GEOLOGIST/ENGINEER SCOTT YANKEY

★ DEPTH BELOW GROUND SURFACE

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MONITORING WELL MW-4S CONSTRUCTION DETAIL

PHASE II HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

AUG 23, 2004 1:50 PM KDE
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Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50L (MW51L)

Site #: _____ County: Fulton Well #: ~~MW51L~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51a~~

State Plane Coordinate: X 16,174.9 Y -5.3 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: gravity

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: >24 hr

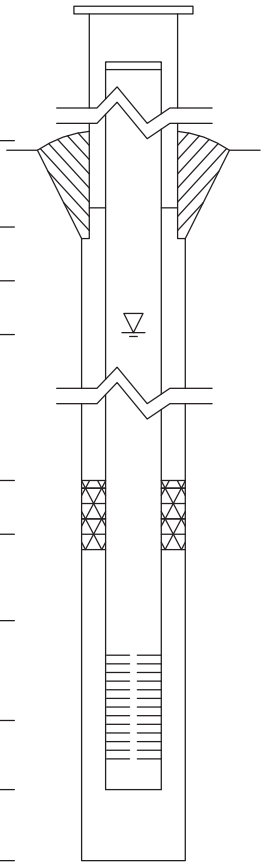
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____
(if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.31	-3.47	Top of Protective Casing
623.83	-2.99	Top of Riser Pipe
620.84	0.00	Ground Surface
620.54	0.30	Top of Annular Sealant
615.27	5.57	Static Water Level (After Completion) 3/29/2007
620.54	0.30	Top of Seal
610.81	10.03	Top of Sand Pack
609.23	11.61	Top of Screen
604.52	16.32	Bottom of Screen
604.13	16.71	Bottom of Well
604.13	16.71	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	14.60
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	19.70
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

G50S (MW51S)

Site #: _____ County: Fulton Well #: ~~MW51S~~

Site Name: Ameren Gypsum Stack Borehole #: ~~B-51b~~

State Plane Coordinate: X 16,180.8 Y -5.1 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, 196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Ryan Keedy Date Started: 3/13/2007 Date Finished: 3/13/2007

Report Form Completed By: Rhonald W Hasenyager Date: 4/17/2007

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- [Granular] Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

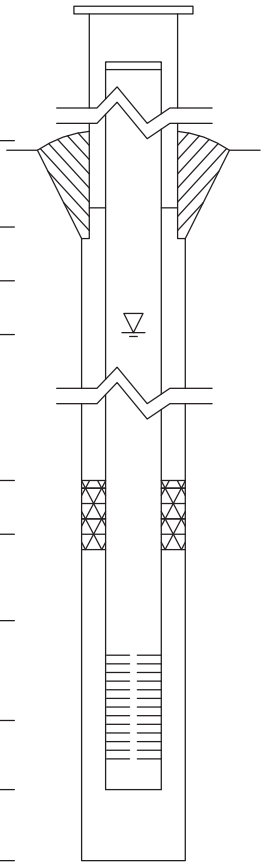
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
624.22	-3.38	Top of Protective Casing
623.82	-2.98	Top of Riser Pipe
620.84	0.00	Ground Surface
620.54	0.30	Top of Annular Sealant
614.98	5.86	Static Water Level (After Completion) 3/29/2007
597.42	23.42	Top of Seal
593.80	27.04	Top of Sand Pack
591.67	29.17	Top of Screen
586.86	33.98	Bottom of Screen
586.52	34.32	Bottom of Well
586.52	34.32	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: [Steel]
Riser Pipe Above W.T.	SS304	SS316	PTFE	[PVC]	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	[PVC]	OTHER:
Screen	SS304	SS316	PTFE	[PVC]	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.25
Bottom of Screen to End Cap	(feet)	0.34
Screen Length (1st slot to last slot)	(feet)	4.71
Total Length of Casing	(feet)	37.30
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.7 Y 15,409.7 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time:

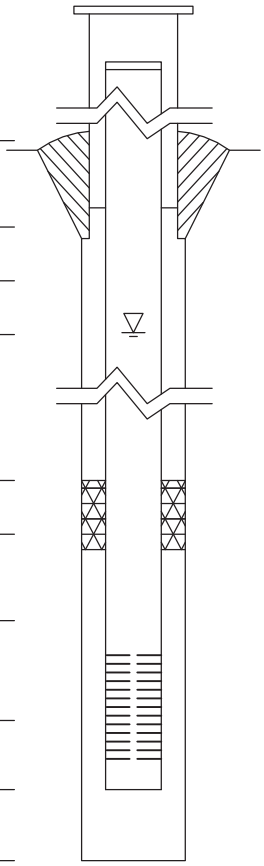
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand
(if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.35	-3.44	Top of Protective Casing
619.91	-3.00	Top of Riser Pipe
616.91	0.00	Ground Surface
614.81	2.10	Top of Annular Sealant
606.34	10.57	Static Water Level (After Completion) 1/30/2008
614.81	2.10	Top of Seal
606.77	10.14	Top of Sand Pack
604.87	12.04	Top of Screen
600.08	16.83	Bottom of Screen
599.70	17.21	Bottom of Well
599.19	17.72	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.15
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	20.32
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G51S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG51a~~

~~State~~ Plant ~~Plane~~ Coordinate: X -75.3 Y 15,405.4 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/28/2008 Date Finished: 1/28/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

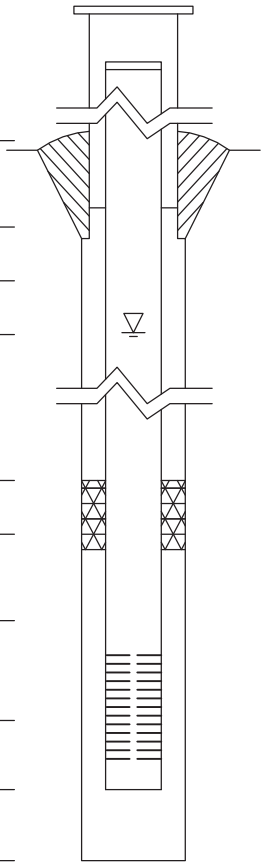
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.32	-3.52	Top of Protective Casing
619.81	-3.01	Top of Riser Pipe
616.80	0.00	Ground Surface
614.50	2.30	Top of Annular Sealant
606.39	10.41	Static Water Level (After Completion) 1/30/2008
597.05	19.75	Top of Seal
594.58	22.22	Top of Sand Pack
592.79	24.01	Top of Screen
588.01	28.79	Bottom of Screen
587.64	29.16	Bottom of Well
587.64	29.16	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	27.02
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	32.17
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52b~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.5 Y 14,660.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/22/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method:

Setting Time: 12 hrs

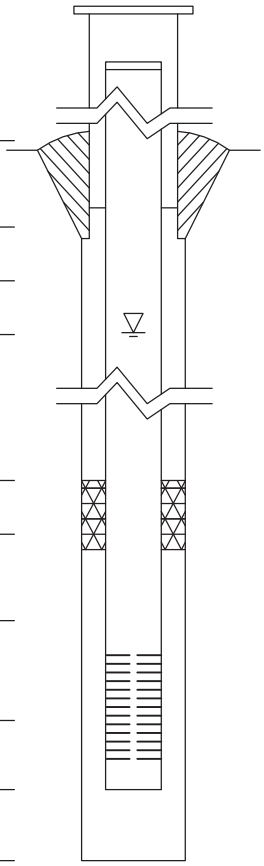
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.10	-3.40	Top of Protective Casing
619.64	-2.94	Top of Riser Pipe
616.70	0.00	Ground Surface
614.50	2.20	Top of Annular Sealant
587.92	28.78	Static Water Level (After Completion) 1/30/2008
591.25	25.45	Top of Seal
588.79	27.91	Top of Sand Pack
587.49	29.21	Top of Screen
582.90	33.80	Bottom of Screen
582.53	34.17	Bottom of Well
582.53	34.17	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.15
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	37.31
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G52S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG52~~

~~State~~ Plant ~~Plane~~ Coordinate: X -76.1 Y 14,655.3 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/21/2008 Date Finished: 1/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 min

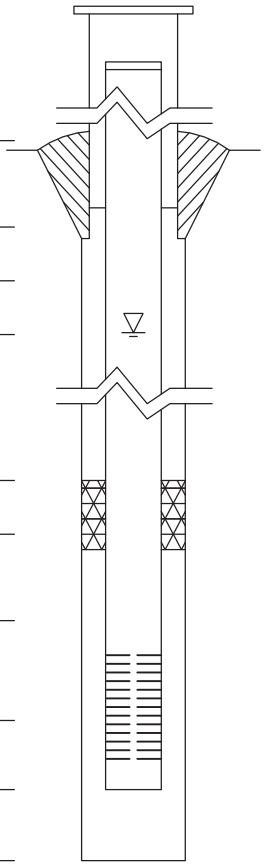
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
620.19	-3.66	Top of Protective Casing
619.64	-3.11	Top of Riser Pipe
616.53	0.00	Ground Surface
613.33	3.20	Top of Annular Sealant
584.08	32.45	Static Water Level (After Completion) 1/30/2008
582.26	34.27	Top of Seal
579.31	37.22	Top of Sand Pack
577.38	39.15	Top of Screen
572.60	43.93	Bottom of Screen
572.33	44.20	Bottom of Well
570.53	46.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	42.29
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	47.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53L

Site Name: Gypsum Management Facility Borehole #: ~~G53a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 506.3 Y 16,200.0 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

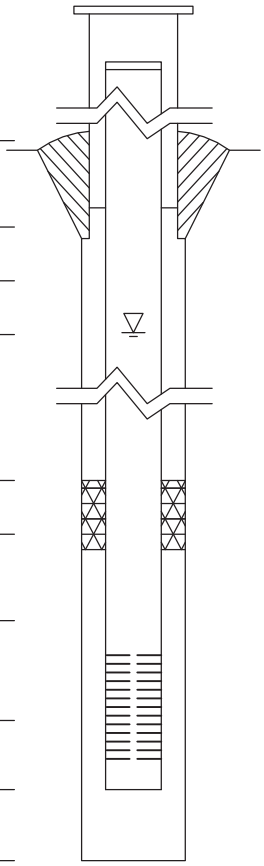
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.61	-3.32	Top of Protective Casing
623.28	-2.99	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
600.45	19.84	Static Water Level (After Completion) 3/4/2009
607.79	12.50	Top of Seal
605.67	14.62	Top of Sand Pack
603.32	16.97	Top of Screen
593.97	26.32	Bottom of Screen
593.50	26.79	Bottom of Well
593.50	26.79	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.96
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	29.78
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G53S

Site Name: Gypsum Management Facility Borehole #: ~~G53~~

~~State~~ Plant ~~Plane~~ Coordinate: X 510.5 Y 16,199.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/5/2009 Date Finished: 2/5/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

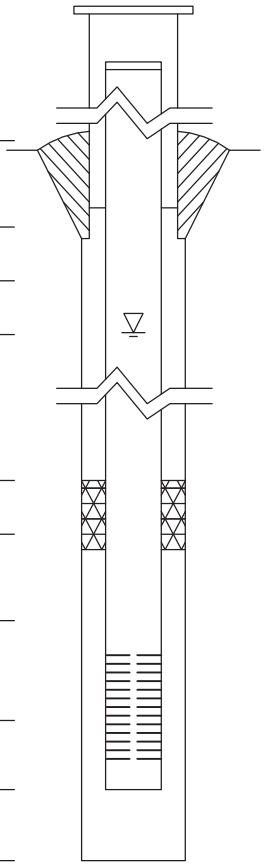
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.33	-3.04	Top of Protective Casing
623.17	-2.88	Top of Riser Pipe
620.29	0.00	Ground Surface
618.29	2.00	Top of Annular Sealant
599.63	20.66	Static Water Level (After Completion) 3/4/2009
595.29	25.00	Top of Seal
592.29	28.00	Top of Sand Pack
589.65	30.64	Top of Screen
585.16	35.13	Bottom of Screen
584.73	35.56	Bottom of Well
584.25	36.04	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	33.52
Bottom of Screen to End Cap	(feet)	0.43
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	38.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: G54C

Site Name: Duck Creek Part 845 Groundwater Borehole #: G54C

State Plane Coordinate: X 2,348,250.1 Y 1,384,885.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Tad A. Gass Date Started: 2/3/2021 Date Finished: 2/5/2021

Report Form Completed By: Tad A. Gass Date: 2/23/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: tremie

Setting Time: 45 min.

Type of Bentonite Seal -- Granular (Pellet) Slurry (choose one)

Installation Method: gravity

Setting Time: 25 min.

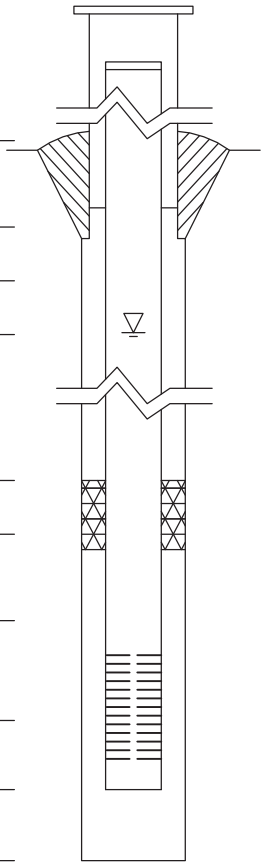
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.03	-3.43	Top of Protective Casing
622.72	-3.13	Top of Riser Pipe
619.59	0.00	Ground Surface
615.59	4.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
530.00	89.59	Top of Sand Pack
528.00	91.59	Top of Screen
518.09	101.50	Bottom of Screen
517.59	102.00	Bottom of Well
517.59	102.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: (Steel)
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	95.56
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.07
Total Length of Casing	(feet)	105.13
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54L

Site Name: Gypsum Management Facility Borehole #: ~~G54a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 463.8 Y 14,664.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

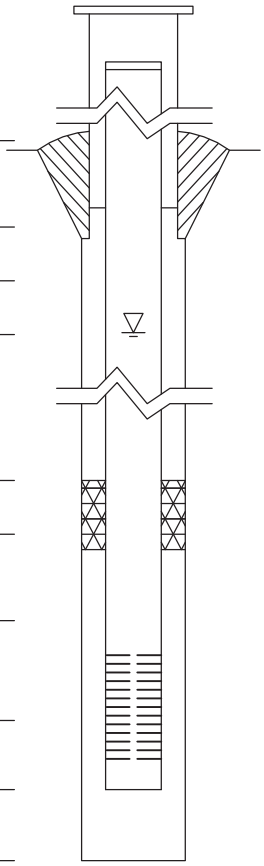
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.37	-3.09	Top of Protective Casing
623.00	-2.72	Top of Riser Pipe
620.28	0.00	Ground Surface
618.48	1.80	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
597.78	22.50	Top of Seal
595.28	25.00	Top of Sand Pack
592.96	27.32	Top of Screen
583.53	36.75	Bottom of Screen
583.06	37.22	Bottom of Well
583.06	37.22	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.04
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.43
Total Length of Casing	(feet)	39.94
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G54S

Site Name: Gypsum Management Facility Borehole #: ~~G54~~

~~State~~ Plant ~~Plane~~ Coordinate: X 460.5 Y 14,664.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/12/2009 Date Finished: 2/12/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

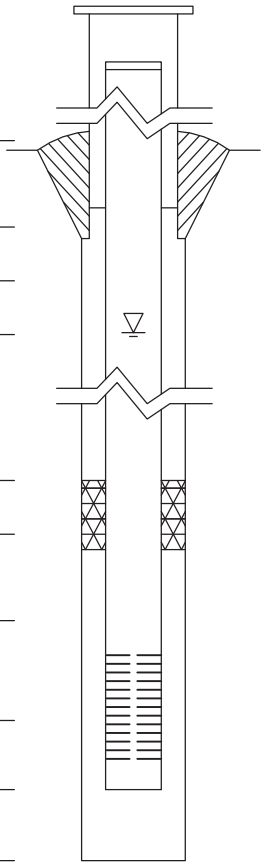
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.54	-3.26	Top of Protective Casing
623.13	-2.85	Top of Riser Pipe
620.28	0.00	Ground Surface
618.38	1.90	Top of Annular Sealant
580.98	39.30	Static Water Level (After Completion) 3/4/2009
580.78	39.50	Top of Seal
578.61	41.67	Top of Sand Pack
576.78	43.50	Top of Screen
572.31	47.97	Bottom of Screen
571.87	48.41	Bottom of Well
571.87	48.41	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	46.50
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.47
Total Length of Casing	(feet)	51.41
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55L

Site Name: Gypsum Management Facility Borehole #: ~~G55a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.1 Y 14,667.7 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 22 minutes

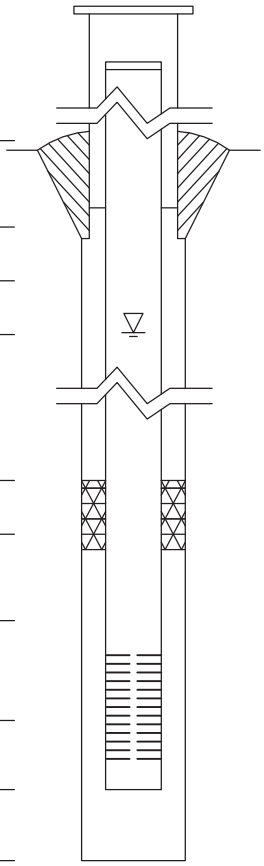
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.47	-3.69	Top of Protective Casing
623.28	-3.50	Top of Riser Pipe
619.78	0.00	Ground Surface
617.78	2.00	Top of Annular Sealant
585.79	33.99	Static Water Level (After Completion) 3/4/2009
597.95	21.83	Top of Seal
596.28	23.50	Top of Sand Pack
593.02	26.76	Top of Screen
583.66	36.12	Bottom of Screen
583.18	36.60	Bottom of Well
583.18	36.60	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.26
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	40.10
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G55S

Site Name: Gypsum Management Facility Borehole #: ~~G55~~

~~State~~ Plant ~~Plane~~ Coordinate: X 705.0 Y 14,663.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/19/2009 Date Finished: 2/19/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 55 minutes

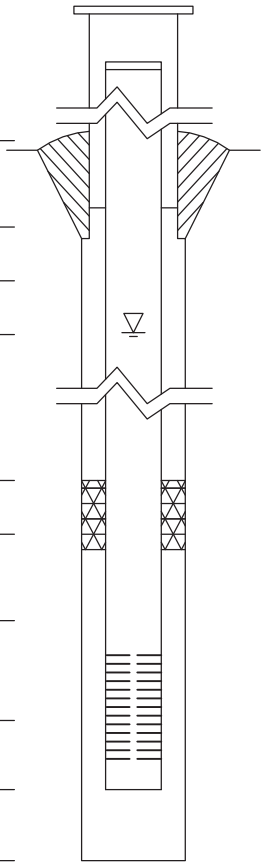
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.21	-3.43	Top of Protective Casing
622.91	-3.13	Top of Riser Pipe
619.78	0.00	Ground Surface
617.95	1.83	Top of Annular Sealant
586.49	33.29	Static Water Level (After Completion) 3/4/2009
582.78	37.00	Top of Seal
580.95	38.83	Top of Sand Pack
578.74	41.04	Top of Screen
574.29	45.49	Bottom of Screen
573.82	45.96	Bottom of Well
573.82	45.96	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	44.17
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	4.45
Total Length of Casing	(feet)	49.09
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G56L

Site Name: Gypsum Management Facility Borehole #: ~~G56a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 979.2 Y 14,708.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/16/2009 Date Finished: 2/16/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

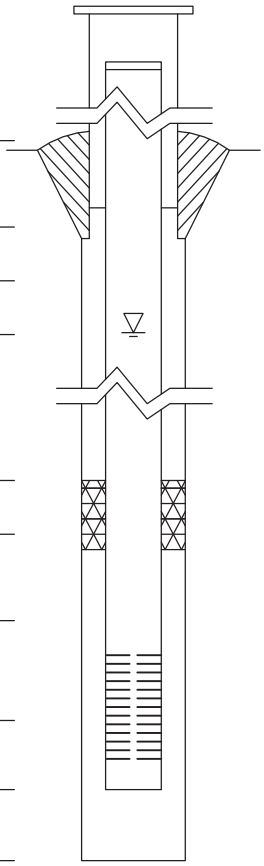
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.94	-3.03	Top of Protective Casing
622.37	-2.46	Top of Riser Pipe
619.91	0.00	Ground Surface
617.91	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
617.91	2.00	Top of Seal
608.91	11.00	Top of Sand Pack
606.14	13.77	Top of Screen
597.80	22.11	Bottom of Screen
597.02	22.89	Bottom of Well
597.02	22.89	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	16.23
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.34
Total Length of Casing	(feet)	26.35
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G56S

Site Name: Gypsum Management Facility Borehole #: ~~G56~~

~~State~~ Plant ~~Plane~~ Coordinate: X 978.8 Y 14,705.0 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/16/2009 Date Finished: 2/16/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 45 minutes

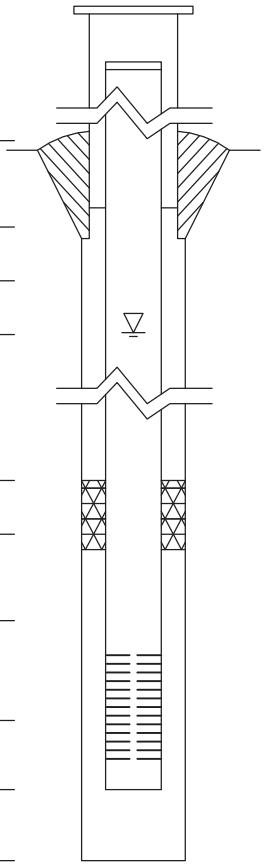
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.14	-3.23	Top of Protective Casing
622.74	-2.83	Top of Riser Pipe
619.91	0.00	Ground Surface
617.95	1.96	Top of Annular Sealant
589.36	30.55	Static Water Level (After Completion) 3/4/2009
591.83	28.08	Top of Seal
588.76	31.15	Top of Sand Pack
586.74	33.17	Top of Screen
582.25	37.66	Bottom of Screen
581.62	38.29	Bottom of Well
579.91	40.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	36.00
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	41.12
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G57L

Site Name: Gypsum Management Facility Borehole #: ~~G57a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 987.5 Y 15,064.7 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 1/30/2009 Date Finished: 1/30/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

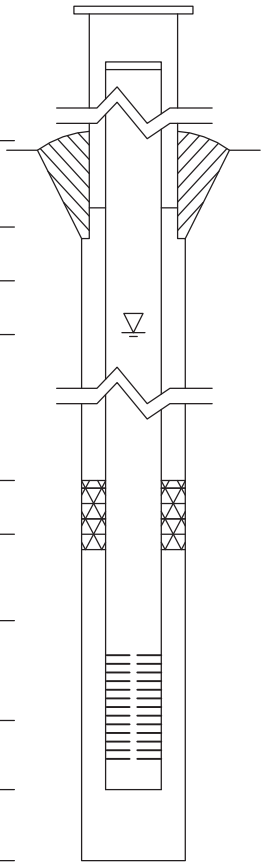
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.12	-3.14	Top of Protective Casing
622.93	-2.95	Top of Riser Pipe
619.98	0.00	Ground Surface
617.98	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
608.48	11.50	Top of Seal
605.48	14.50	Top of Sand Pack
603.81	16.17	Top of Screen
594.36	25.62	Bottom of Screen
593.98	26.00	Bottom of Well
593.98	26.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.12
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	28.95
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G57S

Site Name: Gypsum Management Facility Borehole #: ~~G57~~

~~State~~ Plant ~~Plane~~ Coordinate: X 987.5 Y 15,060.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 1/30/2009 Date Finished: 1/30/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 42 minutes

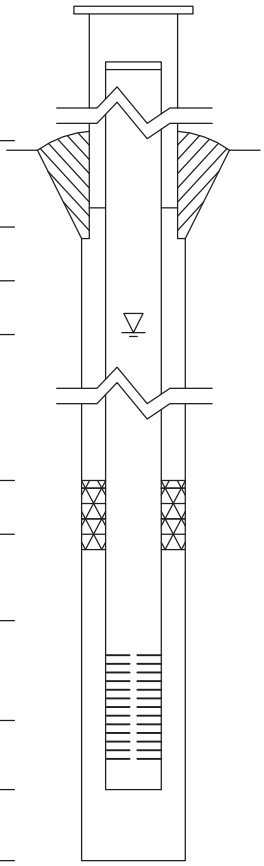
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.96	-2.98	Top of Protective Casing
622.76	-2.78	Top of Riser Pipe
619.98	0.00	Ground Surface
617.98	2.00	Top of Annular Sealant
588.50	31.48	Static Water Level (After Completion) 3/4/2009
596.98	23.00	Top of Seal
593.18	26.80	Top of Sand Pack
590.33	29.65	Top of Screen
585.80	34.18	Bottom of Screen
585.36	34.62	Bottom of Well
581.98	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.43
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.53
Total Length of Casing	(feet)	37.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G58L

Site Name: Gypsum Management Facility Borehole #: ~~G58a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 989.0 Y 15,204.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/26/2009 Date Finished: 1/26/2009

Report Form Completed By: Suzanna Simpson Date: 1/30/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

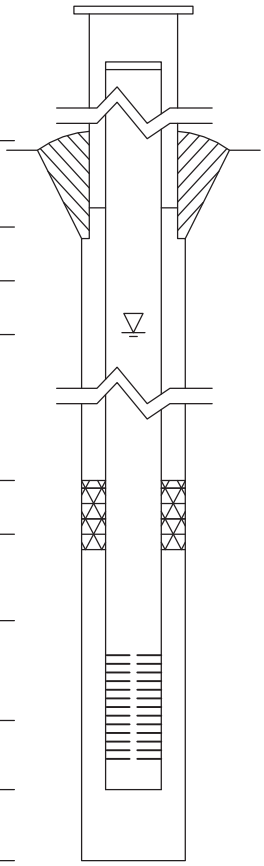
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.24	-3.20	Top of Protective Casing
623.04	-3.00	Top of Riser Pipe
620.04	0.00	Ground Surface
617.94	2.10	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
604.54	15.50	Top of Seal
601.49	18.55	Top of Sand Pack
599.35	20.69	Top of Screen
589.94	30.10	Bottom of Screen
589.48	30.56	Bottom of Well
589.48	30.56	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	23.69
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	9.41
Total Length of Casing	(feet)	33.56
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G58S

Site Name: Gypsum Management Facility Borehole #: ~~G58~~

~~State~~ Plant ~~Plane~~ Coordinate: X 989.6 Y 15,200.2 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/26/2009 Date Finished: 1/26/2009

Report Form Completed By: Suzanna Simpson Date: 1/30/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

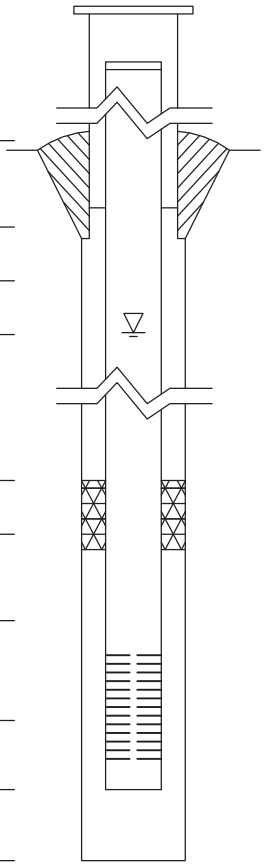
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.27	-3.23	Top of Protective Casing
623.05	-3.01	Top of Riser Pipe
620.04	0.00	Ground Surface
617.94	2.10	Top of Annular Sealant
582.62	37.42	Static Water Level (After Completion) 3/4/2009
593.04	27.00	Top of Seal
590.79	29.25	Top of Sand Pack
588.72	31.32	Top of Screen
584.24	35.80	Bottom of Screen
583.61	36.43	Bottom of Well
583.61	36.43	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.33
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	39.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G59L

Site Name: Gypsum Management Facility Borehole #: ~~G59a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 992.6 Y 15,343.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/23/2009 Date Finished: 1/23/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 30 minutes

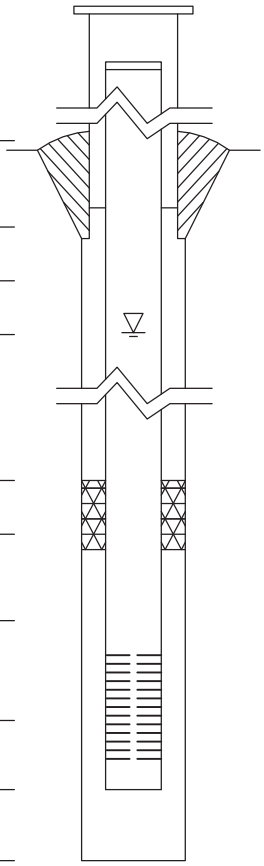
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.76	-2.61	Top of Protective Casing
622.45	-2.30	Top of Riser Pipe
620.15	0.00	Ground Surface
618.15	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
602.29	17.86	Top of Seal
599.47	20.68	Top of Sand Pack
597.24	22.91	Top of Screen
587.82	32.33	Bottom of Screen
587.12	33.03	Bottom of Well
587.12	33.03	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	25.21
Bottom of Screen to End Cap	(feet)	0.70
Screen Length (1st slot to last slot)	(feet)	9.42
Total Length of Casing	(feet)	35.33
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G59S

Site Name: Gypsum Management Facility Borehole #: ~~G59~~

~~State~~ Plant ~~Plane~~ Coordinate: X 992.6 Y 15,339.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/23/2009 Date Finished: 1/23/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 90 minutes

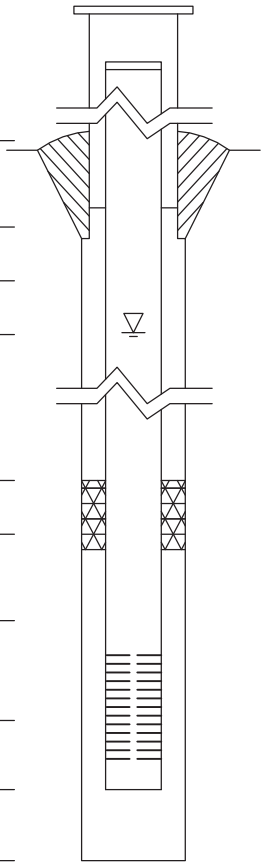
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.23	-3.08	Top of Protective Casing
622.84	-2.69	Top of Riser Pipe
620.15	0.00	Ground Surface
618.15	2.00	Top of Annular Sealant
578.24	41.91	Static Water Level (After Completion) 3/4/2009
588.15	32.00	Top of Seal
584.81	35.34	Top of Sand Pack
582.77	37.38	Top of Screen
578.27	41.88	Bottom of Screen
577.66	42.49	Bottom of Well
577.66	42.49	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	40.07
Bottom of Screen to End Cap	(feet)	0.61
Screen Length (1st slot to last slot)	(feet)	4.50
Total Length of Casing	(feet)	45.18
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G60L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG60b~~

~~State~~ Plant ~~Plane~~ Coordinate: X 1,049.8 Y 15,474.7 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/17/2008 Date Finished: 1/17/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hr

Type of Bentonite Seal -- Granular Pellet Slurry
(choose one)

Installation Method:

Setting Time:

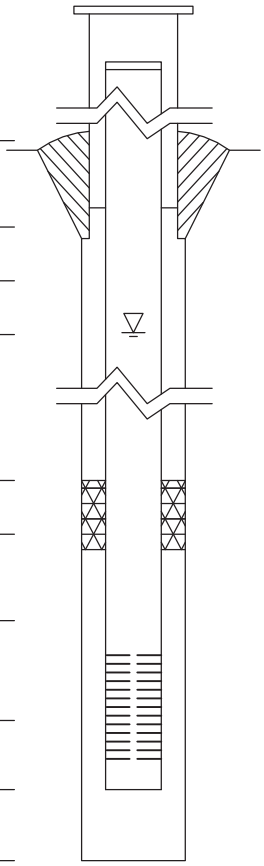
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material:
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
616.00	-3.55	Top of Protective Casing
615.49	-3.04	Top of Riser Pipe
612.45	0.00	Ground Surface
609.85	2.60	Top of Annular Sealant
591.43	21.02	Static Water Level (After Completion) 1/30/2008
596.03	16.42	Top of Seal
593.32	19.13	Top of Sand Pack
592.33	20.12	Top of Screen
587.54	24.91	Bottom of Screen
587.17	25.28	Bottom of Well
587.17	25.28	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	23.45
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	28.61
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G60S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG60~~

~~State~~ Plant ~~Plane~~ Coordinate: X 1,050.2 Y 15,469.5 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/16/2008 Date Finished: 1/16/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 22 min

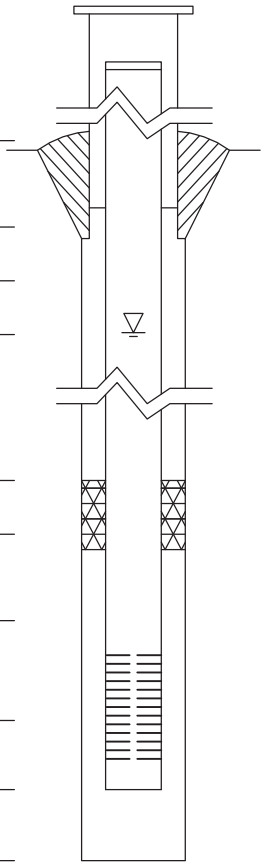
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
615.56	-3.37	Top of Protective Casing
615.11	-2.92	Top of Riser Pipe
612.19	0.00	Ground Surface
609.19	3.00	Top of Annular Sealant
582.46	29.73	Static Water Level (After Completion) 1/30/2008
584.51	27.68	Top of Seal
582.39	29.80	Top of Sand Pack
581.07	31.12	Top of Screen
576.28	35.91	Bottom of Screen
575.90	36.29	Bottom of Well
574.19	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.07
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	39.24
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G61L

Site Name: Gypsum Management Facility Borehole #: ~~G61a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.4 Y 15,640.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/21/2009 Date Finished: 1/21/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

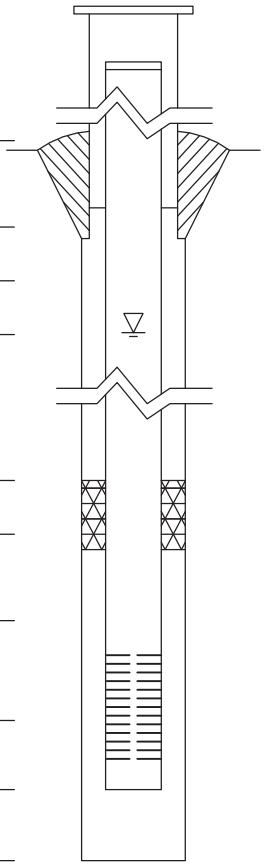
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



	Elevations (MSL)*	Depths (BGS) (0.01 ft.)
Top of Protective Casing	622.97	-2.97
Top of Riser Pipe	622.77	-2.77
Ground Surface	620.00	0.00
Top of Annular Sealant	618.00	2.00
Static Water Level (After Completion) 3/4/2009		DRY
Top of Seal	618.00	2.00
Top of Sand Pack	612.60	7.40
Top of Screen	610.36	9.64
Bottom of Screen	601.00	19.00
Bottom of Well	600.10	19.90
Bottom of Borehole	600.10	19.90

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.41
Bottom of Screen to End Cap	(feet)	0.90
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	22.67
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

4/2000

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 W. JEFFERSON ST.
SPRINGFIELD, IL 62761

WATER WELL SEALING FORM

TYPE OR PRESS FIRMLY

RETURN ALL COPIES TO IDPH OR LOCAL HEALTH DEPARTMENT

This form shall be submitted to this Department or the local health department not more than 30 days after a water well, boring or monitoring well is sealed. Such wells are to be sealed not more than 30 days after they are abandoned in accordance with the sealing requirements in the Water Well Construction Code. THE LOCAL HEALTH DEPARTMENT OR REGIONAL PUBLIC HEALTH DEPARTMENT MUST BE NOTIFIED AT LEAST 48 HOURS PRIOR TO SEALING.

1. **Ownership (Name of Controlling Party)** Duck Creek Power Station - GMF (G61L)

2. **Well Location** 17751 N Cilco Road (Address - Lot Number) Canton (City) Fulton (County)

   General Description **Township** 6 (N)(~~S~~) **Range** 5 (E)(~~W~~) **Section** 18

   SW **Quarter of the** NE **Quarter of the** NW **Quarter**

3. **Year Drilled** 2009

4. **Drilling Permit Number (and date, if known)** n/a

5. **Type of Well** **Bored** ____ **Drilled** ✓ **Other** ____

6. **Total Depth** 19.9 **Diameter (inches)** 8

7. **Formation clear of obstruction** ✓ **Yes** ____ **No**

8. **DETAILS OF PLUGGING** *(riser pipe and screen pulled and annulus was grouted)*

   Filled with Bentonite grout (cement or other materials) **from** 0 **to** 19.9 **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

9. **CASING RECORD** **Upper 2 feet of casing removed** ✓ **Yes** ____ **No**

10. **Date well was sealed** **Month** March **Day** 14 **Year** 2017.

11. **Licensed water well driller or other person approved by the Department performing well sealing.**

    Rhonald W. Hasenyager, L.P.G. (Name) 196-000246 (Complete License Number)

    Hanson Professional Services Inc., 1525 S. 6th St. (Address) Springfield (City) IL 62703 (State/ZIP)

This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center. IL 482-0631

Printed by Authority of the State of Illinois
P.O. #530379 9.6M 4/00

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G61S

Site Name: Gypsum Management Facility Borehole #: ~~G61~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.8 Y 15,644.9 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/20/2009 Date Finished: 1/21/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 2.5 hours

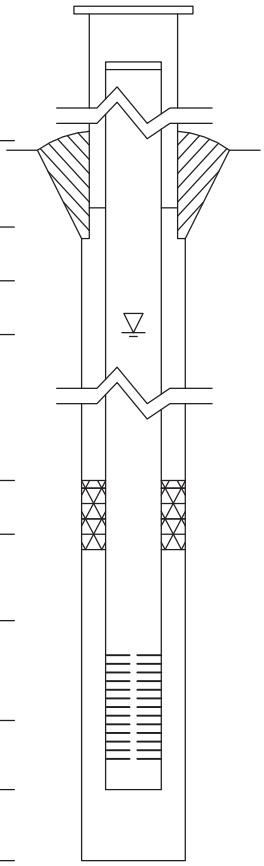
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.80	-2.80	Top of Protective Casing
622.58	-2.58	Top of Riser Pipe
620.00	0.00	Ground Surface
618.00	2.00	Top of Annular Sealant
587.62	32.38	Static Water Level (After Completion) 3/4/2009
595.00	25.00	Top of Seal
591.80	28.20	Top of Sand Pack
589.81	30.19	Top of Screen
585.37	34.63	Bottom of Screen
584.74	35.26	Bottom of Well
582.00	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.77
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.44
Total Length of Casing	(feet)	37.84
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G62L

Site Name: Gypsum Management Facility Borehole #: ~~G62~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.7 Y 15,785.2 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/21/2009 Date Finished: 1/22/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

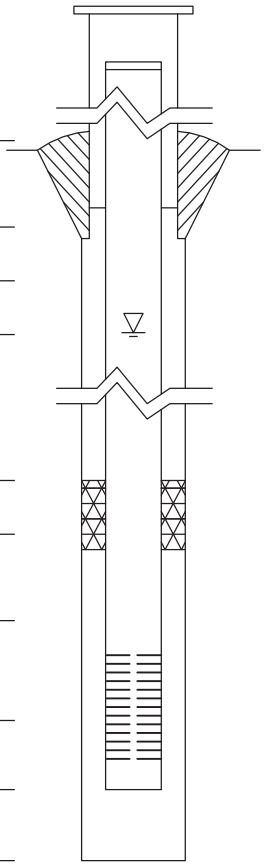
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Bentonite Chips (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.67	-3.65	Top of Protective Casing
623.48	-3.46	Top of Riser Pipe
620.02	0.00	Ground Surface
618.02	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
605.12	14.90	Top of Seal
602.12	17.90	Top of Sand Pack
599.71	20.31	Top of Screen
590.36	29.66	Bottom of Screen
589.90	30.12	Bottom of Well
582.02	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	23.77
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	33.58
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G63L

Site Name: Gypsum Management Facility Borehole #: ~~G63a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 998.0 Y 15,928.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/2/2009 Date Finished: 2/2/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 45 minutes

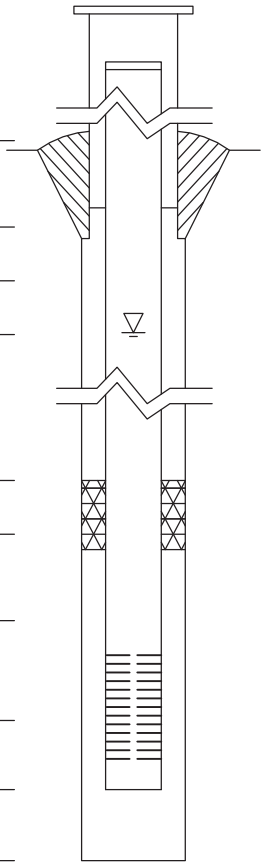
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.33	-3.21	Top of Protective Casing
622.98	-2.86	Top of Riser Pipe
620.12	0.00	Ground Surface
618.12	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
606.62	13.50	Top of Seal
603.62	16.50	Top of Sand Pack
601.65	18.47	Top of Screen
592.23	27.89	Bottom of Screen
591.76	28.36	Bottom of Well
591.76	28.36	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	21.33
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.42
Total Length of Casing	(feet)	31.22
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G63S

Site Name: Gypsum Management Facility Borehole #: ~~G63~~

~~State~~ Plant ~~Plane~~ Coordinate: X 998.3 Y 15,924.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/2/2009 Date Finished: 2/2/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 90 minutes

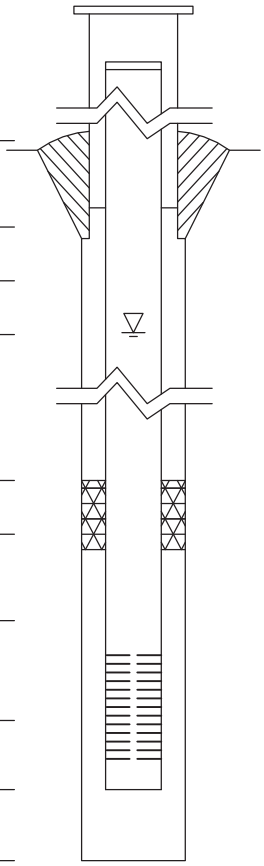
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.28	-3.16	Top of Protective Casing
623.09	-2.97	Top of Riser Pipe
620.12	0.00	Ground Surface
618.12	2.00	Top of Annular Sealant
586.64	33.48	Static Water Level (After Completion) 3/4/2009
590.62	29.50	Top of Seal
587.62	32.50	Top of Sand Pack
585.60	34.52	Top of Screen
581.11	39.01	Bottom of Screen
580.65	39.47	Bottom of Well
580.12	40.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	37.49
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	42.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G64L

Site Name: Gypsum Management Facility Borehole #: ~~G64a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 995.7 Y 16,069.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/22/2009 Date Finished: 1/22/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

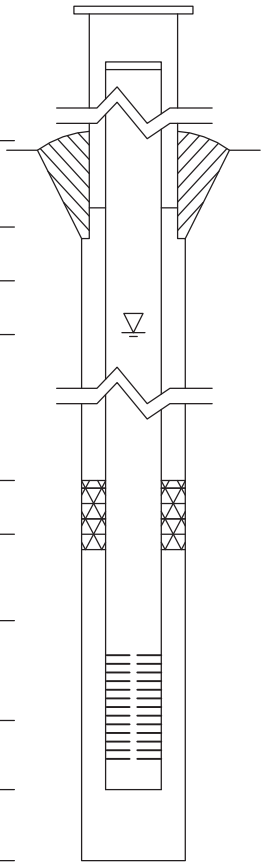
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.76	-2.74	Top of Protective Casing
622.54	-2.52	Top of Riser Pipe
620.02	0.00	Ground Surface
618.02	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
607.02	13.00	Top of Seal
604.22	15.80	Top of Sand Pack
601.90	18.12	Top of Screen
592.54	27.48	Bottom of Screen
592.07	27.95	Bottom of Well
592.07	27.95	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	20.64
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	30.47
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G64S

Site Name: Gypsum Management Facility Borehole #: ~~G64~~

~~State~~ Plant ~~Plane~~ Coordinate: X 994.9 Y 16,064.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 1/22/2009 Date Finished: 1/22/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 90 minutes

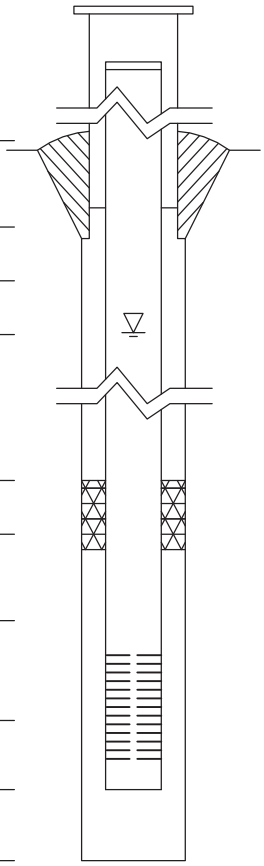
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
623.49	-3.47	Top of Protective Casing
622.98	-2.96	Top of Riser Pipe
620.02	0.00	Ground Surface
618.02	2.00	Top of Annular Sealant
587.70	32.32	Static Water Level (After Completion) 3/4/2009
590.92	29.10	Top of Seal
587.82	32.20	Top of Sand Pack
585.52	34.50	Top of Screen
581.03	38.99	Bottom of Screen
580.54	39.48	Bottom of Well
580.02	40.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	37.46
Bottom of Screen to End Cap	(feet)	0.49
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	42.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G65L

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG65b~~

~~State~~ Plant ~~Plane~~ Coordinate: X 919.9 Y 13,986.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/15/2008 Date Finished: 1/15/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 min

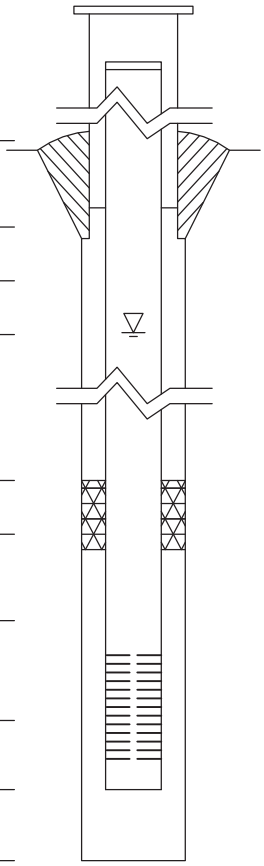
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.34	-3.27	Top of Protective Casing
612.84	-2.77	Top of Riser Pipe
610.07	0.00	Ground Surface
607.97	2.10	Top of Annular Sealant
587.76	22.31	Static Water Level (After Completion) 1/30/2008
596.16	13.91	Top of Seal
593.89	16.18	Top of Sand Pack
592.79	17.28	Top of Screen
587.99	22.08	Bottom of Screen
587.62	22.45	Bottom of Well
587.62	22.45	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	20.42
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.80
Total Length of Casing	(feet)	25.59
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G65S

Site Name: Duck Creek Gypsum Managment Facility Borehole #: ~~BG65a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 914.1 Y 13,985.1 (or) Latitude: Longitude:

Surveyed By: Kimberley R. Lyons IL Registration #: 035-003669

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Testing Services Corp. Date Started: 1/15/2008 Date Finished: 1/15/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 2/20/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite grout

Installation Method: Tremie

Setting Time: >24 hr

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 min

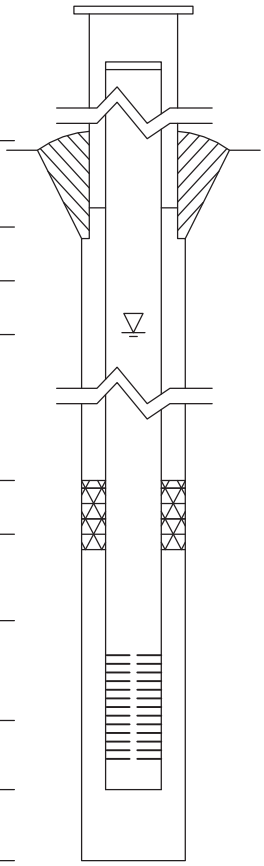
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.55	-3.61	Top of Protective Casing
613.04	-3.10	Top of Riser Pipe
609.94	0.00	Ground Surface
607.34	2.60	Top of Annular Sealant
584.66	25.28	Static Water Level (After Completion) 1/30/2008
586.43	23.51	Top of Seal
583.83	26.11	Top of Sand Pack
583.02	26.92	Top of Screen
578.24	31.70	Bottom of Screen
577.86	32.08	Bottom of Well
577.24	32.70	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	30.26
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.78
Total Length of Casing	(feet)	35.42
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G66L

Site Name: Gypsum Management Facility Borehole #: ~~G66a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 965.7 Y 14,240.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/4/2009 Date Finished: 2/4/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

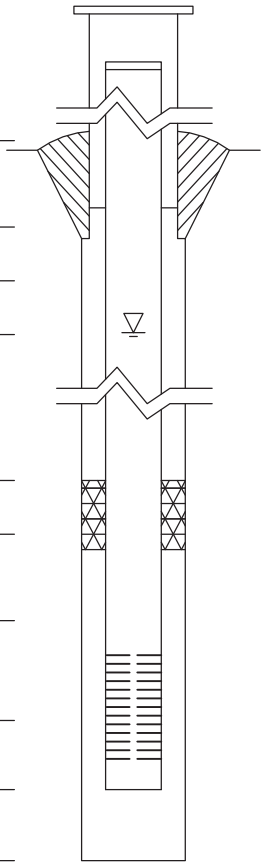
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.11	-3.25	Top of Protective Casing
617.82	-2.96	Top of Riser Pipe
614.86	0.00	Ground Surface
612.94	1.92	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
612.94	1.92	Top of Seal
607.28	7.58	Top of Sand Pack
605.02	9.84	Top of Screen
595.59	19.27	Bottom of Screen
595.12	19.74	Bottom of Well
595.12	19.74	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.80
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	9.43
Total Length of Casing	(feet)	22.70
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G66S

Site Name: Gypsum Management Facility Borehole #: ~~G66~~

~~State~~ Plant ~~Plane~~ Coordinate: X 964.9 Y 14,236.2 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/4/2009 Date Finished: 2/4/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 60 minutes

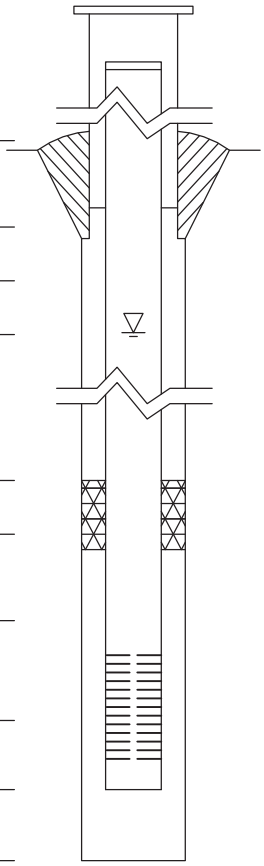
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.13	-3.27	Top of Protective Casing
617.84	-2.98	Top of Riser Pipe
614.86	0.00	Ground Surface
612.86	2.00	Top of Annular Sealant
590.54	24.32	Static Water Level (After Completion) 3/4/2009
584.38	30.48	Top of Seal
581.78	33.08	Top of Sand Pack
579.76	35.10	Top of Screen
575.27	39.59	Bottom of Screen
574.77	40.09	Bottom of Well
574.77	40.09	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	38.08
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	43.07
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G67L

Site Name: Gypsum Management Facility Borehole #: ~~G67a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 928.9 Y 14,527.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/3/2009 Date Finished: 2/3/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 24+ hours

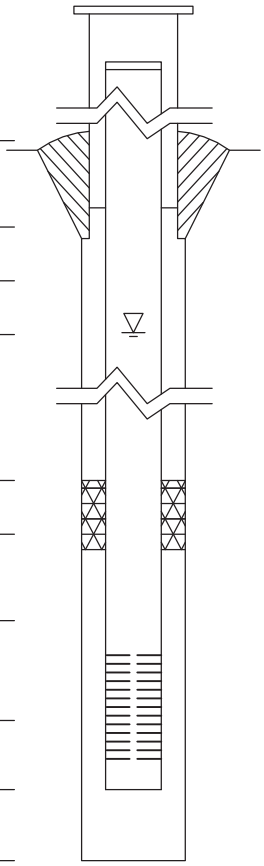
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
617.64	-3.00	Top of Protective Casing
617.22	-2.58	Top of Riser Pipe
614.64	0.00	Ground Surface
612.71	1.93	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
612.71	1.93	Top of Seal
609.12	5.52	Top of Sand Pack
607.28	7.36	Top of Screen
597.92	16.72	Bottom of Screen
597.46	17.18	Bottom of Well
597.46	17.18	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	9.94
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	19.76
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G67S

Site Name: Gypsum Management Facility Borehole #: ~~G67~~

~~State~~ Plant ~~Plane~~ Coordinate: X 925.2 Y 14,530.3 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/3/2009 Date Finished: 2/3/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 45 minutes

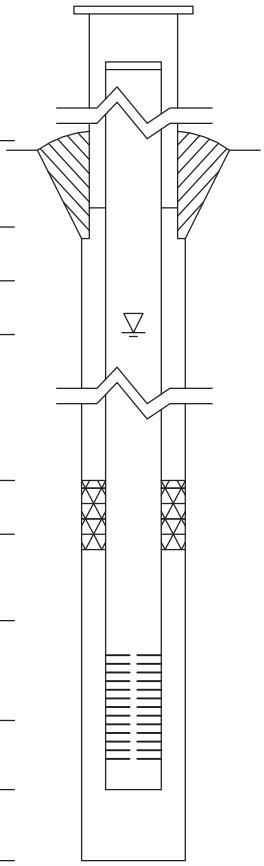
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.03	-3.39	Top of Protective Casing
617.86	-3.22	Top of Riser Pipe
614.64	0.00	Ground Surface
612.64	2.00	Top of Annular Sealant
590.81	23.83	Static Water Level (After Completion) 3/4/2009
589.31	25.33	Top of Seal
586.04	28.60	Top of Sand Pack
583.55	31.09	Top of Screen
579.06	35.58	Bottom of Screen
578.43	36.21	Bottom of Well
576.64	38.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.31
Bottom of Screen to End Cap	(feet)	0.63
Screen Length (1st slot to last slot)	(feet)	4.49
Total Length of Casing	(feet)	39.43
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G71L

Site Name: Gypsum Management Facility Borehole #: ~~G71a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 278.8 Y 14,106.4 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 11/20/2008 Date Finished: 11/20/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 26 minutes

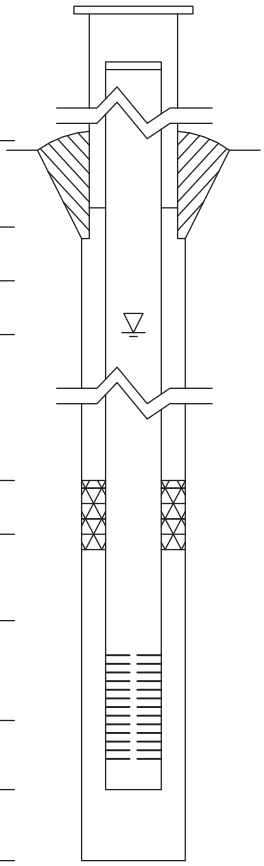
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.05	-3.11	Top of Protective Casing
617.62	-2.68	Top of Riser Pipe
614.94	0.00	Ground Surface
612.94	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
599.46	15.48	Top of Seal
597.02	17.92	Top of Sand Pack
595.14	19.80	Top of Screen
585.65	29.29	Bottom of Screen
584.74	30.20	Bottom of Well
584.74	30.20	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	22.48
Bottom of Screen to End Cap	(feet)	0.91
Screen Length (1st slot to last slot)	(feet)	9.40
Total Length of Casing	(feet)	32.79
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G71S

Site Name: Gypsum Management Facility Borehole #: ~~G71~~

~~State~~ Plant ~~Plane~~ Coordinate: X 277.1 Y 14,110.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 11/20/2008 Date Finished: 11/20/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

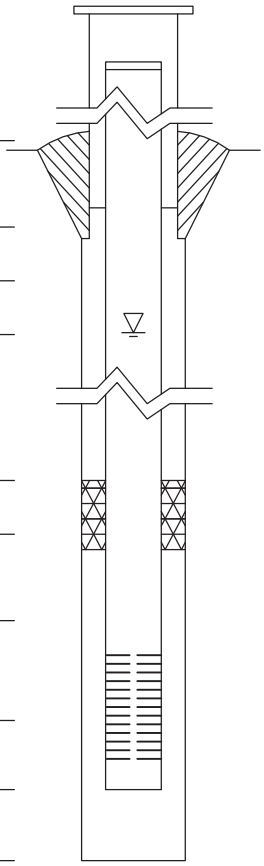
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



	Elevations (MSL)*	Depths (BGS) (0.01 ft.)
Top of Protective Casing	618.13	-3.19
Top of Riser Pipe	617.93	-2.99
Ground Surface	614.94	0.00
Top of Annular Sealant	612.84	2.10
Static Water Level (After Completion) 3/4/2009	577.22	37.72
Top of Seal	586.46	28.48
Top of Sand Pack	582.94	32.00
Top of Screen	580.98	33.96
Bottom of Screen	576.98	37.96
Bottom of Well	576.54	38.40
Bottom of Borehole	574.94	40.00

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	36.95
Bottom of Screen to End Cap	(feet)	0.44
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	41.87
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G72L

Site Name: Gypsum Management Facility Borehole #: ~~G72a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 509.9 Y 13,904.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 11/19/2008 Date Finished: 11/19/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 21 minutes

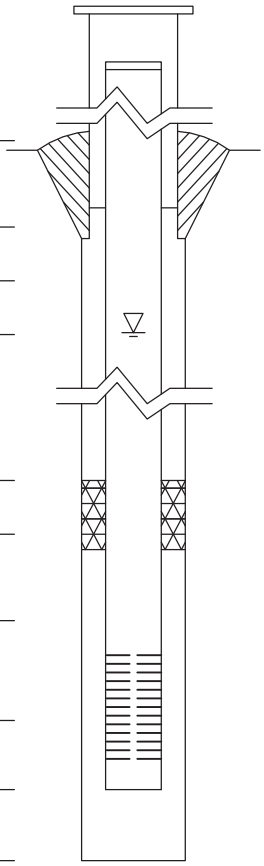
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
617.99	-2.98	Top of Protective Casing
617.80	-2.79	Top of Riser Pipe
615.01	0.00	Ground Surface
613.21	1.80	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
604.10	10.91	Top of Seal
601.66	13.35	Top of Sand Pack
600.36	14.65	Top of Screen
591.00	24.01	Bottom of Screen
590.22	24.79	Bottom of Well
590.22	24.79	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	17.44
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	27.58
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G72S

Site Name: Gypsum Management Facility Borehole #: ~~G72~~

~~State~~ Plant ~~Plane~~ Coordinate: X 504.9 Y 13,905.1 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Date Started: 11/19/2008 Date Finished: 11/19/2008

Report Form Completed By: Suzanna Simpson Date: 12/23/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 20 minutes

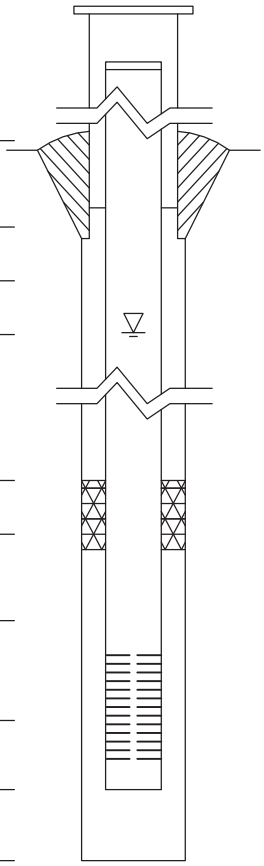
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Bentonite Chips
(if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.12	-3.11	Top of Protective Casing
617.68	-2.67	Top of Riser Pipe
615.01	0.00	Ground Surface
612.71	2.30	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
589.46	25.55	Top of Seal
587.18	27.83	Top of Sand Pack
584.85	30.16	Top of Screen
580.37	34.64	Bottom of Screen
579.92	35.09	Bottom of Well
575.61	39.40	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.83
Bottom of Screen to End Cap	(feet)	0.45
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	37.76
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

4/2000

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 W. JEFFERSON ST.
SPRINGFIELD, IL 62761

WATER WELL SEALING FORM

TYPE OR PRESS FIRMLY

RETURN ALL COPIES TO IDPH OR LOCAL HEALTH DEPARTMENT

This form shall be submitted to this Department or the local health department not more than 30 days after a water well, boring or monitoring well is sealed. Such wells are to be sealed not more than 30 days after they are abandoned in accordance with the sealing requirements in the Water Well Construction Code. THE LOCAL HEALTH DEPARTMENT OR REGIONAL PUBLIC HEALTH DEPARTMENT MUST BE NOTIFIED AT LEAST 48 HOURS PRIOR TO SEALING.

1. **Ownership (Name of Controlling Party)** Duck Creek Power Station - Recycle Pond (G72S)

2. **Well Location** 17751 N Cilco Road (Address - Lot Number) Canton (City) Fulton (County)

   General Description **Township** 6 (N)(~~S~~) **Range** 5 (E)(~~W~~) **Section** 18

   NE **Quarter of the** NW **Quarter of the** SW **Quarter**

3. **Year Drilled** 2008

4. **Drilling Permit Number (and date, if known)** n/a

5. **Type of Well** **Bored** ____ **Drilled** ✓ **Other** ____

6. **Total Depth** 35.09 **Diameter (inches)** 8

7. **Formation clear of obstruction** ✓ **Yes** ____ **No**

   After G72S was sealed, replacement well R72S was installed approximately 5 feet west in a blind-drilled borehole.

8. **DETAILS OF PLUGGING**

   Filled with Bentonite grout (cement or other materials) **from** 2 **to** 35.09 **ft.**

   Kind of plug Random soil **from** 0 **to** 2.0 **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

   Filled with ____ **from** ____ **to** ____ **ft.**

   Kind of plug ____ **from** ____ **to** ____ **ft.**

9. **CASING RECORD** **Upper 2 feet of casing removed** ✓ **Yes** ____ **No**

10. **Date well was sealed** **Month** November **Day** 9 **Year** 2016.

11. **Licensed water well driller or other person approved by the Department performing well sealing.**

    Rhonald W. Hasenyager, L.P.G. (Name) 196-000246 (Complete License Number)

    Hanson Professional Services Inc., 1525 S. 6th St. (Address) Springfield (City) IL 62703 (State/ZIP)

This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center. IL 482-0631

Printed by Authority of the State of Illinois
P.O. #530379 9.6M 4/00

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: G73L

Site Name: Gypsum Management Facility Borehole #: ~~G73a~~

~~State~~ Plant ~~Plane~~ Coordinate: X 799.5 Y 13,924.5 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 2/6/2009 Date Finished: 2/6/2009

Report Form Completed By: Suzanna Simpson Date: 2/26/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 12+ hours

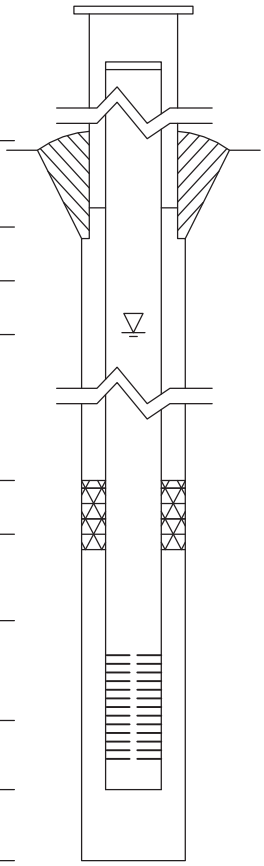
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.23	-3.59	Top of Protective Casing
617.58	-2.94	Top of Riser Pipe
614.64	0.00	Ground Surface
612.64	2.00	Top of Annular Sealant
	DRY	Static Water Level (After Completion) 3/4/2009
594.64	20.00	Top of Seal
592.22	22.42	Top of Sand Pack
590.01	24.63	Top of Screen
580.66	33.98	Bottom of Screen
579.88	34.76	Bottom of Well
579.88	34.76	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	27.57
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	37.70
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: P01L

Site Name: Gypsum Management Facility Borehole #: ~~P01b~~

~~State~~ Plant
~~Plane~~ Coordinate: X -194.6 Y 16,744.8 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 11/10/2008 Date Finished: 11/10/2008

Report Form Completed By: Suzanna Simpson Date: 11/21/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry
(choose one)

Installation Method: Gravity

Setting Time: 24+ hours

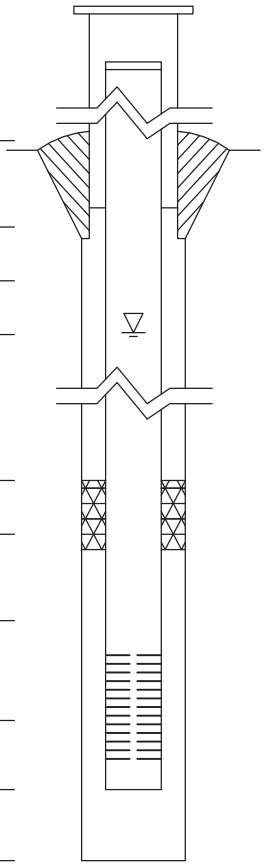
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a
(if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
625.26	-3.26	Top of Protective Casing
624.99	-2.99	Top of Riser Pipe
622.00	0.00	Ground Surface
619.80	2.20	Top of Annular Sealant
604.00	18.00	Static Water Level (After Completion) 1/8/2009
619.80	2.20	Top of Seal
614.00	8.00	Top of Sand Pack
611.79	10.21	Top of Screen
602.44	19.56	Bottom of Screen
601.65	20.35	Bottom of Well
601.65	20.35	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	13.20
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.35
Total Length of Casing	(feet)	23.34
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: WPC Permit No. 2007-EA-4026 County: Fulton Well #: P01S

Site Name: Gypsum Management Facility Borehole #: ~~P01a~~

~~State~~ Plant ~~Plane~~ Coordinate: X -194.7 Y 16,754.6 (or) Latitude: Longitude:

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corp. Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna Simpson Date Started: 11/10/2008 Date Finished: 11/10/2008

Report Form Completed By: Suzanna Simpson Date: 11/21/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

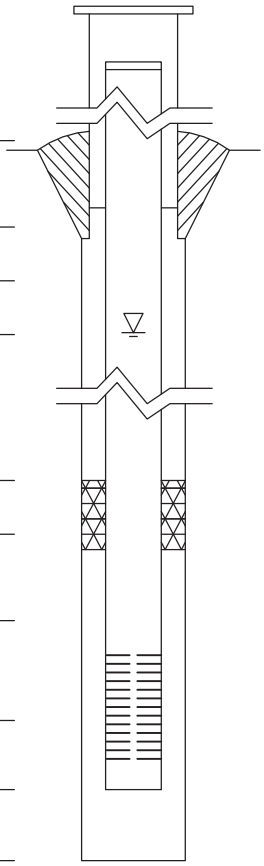
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
624.76	-2.76	Top of Protective Casing
624.52	-2.52	Top of Riser Pipe
622.00	0.00	Ground Surface
619.40	2.60	Top of Annular Sealant
604.00	18.00	Static Water Level (After Completion) 1/8/2009
602.50	19.50	Top of Seal
601.18	20.82	Top of Sand Pack
599.42	22.58	Top of Screen
594.94	27.06	Bottom of Screen
594.26	27.74	Bottom of Well
594.26	27.74	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

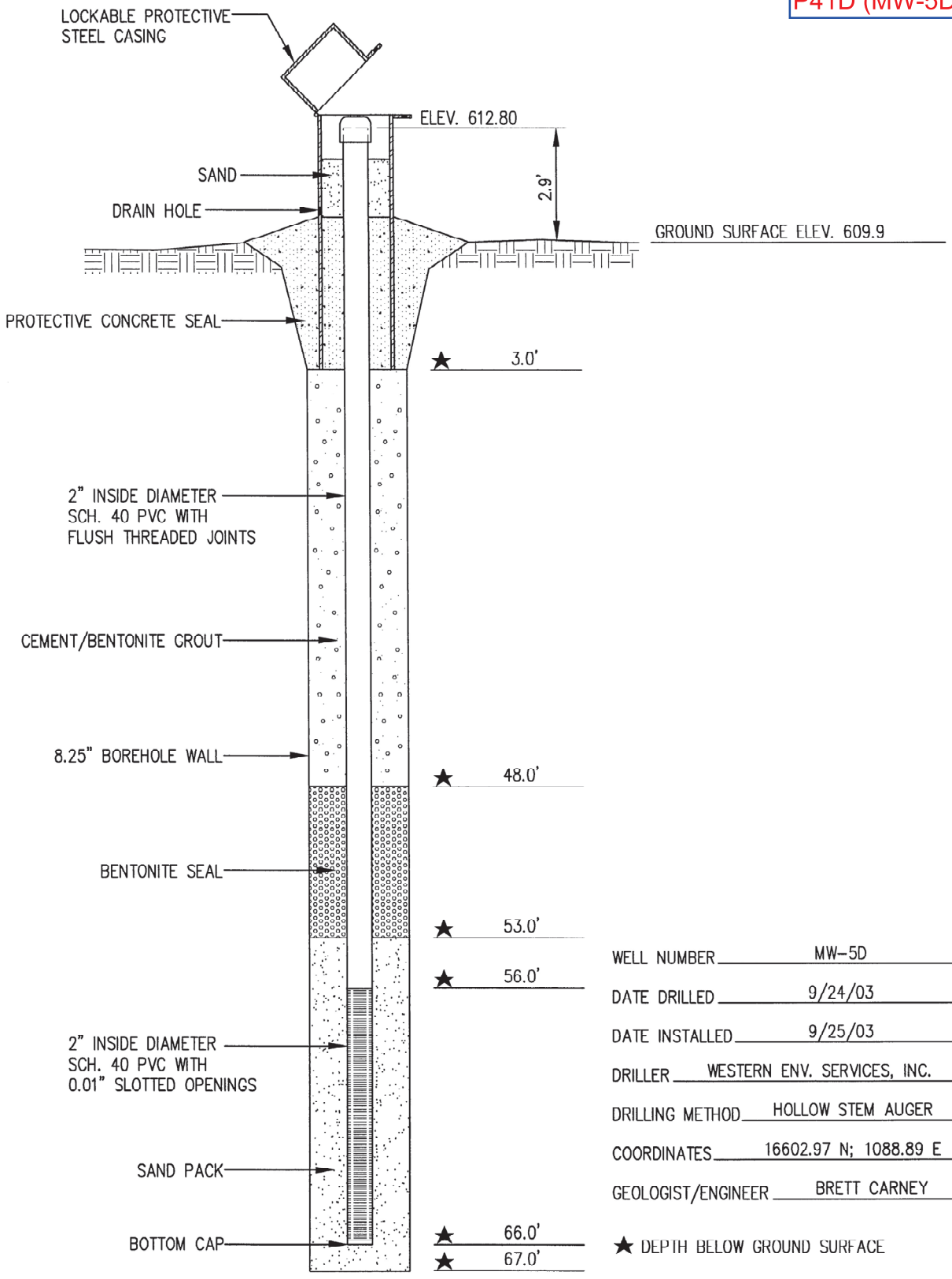
CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	25.10
Bottom of Screen to End Cap	(feet)	0.68
Screen Length (1st slot to last slot)	(feet)	4.48
Total Length of Casing	(feet)	30.26
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

P41D (MW-5D)



WELL NUMBER MW-5D

DATE DRILLED 9/24/03

DATE INSTALLED 9/25/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 16602.97 N; 1088.89 E

GEOLOGIST/ENGINEER BRETT CARNEY

★ DEPTH BELOW GROUND SURFACE

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MONITORING WELL MW-5D CONSTRUCTION DETAIL

PHASE II HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

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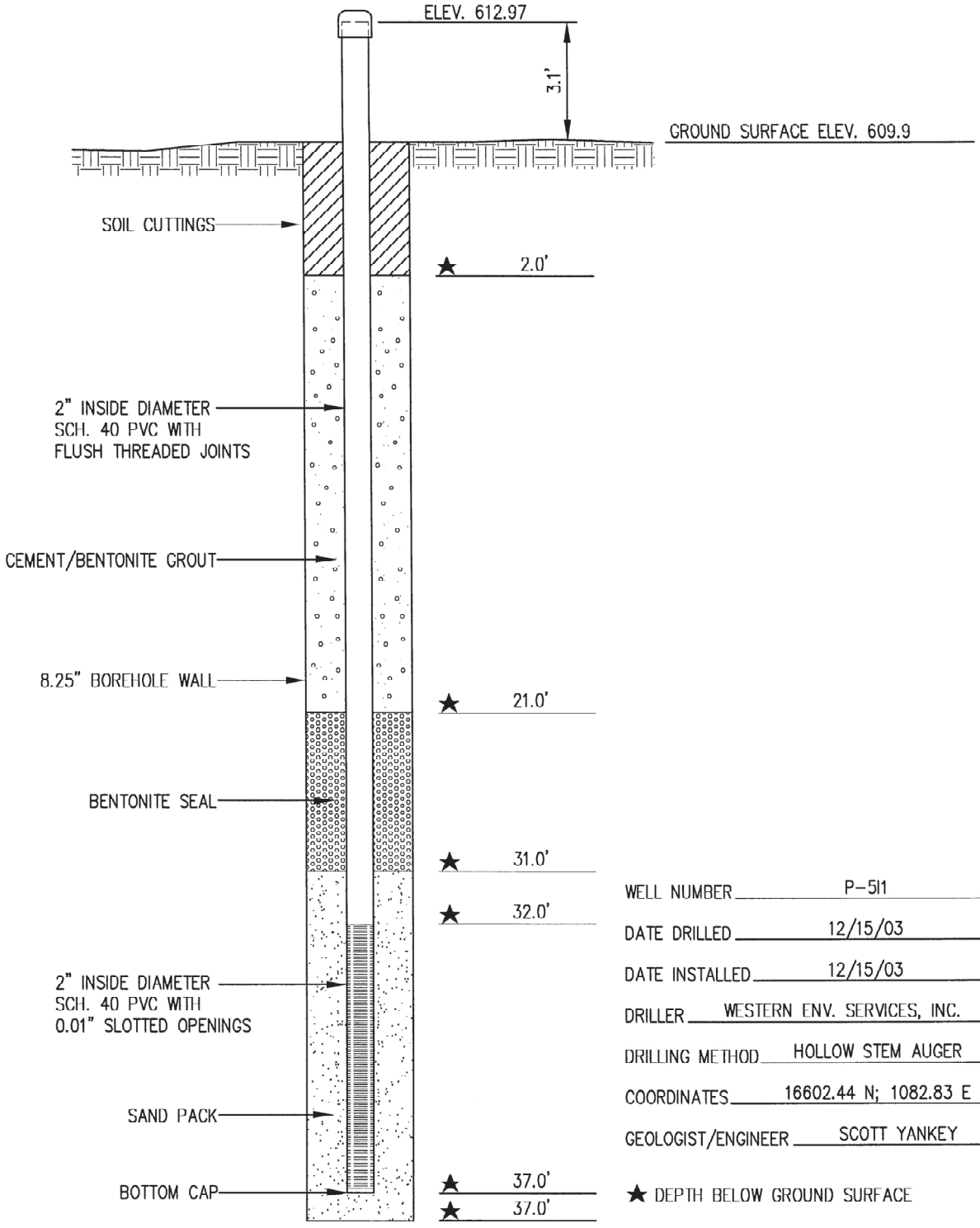
Electronic Filing: Received, Clerk's Office 06/20/2024

P41I1 (MW-5I1)



WELL NUMBER P-5I1

DATE DRILLED 12/15/03

DATE INSTALLED 12/15/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 16602.44 N; 1082.83 E

GEOLOGIST/ENGINEER SCOTT YANKEY

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PIEZOMETER P-5I1 CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

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Electronic Filing: Received, Clerk's Office 06/20/2024

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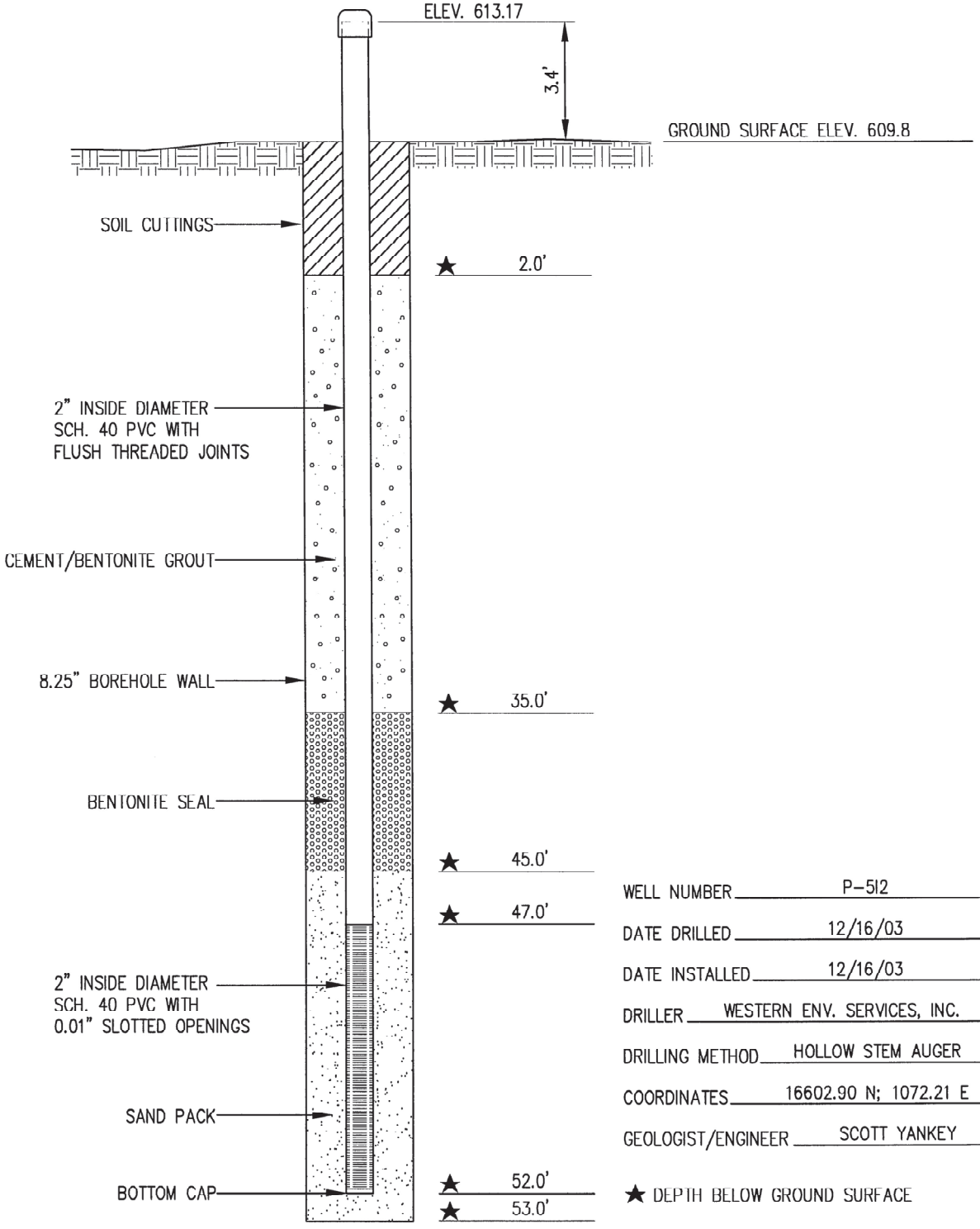

WELL NUMBER P-5I2

DATE DRILLED 12/16/03

DATE INSTALLED 12/16/03

DRILLER WESTERN ENV. SERVICES, INC.

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 16602.90 N; 1072.21 E

GEOLOGIST/ENGINEER SCOTT YANKEY

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PIEZOMETER P-5I2 CONSTRUCTION DETAIL

PHASE III HYDROGEOLOGIC SITE INVESTIGATION
AERG - DUCK CREEK STATION CCB LANDFILL
CANTON, ILLINOIS

JOB NO. 03S5010 ATTACHMENT B

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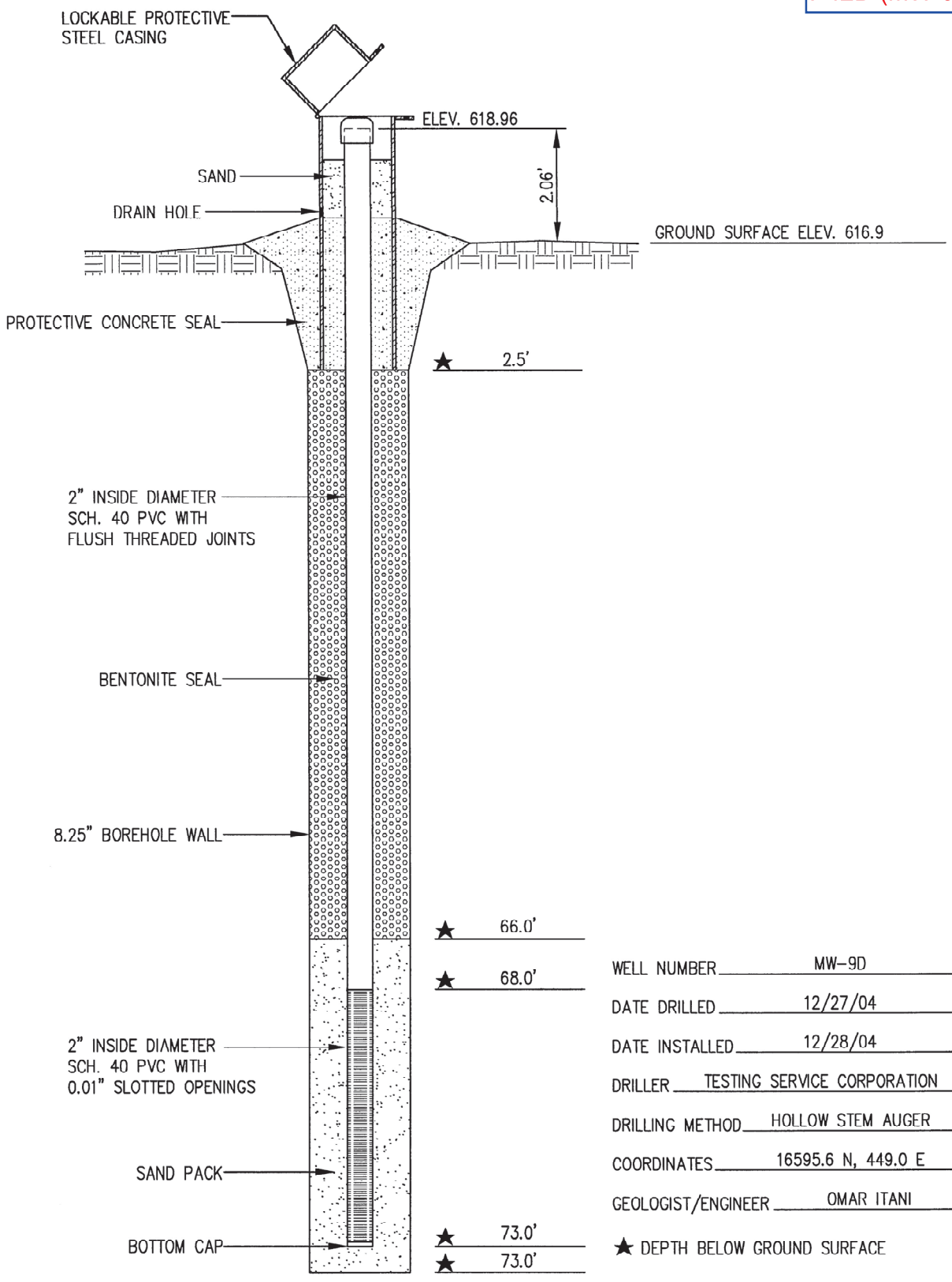
Electronic Filing: Received, Clerk's Office 06/20/2024

P42D (MW-9D)



WELL NUMBER MW-9D

DATE DRILLED 12/27/04

DATE INSTALLED 12/28/04

DRILLER TESTING SERVICE CORPORATION

DRILLING METHOD HOLLOW STEM AUGER

COORDINATES 16595.6 N, 449.0 E

GEOLOGIST/ENGINEER OMAR ITANI

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MONITORING WELL MW-9D CONSTRUCTION DETAIL

PHASE IV HYDROGEOLOGIC SITE INVESTIGATION
AMEREN/CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 03S5010

FEB 07, 2005 1:19 PM KDE
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Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: 0570255197 County: Fulton Well #: P60

Site Name: Duck Creek Power Station - Ash Landfill Borehole #: P60

~~State~~ Plant ~~Plane~~ Coordinate: X 992.2 Y 15,477.1 (or) Latitude: 40° 30' 24.310" Longitude: 89° 59' 13.282"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 3/15/2017 Date Finished: 3/15/2017

Report Form Completed By: Suzanna L. Keim Date: 3/16/2017

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 20 minutes

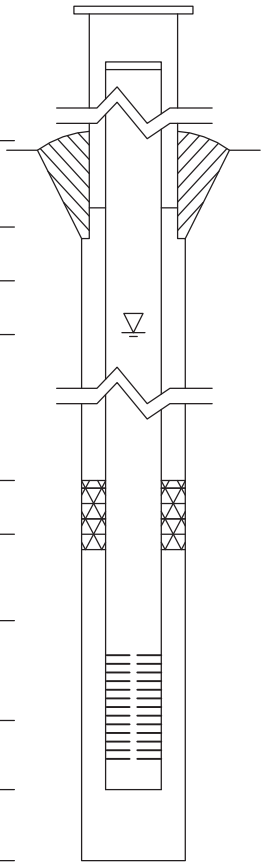
Type of Sand Pack: Quartz Sand

Grain Size: 10-40 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.82	-2.70	Top of Protective Casing
622.52	-2.40	Top of Riser Pipe
620.12	0.00	Ground Surface
618.12	2.00	Top of Annular Sealant
		Static Water Level (After Completion)
594.67	25.45	Top of Seal
592.10	28.02	Top of Sand Pack
590.57	29.55	Top of Screen
585.98	34.14	Bottom of Screen
585.50	34.62	Bottom of Well
585.50	34.62	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	31.95
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	4.59
Total Length of Casing	(feet)	37.02
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P61

Site Name: Duck Creek Part 845 Groundwater Borehole #: P61

State Plane Coordinate: X 2,346,779.3 Y 1,398,670.8 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

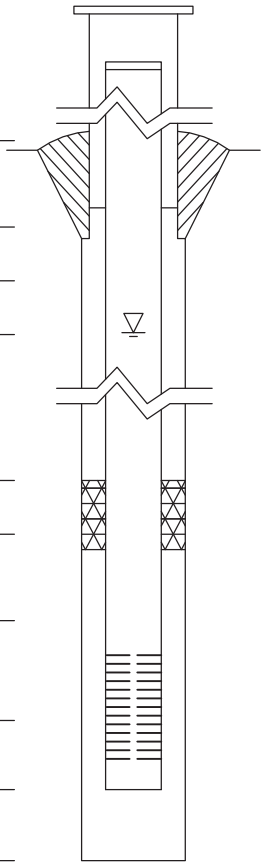
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.31	-3.21	Top of Protective Casing
613.96	-2.87	Top of Riser Pipe
611.09	0.00	Ground Surface
607.58	3.51	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
603.54	7.55	Top of Sand Pack
602.38	8.71	Top of Screen
592.72	18.37	Bottom of Screen
592.33	18.76	Bottom of Well
591.09	20.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	11.58
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	9.66
Total Length of Casing	(feet)	21.63
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P62

Site Name: Duck Creek Part 845 Groundwater Borehole #: P62

State Plane Coordinate: X 2,346,602.3 Y 1,398,887.3 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

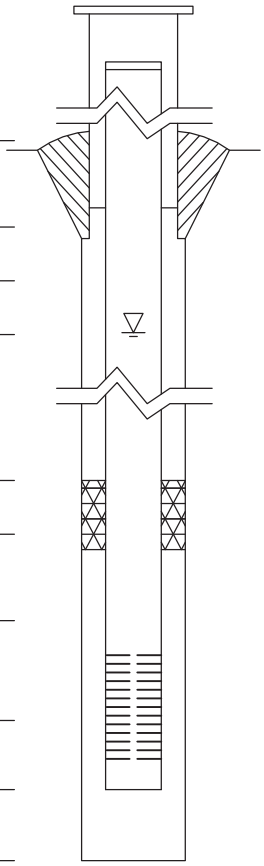
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
613.96	-3.15	Top of Protective Casing
613.54	-2.73	Top of Riser Pipe
610.81	0.00	Ground Surface
607.89	2.92	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
601.33	9.48	Top of Sand Pack
599.63	11.18	Top of Screen
595.03	15.78	Bottom of Screen
594.51	16.30	Bottom of Well
594.51	16.30	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	16.30
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	4.60
Total Length of Casing	(feet)	21.42
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P63

Site Name: Duck Creek Part 845 Groundwater Borehole #: P63

State Plane Coordinate: X 2,346,605.9 Y 1,399,026.6 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/24/2021 Date Finished: 2/24/2021

Report Form Completed By: Tad A. Gass Date: 2/24/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

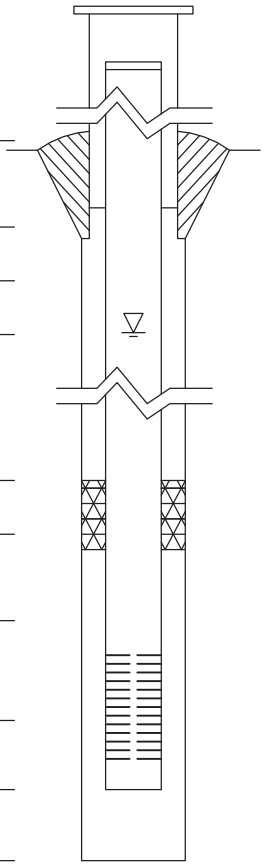
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.85	-2.52	Top of Protective Casing
614.47	-2.15	Top of Riser Pipe
612.33	0.00	Ground Surface
609.23	3.10	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
600.98	11.35	Top of Sand Pack
599.29	13.04	Top of Screen
594.70	17.63	Bottom of Screen
594.08	18.25	Bottom of Well
594.08	18.25	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.19
Bottom of Screen to End Cap	(feet)	0.62
Screen Length (1st slot to last slot)	(feet)	4.59
Total Length of Casing	(feet)	20.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: P64

Site Name: Duck Creek Part 845 Groundwater Borehole #: P64

State Plane Coordinate: X 2,346,598.0 Y 1,399,305.9 (or) Latitude: _____ Longitude: _____

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Geotechnics Driller: Matt

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/25/2021 Date Finished: 2/25/2021

Report Form Completed By: Tad A. Gass Date: 2/25/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: _____

Setting Time: _____

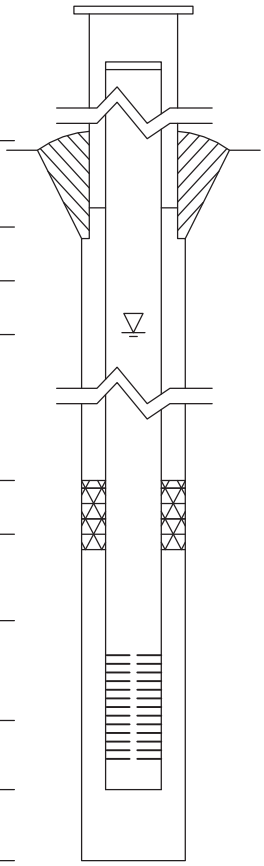
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: _____ (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
616.83	-2.78	Top of Protective Casing
616.47	-2.43	Top of Riser Pipe
614.04	0.00	Ground Surface
611.04	3.00	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
n/a	n/a	Top of Seal
608.96	5.08	Top of Sand Pack
607.87	6.17	Top of Screen
598.08	15.96	Bottom of Screen
597.57	16.47	Bottom of Well
597.57	16.47	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	10.0
Riser Pipe Length	(feet)	9.19
Bottom of Screen to End Cap	(feet)	0.52
Screen Length (1st slot to last slot)	(feet)	9.19
Total Length of Casing	(feet)	18.90
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: 0570255197 County: Fulton Well #: R61L

Site Name: Duck Creek Power Station - Ash Landfill Borehole #: R61L

~~State~~ Plant ~~Plane~~ Coordinate: X 994.3 Y 15,649.9 (or) Latitude: 40° 30' 26.021" Longitude: 89° 59' 13.252"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 3/14/2017 Date Finished: 3/14/2017

Report Form Completed By: Suzanna L. Keim Date: 3/16/2017

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 75 minutes

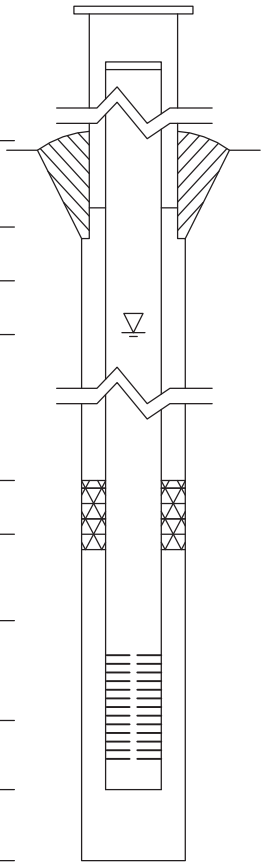
Type of Sand Pack: Quartz Sand

Grain Size: 10-40 (sieve size)

Installation Method: Gravity

Type of Backfill Material: (if applicable)

Installation Method:



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
622.99	-3.03	Top of Protective Casing
622.69	-2.73	Top of Riser Pipe
619.96	0.00	Ground Surface
617.96	2.00	Top of Annular Sealant
		Static Water Level (After Completion)
605.16	14.80	Top of Seal
603.14	16.82	Top of Sand Pack
601.42	18.54	Top of Screen
591.79	28.17	Bottom of Screen
591.29	28.67	Bottom of Well
591.29	28.67	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	21.27
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.63
Total Length of Casing	(feet)	31.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Fulton Well #: R72S

Site Name: Duck Creek Power Station - Recycle Pond Borehole #: R72S

~~State~~ Plant ~~Plane~~ Coordinate: X 500.0 Y 13,905.4 (or) Latitude: 40° 30' 8.792" Longitude: 89° 59' 19.692"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 11/9/2016 Date Finished: 11/9/2016

Report Form Completed By: Suzanna L. Keim Date: 11/18/2016

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 24+ hours

Type of Bentonite Seal -- (Granular) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 50 minutes

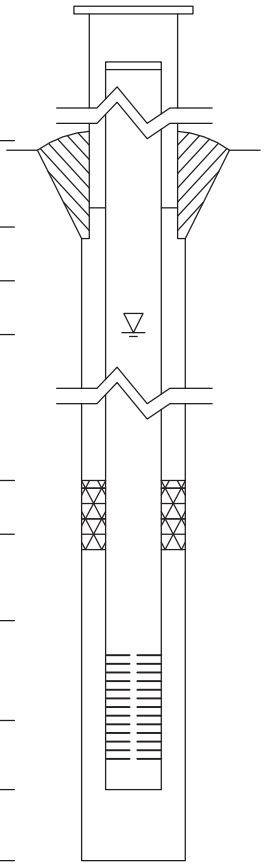
Type of Sand Pack: Quartz Sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
618.11	-3.00	Top of Protective Casing
617.87	-2.76	Top of Riser Pipe
615.11	0.00	Ground Surface
613.01	2.10	Top of Annular Sealant
_____	_____	Static Water Level (After Completion)
590.01	25.10	Top of Seal
587.06	28.05	Top of Sand Pack
585.28	29.83	Top of Screen
580.62	34.49	Bottom of Screen
580.16	34.95	Bottom of Well
580.16	34.95	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	(PVC)	OTHER:
Screen	SS304	SS316	PTFE	(PVC)	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	6.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	32.59
Bottom of Screen to End Cap	(feet)	0.46
Screen Length (1st slot to last slot)	(feet)	4.66
Total Length of Casing	(feet)	37.71
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX C
GEOTECHNICAL LABORATORY REPORTS

Electronic Filing: Received, Clerk's Office 06/20/2024

GEOTECHNOLOGY INC
FROM THE GROUND UP

Via email: dramsey@ramgeoeng.com

April 5, 2021 J037264.01.6001

Mr. Douglas P. Ramsey, P.E.
Ramsey Geotechnical Engineering
1701 W. Market Street
Bloomington, Illinois 61701

Re: Duck Creek Power Station
Fulton County, Illinois

Dear Mr. Ramsey:

Included in this report are the test results from a bulk sample of gypsum received in our laboratory on March 15, 2021. The sample was tested in general accordance with the test method listed below.

Test to Determine	Method of Test
Hydraulic Conductivity of Soil Using Flexible Wall Permeameter	ASTM D5084

We trust this is the information you require. Please contact the undersigned if you have any questions regarding this report.

Respectfully submitted,

GEOTECHNOLOGY, INC.

Janet M. May
Illinois Laboratory Manager

JMM/LPH:jmm

Attachment: Test Result Summary
Hydraulic Conductivity Test Data Sheet
Proctor Curve (Provided by Ramsey)
Testing Assignment Sheets

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TEST RESULT SUMMARY

Duck Creek Power Station
Fulton County, Illinois

Sample Number/ Material	Optimum Moisture Content, %	Maximum Dry Unit Weight, pcf	Percent Compact	Moisture Content, %	Dry Unit Weight, pcf	Hydraulic Conductivity, cm/sec	Range of Hydraulic Gradient
LSN-3781/ Gypsum	27.0	81.0	91.2	28.8	73.9	6.7×10^{-4}	0.2 - 2.2

Notes and abbreviations:
% - Percent
cm/sec - Centimeters per second
pcf - Pounds per cubic foot

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HYDRAULIC CONDUCTIVITY TEST DATA

(ASTM D 5084)

				Initial Unit Weight		**Unit Weight as Tested**	
JOB NO.:	J037264.01.6002	ASTM D698 Results		WET UNIT WEIGHT, pcf:	95.2	WET UNIT WEIGHT, pcf:	95.2
PROJECT:	Duck Creek Bottom Ash Basins	Maximum Dry Unit Weight, pcf	81.0	DRY UNIT WEIGHT, pcf:	73.9	DRY UNIT WEIGHT, pcf:	69.4
SAMPLE NO.:	LSN-3781	Optimum Water Content, %	27.0	**Percent Compact:**	**91.2%**		
MATERIAL:	Gypsum						

	Initial	After Test**		Initial	As Tested	INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	2.878		LENGTH, cm:	7.310		WET WT SPLE+TARE	754.45	WET WT SPLE+TARE	784.98
DIAMETER, in.:	2.878		DIAMETER, cm	7.310		DRY WT SPLE+TARE	649.86	DRY WT SPLE+TARE	649.86
WET WT., gms.:	467.82					TARE WEIGHT	286.63	TARE WEIGHT	286.63
AREA, sq.in.:	6.505		AREA, sq cm:	41.970		**% MOISTURE**	28.8	% MOISTURE	37.2

B VALUE (before Permeation): 95% Cell / Back Pressure, psi: 88 / 85 **Percent Wet of Optimum: 1.8**

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP °C	ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC	HYDRAULIC GRADIENT	HYDRAULIC HEAD	HEAD LOSS,%	k (in/sec)
0.0	30-Mar-21	10:19 AM	20.8	0	7.32	23.70			2.24	16.38		
0.0	30-Mar-21	10:20 AM	20.8	1	10.18	20.51	2.86	7.0E-04	1.41	10.33	36.94	2.8E-04
0.0	30-Mar-21	10:22 AM	20.8	2	13.33	17.40	3.15	7.1E-04	0.56	4.07	60.60	2.8E-04
0.0	30-Mar-21	10:24 AM	20.8	2	14.46	16.18	1.13	6.6E-04	0.24	1.72	57.74	2.6E-04
0.0	30-Mar-21	11:32 AM	20.8	0	8.77	23.40			2.00	14.63		
0.0	30-Mar-21	11:33 AM	20.8	1	11.43	20.73	2.66	6.9E-04	1.27	9.30	36.43	2.7E-04
0.0	30-Mar-21	11:34 AM	20.8	1	13.10	19.03	1.67	6.9E-04	0.81	5.93	36.24	2.7E-04
0.0	30-Mar-21	11:36 AM	20.8	2	14.83	17.30	1.73	6.7E-04	0.34	2.47	58.35	2.6E-04

Average Temp. = 20.8

AVERAGE K = 6.9E-04

Corrected K for 20ºC = 6.7E-04

AVERAGE K = 2.7E-04

Corrected K for 20ºC = 2.6E-04

** Measurements not available at end of test.

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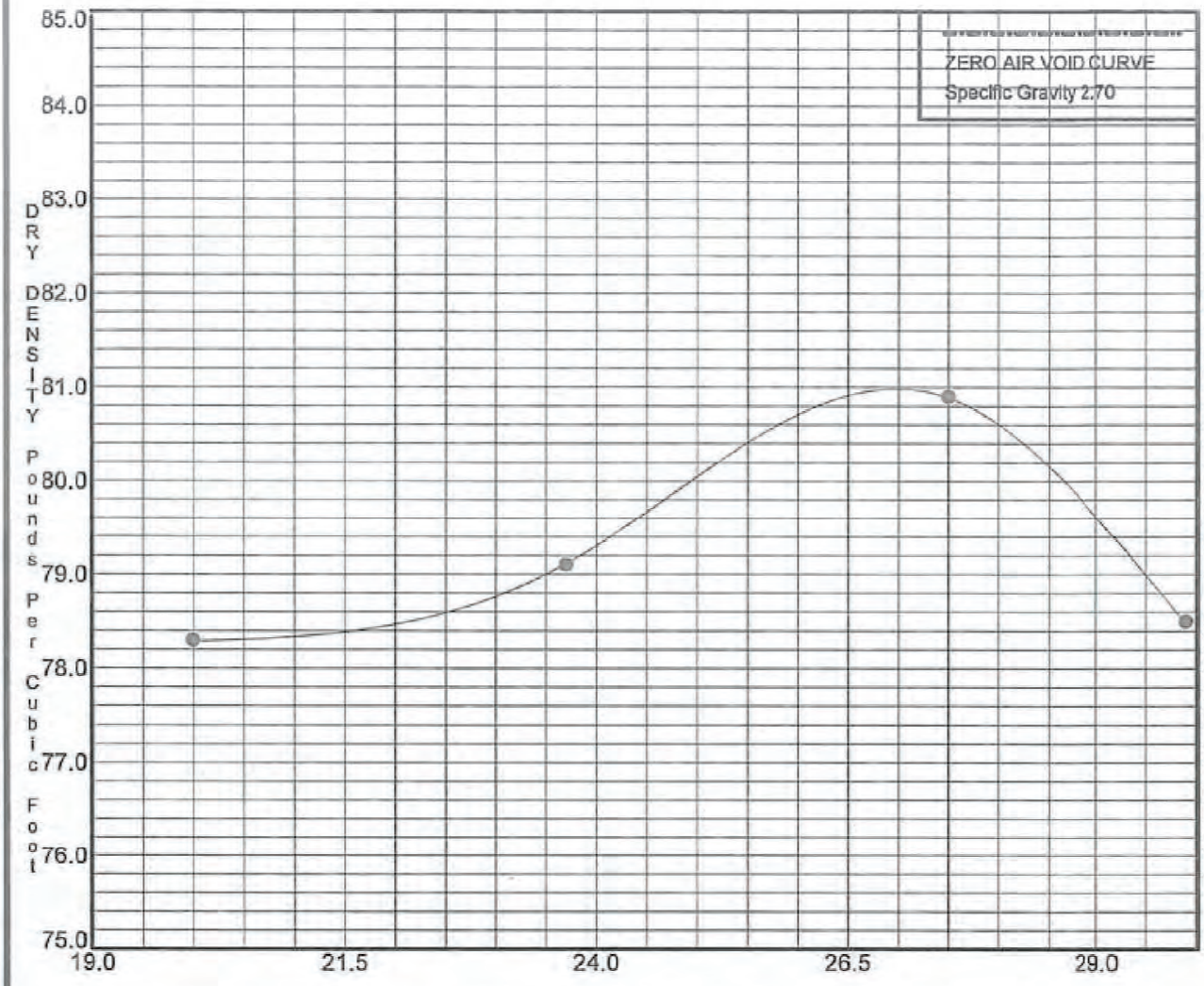

SPECIMEN IDENTIFICATION	CLASSIFICATION
Gypsum	Gypsum
LSN-3781	

MOISTURE/DENSITY RELATIONSHIP	
Standard ASTM D698/AASHTO T99	
Modified ASTM D1557/AASHTO T180	
Maximum Dry Density (PCF)	81.0
Optimum Water Content (%)	27.0

NOTES :

PROJECT Duck Creek Bottom Ash Basins JOB NO. 21-026
LOCATION Fulton County, Illinois DATE March 18, 2021
Gypsum

MOISTURE-DENSITY RELATIONSHIP

Ramsey Geotechnical Engineering
Bloomington, IL 61701

R0002549

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21.026

DUCK CREEK @ OTTOM ASH BASIN

Hanson Professional Services Inc.

Subcontract Agreement: RGE2014

Task Order No. 20E0111A/3000A

SCHEDULE OF LABORATORY TESTING

Sample ID	Routine Testing [1]											Complex Testing [1]														Analytical Testing [1]						
	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB01																																
6A																																
7A																																
8A																																
10A																																
11A																																
12A																																
Comp1				x	x			x			x			x																		
ST9																					x	DONE										
14A																																
ST15																																
Comp2				x	x			x			x			x																		
ST15																					x	DONE										
17A																																
18A																																
19A																																
Comp3				x	x			x			x			x																		
20A																																
21A																																
22A																																
23A																																
Comp4				x	x			x			x			x																		

Note 1: All testing to be in accordance with *Laboratory Testing Specifications*.

See Task Order or Attachment for any special instructions regarding scheduled testing.

R002550

Electronic Filing: Received, Clerk's Office 06/20/2024

SCHEDULE OF LABORATORY TESTING

Sample ID	Routine Testing											Complex Testing												Analytical Testing						
	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB02																																
3A																																
4A																																
6A																																
7A																																
8A																																
Comp1				x	x			x			x			x																	
ST5																					x	DONE										
9A																																
ST10																																
11A																																
Comp2				x	x			x			x			x																	
ST10																					x	DONE										
12A																																
ST13																																
Comp3				x	x			x			x			x																	
ST13																					x	DONE										
15A																																
16A																																
17A																																
18A																																
19A																																
20A																																
Comp4				x	x			x			x			x																	

R0002551

Electronic Filing: Received, Clerk's Office 06/20/2024

SCHEDULE OF LABORATORY TESTING

Sample ID	Routine Testing											Complex Testing												Analytical Testing						
	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB03																																
4A																																
6A																																
7A																																
8A																																
Comp1				x	x			x			x			x																	
ST5																					x	Dark										
ST10*				x	x			x			x			x																	
ST10^																					x	Dark										
11A																																
12A																																
13A																																
Comp3				x	x			x			x			x																	
Gypsum				x	x			x	x		x			x							x*	*Remolded permeability*										

* If sand is present in Shelby tube.

^ if sufficient sample, use lower portion of Shelby tube.

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GEOTECHNICS
Soil & Material Testing
A DIVISION OF KLINGNER
4510 Paris Gravel Road • Hannibal, MO 63401 • voice 573.221.7714 • fax 573.221.7762

March 26, 2021 21-1004

Hanson Professional Services, Inc.
1525 S. Sixth St.
Springfield, IL 62703-6801

Attn: Mr. Rhonald Hasenyager

RE: Duck Creek Power Station GMF: Fulton County, IL

Dear Mr. Hasenyager:

In accordance with your request, we have completed the analysis of the samples obtained from the exploration borings from the above mentioned project. The selected samples were analyzed in accordance with the applicable ASTM standards. A laboratory results summary sheet is included for your reference.

As always, if you have any questions do not hesitate to contact us.

Sincerely,

GEOTECHNICS, A DIVISION OF KLINGNER

Brian Joseph Sick

Brian Joseph Sick, P.E.
Geotechnical Services Department Manager

Enclosure: Data Results Summary, Laboratory Analysis Data Reports

Electronic Filing: Received, Clerk's Office 06/20/2024

Job #: 21-1004

Duck Creek Power Station
Hanson Professional Services

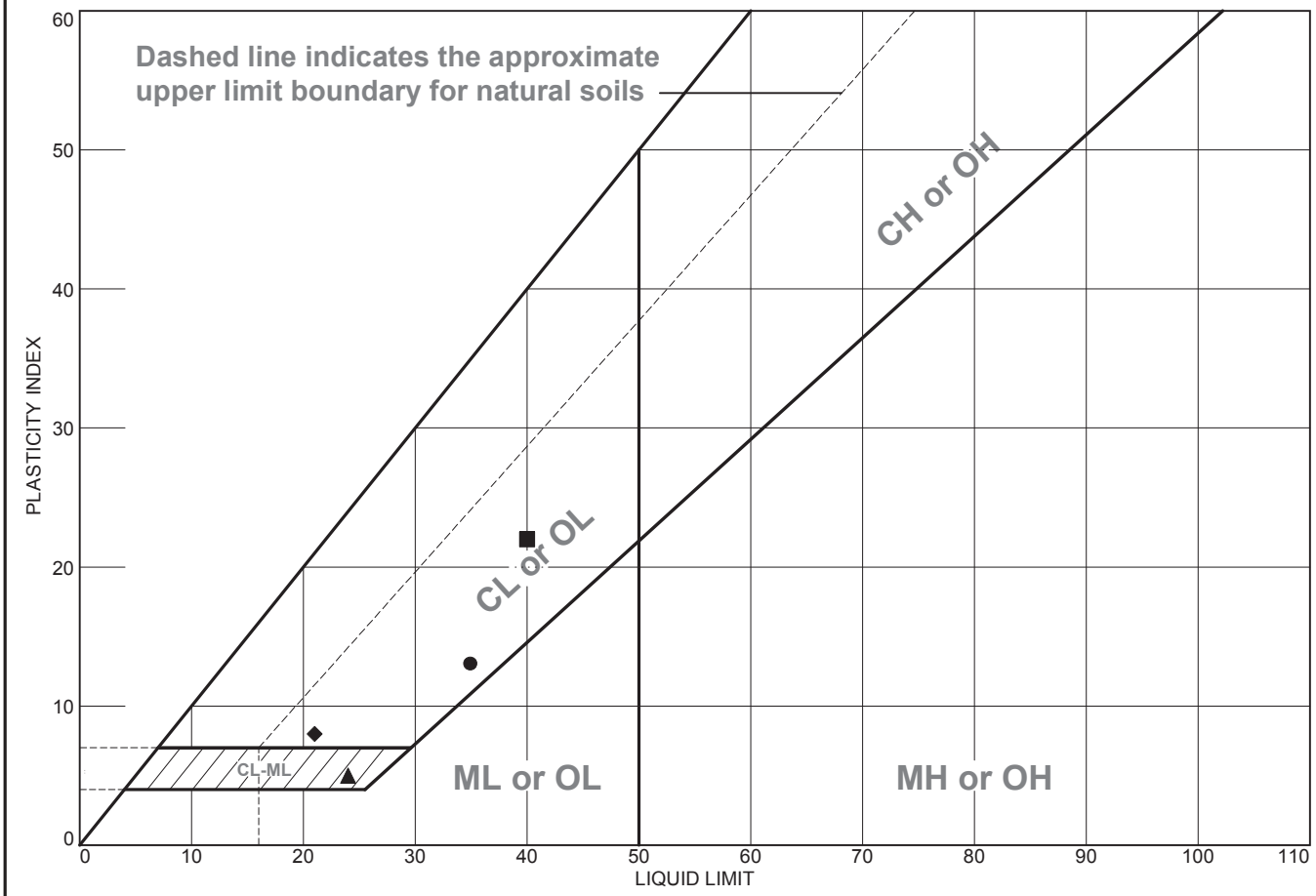
Date: 3/26/2021

SAMPLE NO.	DEPTH	% Gravel	% Sand	% Silt	% Clay	USCS	LL	PL	PI	Sp. Gr.	Hyd. Cond.	Moist.	WET DENS.	DRY DENS.
SB50-Comp 1	5-19	0.0	2.6	81.8	15.6	CL	32	23	9	2.68		24.9	121.5	97.3
SB50-Comp 2	21-31	3.4	26.5	46.1	24.0	CL	28	18	10	2.70		21.1	141.4	116.7
SB50-Comp 3	31-39	3.6	32.0	50.5	13.9	CL	27	18	9	2.70		17.1	143.2	122.3
SB50-Comp 4	41-51	12.9	37.8	34.3	15.0	SC-SM	21	15	6	2.70		7.7	144.2	133.8
SB50/ST10-12	10-12										6.34E-07	25.9	123.5	98.0
SB50/ST22-24	22-24										2.59E-07	21.8	129.5	106.3
G54C-Comp 1	7-19	0.2	11.6	66.1	22.1	CL	35	22	13	2.68		18.6	134.2	113.1
G54C-Comp 2	25-33	1.0	18.4	49.1	31.5	CL	40	18	22	2.68		24.6	122.1	98.0
G54C-Comp 3	35-41	10.6	25.8	45.2	18.4	CL-ML	24	19	5	2.64		18.2	133.6	113.0
G54C-Comp 4	47-73	7.4	36.3	38.0	18.3	CL	21	13	8	2.67		9.8	141.0	128.4
G54C/ST14-16	14-16										7.06E-08	22.2	127.0	104.0
G54C/ST32-34	32-34										7.47E-07	21.9	128.2	105.1
G54C/ST44-46	44-46										5.39E-06	12.2	141.5	126.1
G54C/ST76-78	76-78										4.11E-08	12.6	138.7	123.2
SB62-Comp 1	7-19	0.0	11.5	62.0	26.5	CL	35	22	13	2.65		19.3	124.9	104.7
SB62-Comp 2	23-33	0.0	23.0	48.6	28.4	CL	29	17	12	2.70		21.5	126.6	104.1
SB62-Comp 3	33-39	2.9	23.4	57.5	16.2	CL-ML	26	19	7	2.65		14.5	133.0	116.1
SB62-Comp 4	41-51	2.8	40.7	38.7	17.8	CL-ML	21	15	6	2.64		10.0	138.6	126.1
SB62/ST12-14	12-14										1.94E-07	21.1	127.8	105.5
SB62/ST26-28	26-28										2.28E-06	23.2	129.8	105.3
SB62/ST38-40	38-40										1.09E-06	15.6	136.8	118.4

Lab Results

Electronic Filing: Received, Clerk's Office 06/20/2024

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist	35	22	13	94.5	88.2	CL
■	Lean Clay with Sand (CL), Yellow Brown, Silty, Moist	40	18	22	95.5	80.6	CL
▲	Sandy Silty Clay (CL-ML), Gray, Moist	24	19	5	79.9	63.6	CL-ML
◆	Sandy Lean Clay (CL), Gray, Silty	21	13	8	80.1	56.3	CL

Project No. 21-1004 **Client:** Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

●**Location:** G54C **Depth:** 7 to 19 ft. **Sample Number:** Comp 1
■**Location:** G54C **Depth:** 25 to 33 ft. **Sample Number:** Comp 2
▲**Location:** G54C **Depth:** 35 to 41 ft. **Sample Number:** Comp 3
◆**Location:** G54C **Depth:** 47 to 73 ft. **Sample Number:** Comp 4

Remarks:
●Moisture Content = 18.6%
■Moisture Content = 24.6%
▲Moisture Content = 18.2%
◆Moisture Content = 9.8%

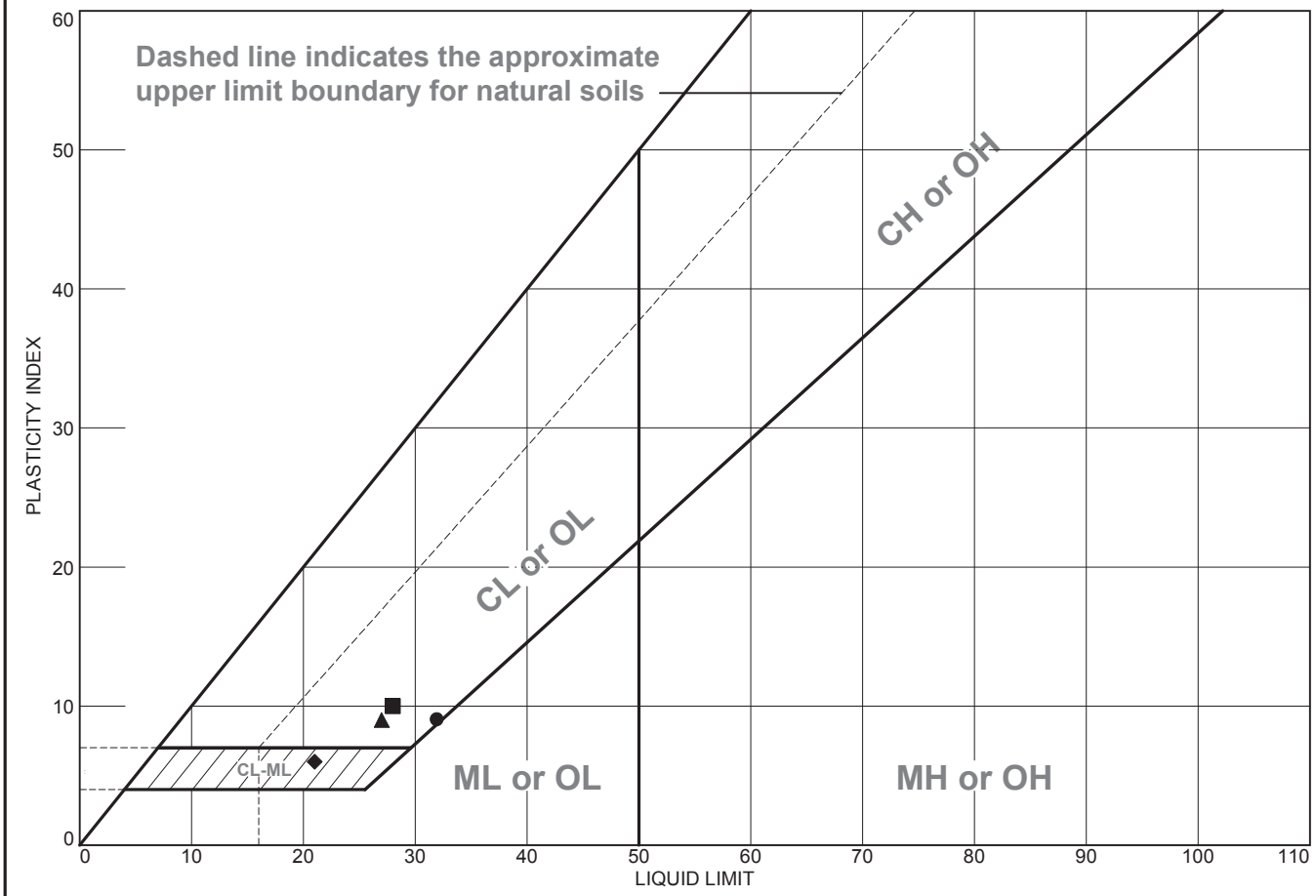
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Figure

Tested By: AJK **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay (CL), Light Brown, Silty, Moist	32	23	9	99.5	97.4	CL
■	Lean Clay with Sand (CL), Yellow Brown/Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist	28	18	10	86.3	70.1	CL
▲	Sandy Lean Clay (CL), Gray, Silty, Moist	27	18	9	85.9	64.4	CL
◆	Silty, Clayey Sand (SC-SM), Gray, Dry	21	15	6	75.0	49.3	SC-SM

Project No. 21-1004 **Client:** Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

●**Location:** SB50 **Depth:** 5 to 19 ft. **Sample Number:** Comp 1
■**Location:** SB50 **Depth:** 21 to 31 ft. **Sample Number:** Comp 2
▲**Location:** SB50 **Depth:** 31 to 39 ft. **Sample Number:** Comp 3
◆**Location:** SB50 **Depth:** 41 to 51 ft. **Sample Number:** Comp 4

Remarks:
●Moisture Content = 24.9%
■Moisture Content = 21.1%
▲Moisture Content = 17.1%
◆Moisture Content = 7.7%

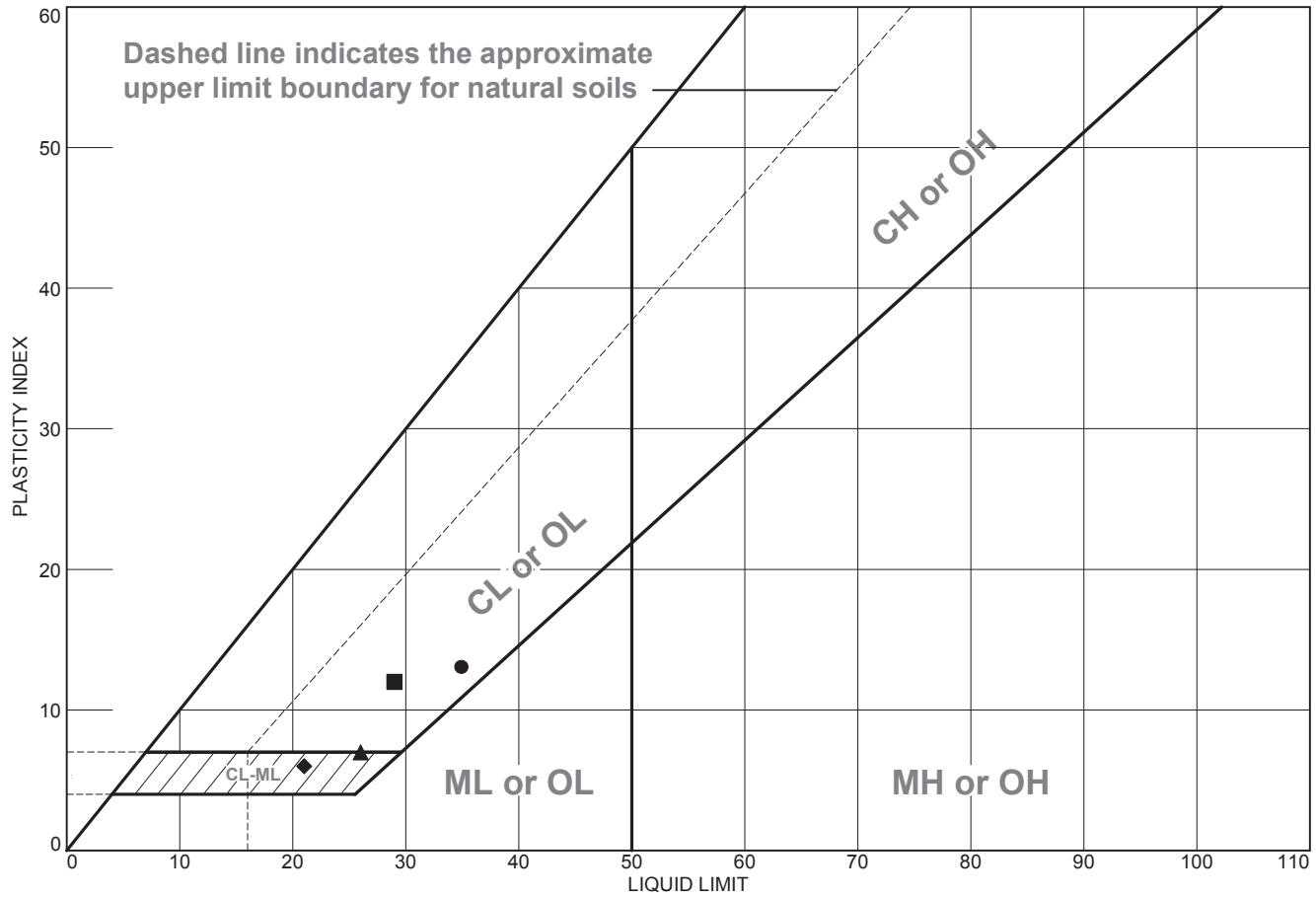
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Figure

Tested By: ○ NAS □ NAS △ AJK ◇ AJK **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist	35	22	13	93.1	88.5	CL
■	Lean Clay with Sand (CL), Gray, Silty, Moist	29	17	12	94.3	77.0	CL
▲	Silty Clay with Sand (CL-ML), Gray, Moist	26	19	7	88.5	73.7	CL-ML
◆	Sandy Silty Clay (CL-ML), Gray, Dry	21	15	6	83.5	56.5	CL-ML

Project No. 21-1004 **Client:** Hanson Professional Services, Inc.

Project: Duck Creek Power Station GMF

●**Location:** SB62 **Depth:** 7 to 19 ft. **Sample Number:** Comp 1
■**Location:** SB62 **Depth:** 23 to 33 ft. **Sample Number:** Comp 2
▲**Location:** SB62 **Depth:** 33 to 39 ft. **Sample Number:** Comp 3
◆**Location:** SB62 **Depth:** 41 to 51 ft. **Sample Number:** Comp 4

Remarks:
●Moisture Content = 19.3%
■Moisture Content = 21.5%
▲Moisture Content = 14.5%
◆Moisture Content = 10.0%

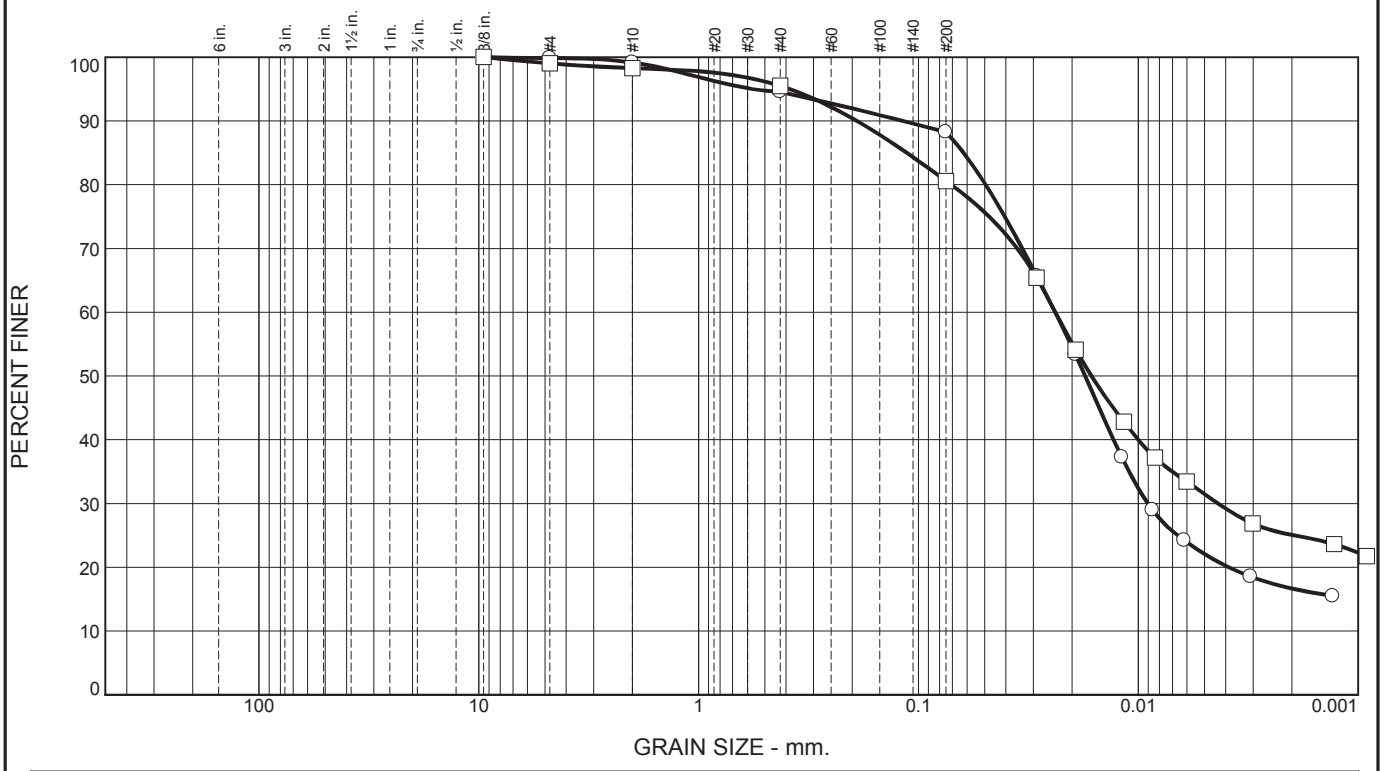
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Figure

Tested By: AJK **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	0.2	11.6	66.1	22.1	CL	35	22	13
□	0.0	1.0	18.4	49.1	31.5	CL	40	18	22

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/8	100.0	100.0
	GRAIN SIZE	
D_{60}	0.0239	0.0238
D_{30}	0.0090	0.0043
D_{10}		
	COEFFICIENTS	
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	99.8	99.0
#10	99.1	98.3
#40	94.5	95.5
#200	88.2	80.6

Material Description

○ Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

□ Lean Clay with Sand (CL), Yellow Brown, Silty, Moist

REMARKS:

○ Moisture Content = 18.6%

□ Moisture Content = 24.6%

○ Location: G54C Depth: 7 to 19 ft. Sample Number: Comp 1

□ Location: G54C Depth: 25 to 33 ft. Sample Number: Comp 2

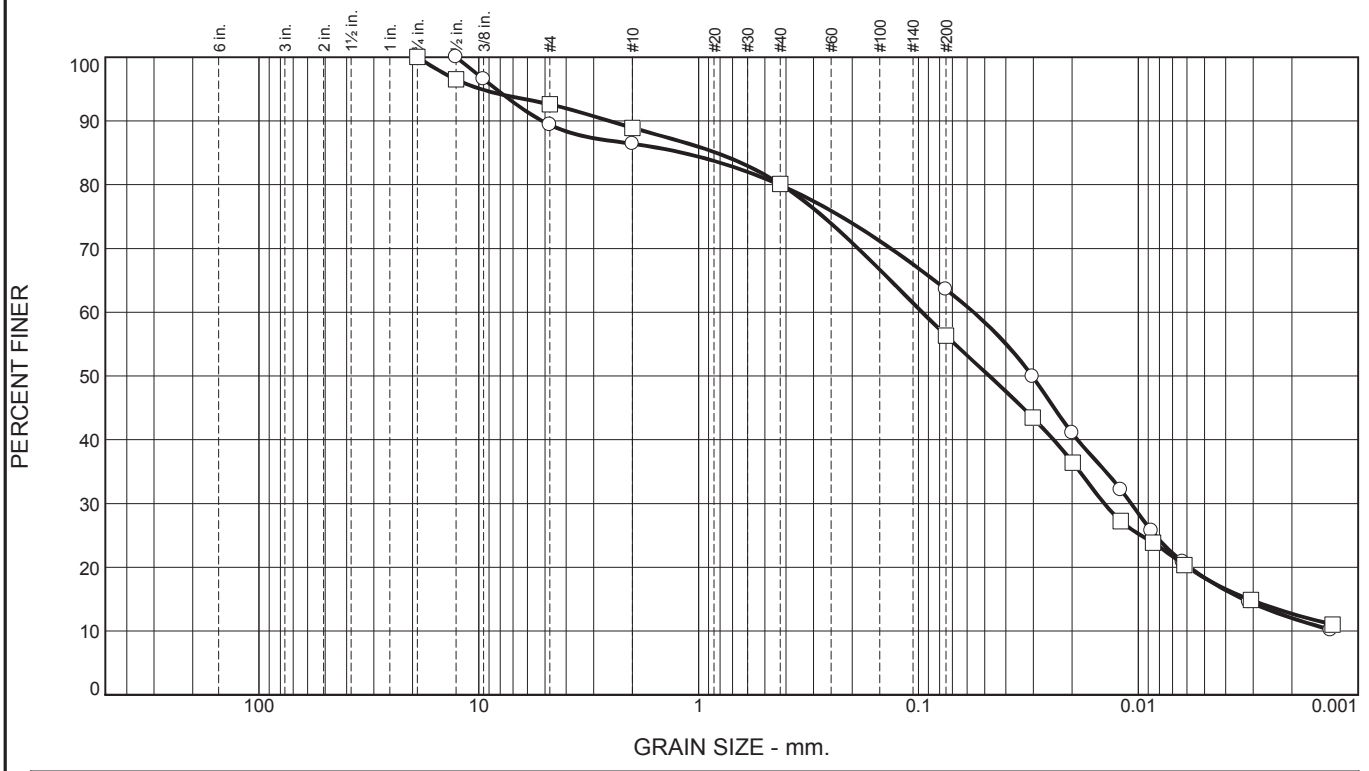
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.
Project: Duck Creek Power Station GMF
Project No.: 21-1004 Figure

Tested By: MAS/NAS **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	10.6	25.8	45.2	18.4	CL-ML	24	19	5
□	0.0	7.4	36.3	38.0	18.3	CL	21	13	8

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/4		100.0
.5	100.0	96.5
3/8	96.6	

	GRAIN SIZE ○	GRAIN SIZE □
D_{60}	0.0562	0.0963
D_{30}	0.0108	0.0143
D_{10}		
	COEFFICIENTS	
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	89.4	92.6
#10	86.4	88.9
#40	79.9	80.1
#200	63.6	56.3

Material Description

○ Sandy Silty Clay (CL-ML), Gray, Moist

□ Sandy Lean Clay (CL), Gray, Silty

REMARKS:

○ Moisture Content = 18.2%

□ Moisture Content = 9.8%

○ Location: G54C Depth: 35 to 41 ft. Sample Number: Comp 3

□ Location: G54C Depth: 47 to 73 ft. Sample Number: Comp 4

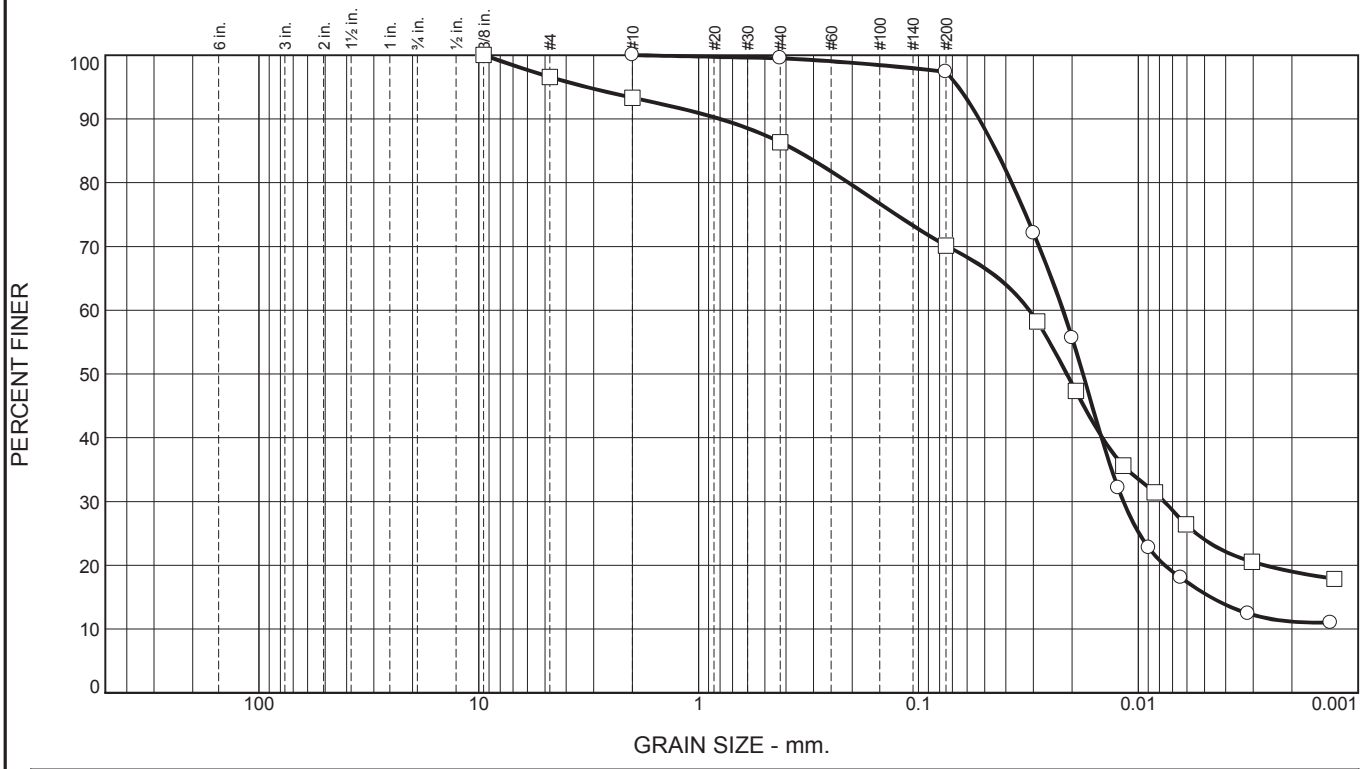
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.
Project: Duck Creek Power Station GMF
Project No.: 21-1004 Figure

Tested By: ○ DAW/NAS □ MAS/NAS **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	0.0	2.6	81.8	15.6	CL	32	23	9
□	0.0	3.4	26.5	46.1	24.0	CL	28	18	10

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/8		100.0
GRAIN SIZE		
D_{60}	0.0220	0.0314
D_{30}	0.0117	0.0076
D_{10}		
COEFFICIENTS		
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4		96.6
#10	100.0	93.3
#40	99.5	86.3
#200	97.4	70.1

Material Description

○ Lean Clay (CL), Light Brown, Silty, Moist

□ Lean Clay with Sand (CL), Yellow Brown/Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist

REMARKS:

○ Moisture Content = 24.9%

□ Moisture Content = 21.1%

○ Location: SB50 Depth: 5 to 19 ft. Sample Number: Comp 1

□ Location: SB50 Depth: 21 to 31 ft. Sample Number: Comp 2

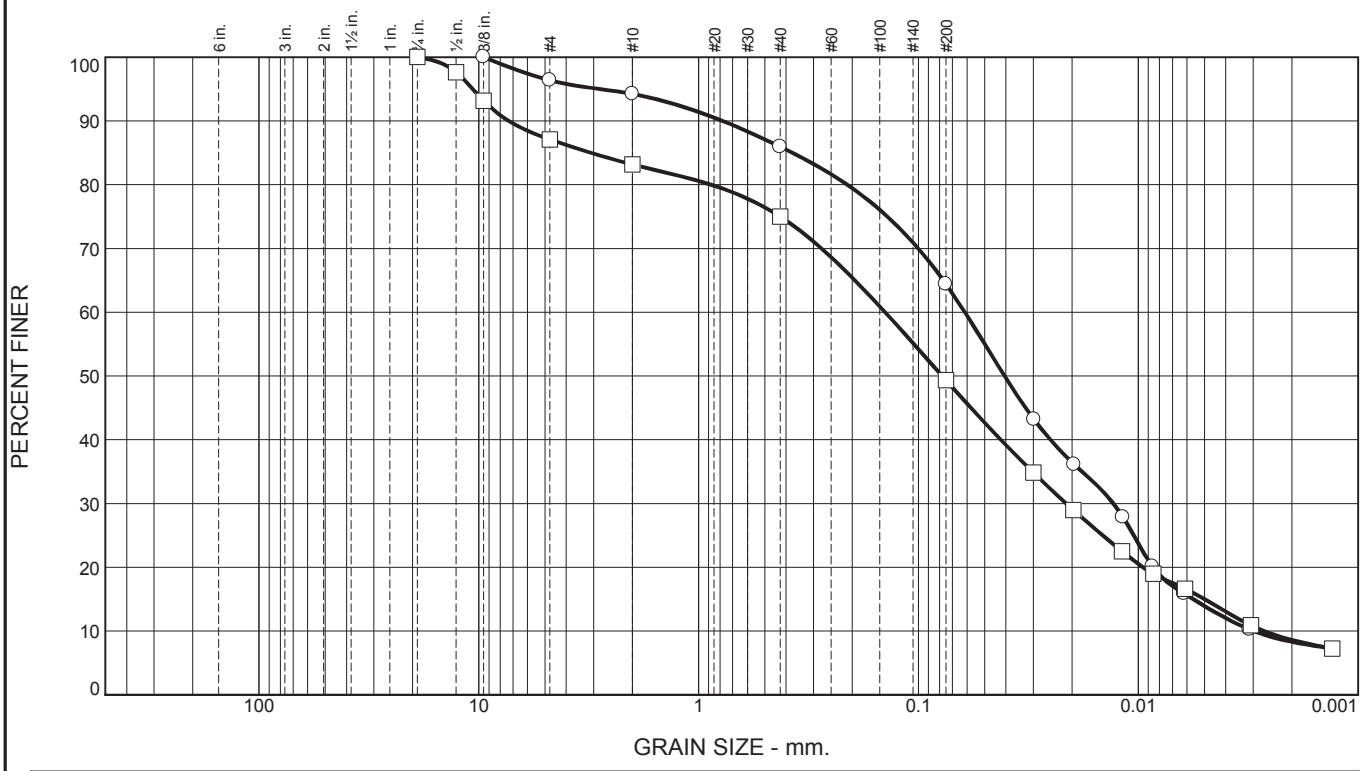
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.
Project: Duck Creek Power Station GMF
Project No.: 21-1004 Figure

Tested By: MAS/NAS **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	3.6	32.0	50.5	13.9	CL	27	18	9
□	0.0	12.9	37.8	34.3	15.0	SC-SM	21	15	6

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/4		100.0
.5		97.6
3/8	100.0	93.2
GRAIN SIZE		
D_{60}	0.0616	0.1419
D_{30}	0.0130	0.0213
D_{10}	0.0030	0.0027
COEFFICIENTS		
C_c	0.92	1.19
C_u	20.67	53.01

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	96.4	87.1
#10	94.2	83.2
#40	85.9	75.0
#200	64.4	49.3

Material Description
○ Sandy Lean Clay (CL), Gray, Silty, Moist

□ Silty, Clayey Sand (SC-SM), Gray, Dry

REMARKS:
○ Moisture Content = 17.1%

□ Moisture Content = 7.7%

○ Location: SB50 Depth: 31 to 39 ft. Sample Number: Comp 3
□ Location: SB50 Depth: 41 to 51 ft. Sample Number: Comp 4

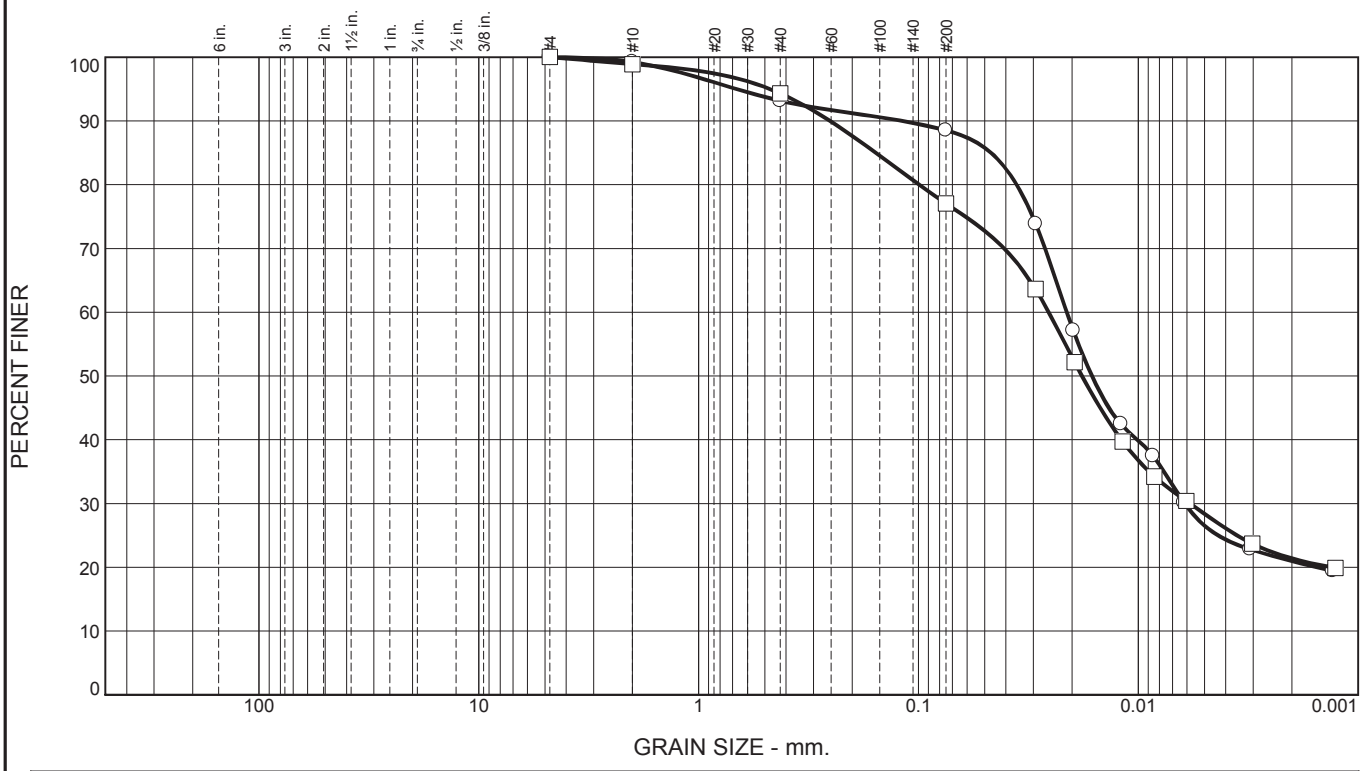
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.
Project: Duck Creek Power Station GMF
Project No.: 21-1004 Figure

Tested By: ○ MAS □ MAS/NAS **Checked By:** NAS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	0.0	11.5	62.0	26.5	CL	35	22	13
□	0.0	0.0	23.0	48.6	28.4	CL	29	17	12

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
GRAIN SIZE		
D_{60}	0.0212	0.0256
D_{30}	0.0062	0.0058
D_{10}		
COEFFICIENTS		
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	100.0	100.0
#10	99.2	98.9
#40	93.1	94.3
#200	88.5	77.0

Material Description

○ Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

□ Lean Clay with Sand (CL), Gray, Silty, Moist

REMARKS:

○ Moisture Content = 19.3%

□ Moisture Content = 21.5%

○ Location: SB62 Depth: 7 to 19 ft. Sample Number: Comp 1

□ Location: SB62 Depth: 23 to 33 ft. Sample Number: Comp 2

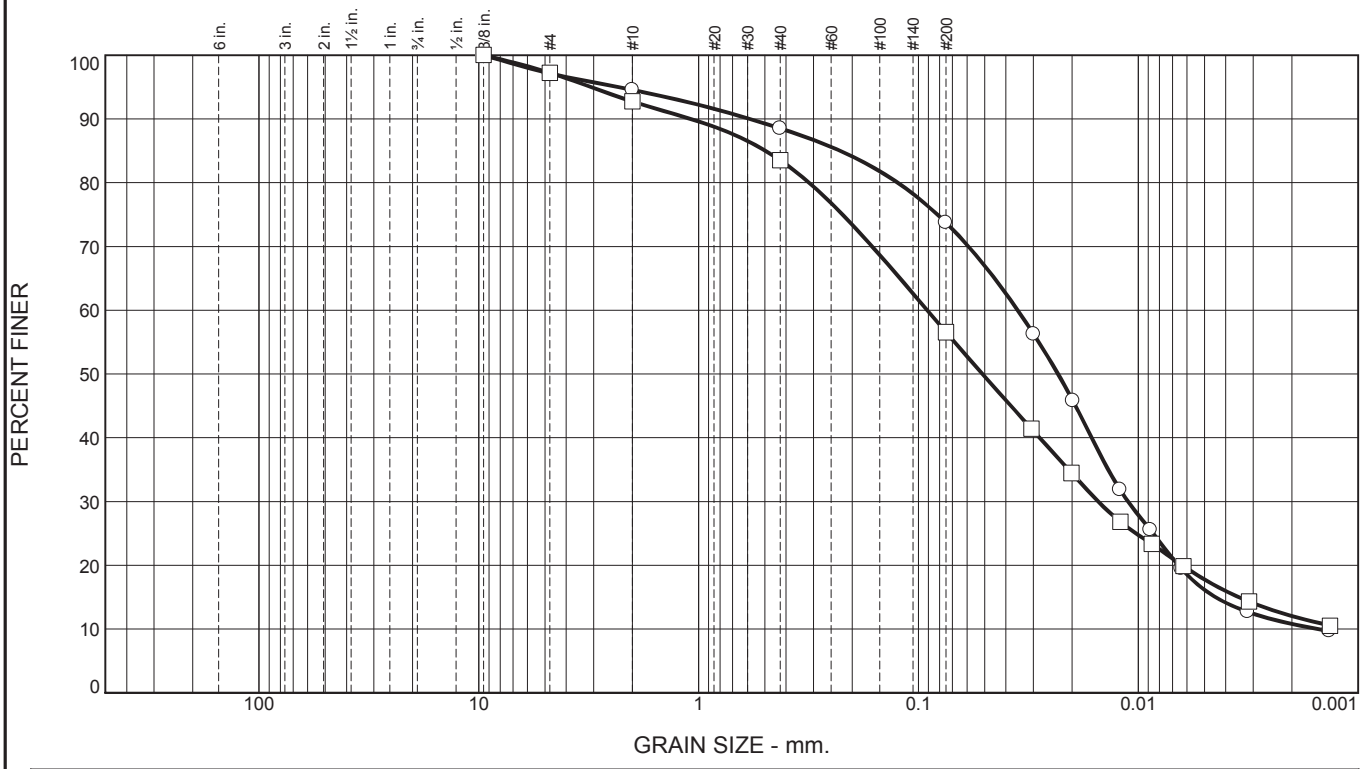
GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.
Project: Duck Creek Power Station GMF
Project No.: 21-1004 Figure

Tested By: DAW/NAS **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	2.9	23.4	57.5	16.2	CL-ML	26	19	7
□	0.0	2.8	40.7	38.7	17.8	CL-ML	21	15	6

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
3/8	100.0	100.0
GRAIN SIZE		
D_{60}	0.0354	0.0913
D_{30}	0.0111	0.0152
D_{10}	0.0015	
COEFFICIENTS		
C_c	2.31	
C_u	23.34	

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	97.1	97.2
#10	94.5	92.7
#40	88.5	83.5
#200	73.7	56.5

Material Description

○ Silty Clay with Sand (CL-ML), Gray, Moist

□ Sandy Silty Clay (CL-ML), Gray, Dry

REMARKS:

○ Moisture Content = 14.5%

□ Moisture Content = 10.0%

○ Location: SB62 Depth: 33 to 39 ft. Sample Number: Comp 3

□ Location: SB62 Depth: 41 to 51 ft. Sample Number: Comp 4

GEOTECHNICS
Soil & Material Testing
4510 Paris Gravel Road - Hannibal, MO

Client: Hanson Professional Services, Inc.
Project: Duck Creek Power Station GMF
Project No.: 21-1004 Figure

Tested By: DAW/NAS **Checked By:** BJS

Electronic Filing: Received, Clerk's Office 06/20/2024

Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#1 Maximum Particle Size: 3/8"

Sample Depth: 7 to 19 ft. Percent Passing No. 4 Sieve: 99.8%

Sample Type: SS Percent Passing No. 200 Sieve: 88.2%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp1		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	26.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99844		
Tare No.	239		
Wt. of Tare & Dry Soil	99.02		
Wt. of Tare	48.70		
Wt. of Dry Soil **(M_s)**	50.32		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.70		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99665		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	673.23		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.689		
Specific Gravity @ 20ºC=K*G_t	2.68		

Sample Obtained By: Geotechnics Date: 2/4/2021

Tested By Technician: NAS Date: 2/15/2021

Checked By Project Engineer: BJS Date: 3/26/2021

GEOTECHNICS
Soil & Material Testing
A Division of Klingner

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay with Sand (CL), Yellow Brown, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#2 Maximum Particle Size: 3/8"

Sample Depth: 25 to 33 ft. Percent Passing No. 4 Sieve: 99.0%

Sample Type: SS Percent Passing No. 200 Sieve: 80.6%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp2		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	21.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99979		
Tare No.	231		
Wt. of Tare & Dry Soil	93.41		
Wt. of Tare	49.02		
Wt. of Dry Soil **(M_s)**	44.39		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	642.30		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99799		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	670.15		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.684		
Specific Gravity @ 20ºC=K*G_t	2.68		

Sample Obtained By: Geotechnics Date: 2/4/2021

Tested By Technician: NAS Date: 2/15/2021

Checked By Project Engineer: BJS Date: 3/26/2021

GEOTECHNICS
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Electronic Filing: Received, Clerk's Office 06/20/2024

Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Silty Clay (CL-ML), Gray, Moist

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#3 Maximum Particle Size: 1/2"

Sample Depth: 35 to 41 ft. Percent Passing No. 4 Sieve: 89.4%

Sample Type: SS Percent Passing No. 200 Sieve: 63.6%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp3		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	26.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99844		
Tare No.	237		
Wt. of Tare & Dry Soil	105.00		
Wt. of Tare	49.34		
Wt. of Dry Soil **(M_s)**	55.66		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	642.24		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99665		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	676.82		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.640		
Specific Gravity @ 20ºC=K*G_t	2.64		

Sample Obtained By: Geotechnics Date: 2/4/2021

Tested By Technician: NAS Date: 2/16/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Electronic Filing: Received, Clerk's Office 06/20/2024

Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Lean Clay (CL), Gray, Silty, Dry

Sample Source: SS Composite

Boring or Test Pit No.: G54C/Comp#4 Maximum Particle Size: 3/4"

Sample Depth: 47 to 73 ft. Percent Passing No. 4 Sieve: 92.6%

Sample Type: SS Percent Passing No. 200 Sieve: 56.3%

Specific gravity of soil solids (ASTM D854)			
Sample No.	G54C-Comp4		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	25.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99884		
Tare No.	228		
Wt. of Tare & Dry Soil	105.70		
Wt. of Tare	49.94		
Wt. of Dry Soil **(M_s)**	55.76		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.40		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99705		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	666.34		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.678		
Specific Gravity @ 20ºC=K*G_t	2.67		

Sample Obtained By: Geotechnics Date: 2/4/2021

Tested By Technician: NAS Date: 2/16/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay (CL), Light Brown, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#1 Maximum Particle Size: #10

Sample Depth: 5 to 19 ft. Percent Passing No. 4 Sieve: 100.0%

Sample Type: SS Percent Passing No. 200 Sieve: 97.4%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp1		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	24.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99897		
Tare No.	233		
Wt. of Tare & Dry Soil	96.94		
Wt. of Tare	49.38		
Wt. of Dry Soil **(M_s)**	47.56		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.88		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99717		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	671.72		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.684		
Specific Gravity @ 20ºC=K*G_t	2.68		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/12/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Electronic Filing: Received, Clerk's Office 06/20/2024

Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay with Sand (CL), YBrn/Lt Brn mot. Lt Gray, RBrn Ox, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#2 Maximum Particle Size: 3/8

Sample Depth: 21 to 31 ft. Percent Passing No. 4 Sieve: 96.6%

Sample Type: SS Percent Passing No. 200 Sieve: 70.1%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp2		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	21.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99979		
Tare No.	236		
Wt. of Tare & Dry Soil	97.27		
Wt. of Tare	49.36		
Wt. of Dry Soil **(M_s)**	47.91		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.87		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99799		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	662.03		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.699		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/12/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Lean Clay (CL), Gray, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#3 Maximum Particle Size: 3/8

Sample Depth: 31 to 39 ft. Percent Passing No. 4 Sieve: 96.4%

Sample Type: SS Percent Passing No. 200 Sieve: 64.4%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp3		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	26.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99858		
Tare No.	220		
Wt. of Tare & Dry Soil	98.97		
Wt. of Tare	49.09		
Wt. of Dry Soil **(M_s)**	49.88		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.27		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99679		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	662.68		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.701		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/15/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Silty, Clayey Sand (SC-SM), Gray, Dry

Sample Source: SS Composite

Boring or Test Pit No.: SB50/Comp#4 Maximum Particle Size: 3/4

Sample Depth: 41 to 51 ft. Percent Passing No. 4 Sieve: 87.1%

Sample Type: SS Percent Passing No. 200 Sieve: 49.3%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB50-Comp4		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	25.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99884		
Tare No.	237		
Wt. of Tare & Dry Soil	99.71		
Wt. of Tare	49.44		
Wt. of Dry Soil **(M_s)**	50.27		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.83		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99705		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	673.49		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.701		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/12/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay (CL), Yellow Brown, Silty, Trace Sand, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#1 Maximum Particle Size: #4

Sample Depth: 7 to 19 ft. Percent Passing No. 4 Sieve: 100.0%

Sample Type: SS Percent Passing No. 200 Sieve: 88.5%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp1		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	24.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99909		
Tare No.	239		
Wt. of Tare & Dry Soil	88.7		
Wt. of Tare	48.66		
Wt. of Dry Soil **(M_s)**	40.04		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	641.95		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99730		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	666.87		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.648		
Specific Gravity @ 20ºC=K*G_t	2.65		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/16/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Lean Clay with Sand (CL), Gray, Silty, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#2 Maximum Particle Size: #4

Sample Depth: 23 to 33 ft. Percent Passing No. 4 Sieve: 100.0%

Sample Type: SS Percent Passing No. 200 Sieve: 77.0%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp2		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	26.0		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99858		
Tare No.	234		
Wt. of Tare & Dry Soil	101.50		
Wt. of Tare	49.10		
Wt. of Dry Soil **(M_s)**	52.40		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.27		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99679		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	664.27		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.701		
Specific Gravity @ 20ºC=K*G_t	2.70		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/16/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Silty Clay with Sand (CL-ML), Gray, Moist

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#3 Maximum Particle Size: 3/8"

Sample Depth: 33 to 39 ft. Percent Passing No. 4 Sieve: 97.1%

Sample Type: SS Percent Passing No. 200 Sieve: 73.7%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp3		
Pycnometer No.	1		
Temp. of Water & Soil, T, ºC	26.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99844		
Tare No.	223		
Wt. of Tare & Dry Soil	103.96		
Wt. of Tare	49.21		
Wt. of Dry Soil **(M_s)**	54.75		
Wt. of Calibrated Pycnometer, dry **(M_p)**	143.91		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	647.24		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99665		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	676.33		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.650		
Specific Gravity @ 20ºC=K*G_t	2.65		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/17/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Project No: 21-1004

Specific Gravity of Soil Solids by Water Pycnometer (ASTM D854)

Project: Duck Creek Power Station GMF Location: Canton, IL

Client: Hanson Professional Services Test Method: B

Sample Description: Sandy Silty Clay (CL-ML), Gray, Dry

Sample Source: SS Composite

Boring or Test Pit No.: SB62/Comp#4 Maximum Particle Size: 3/8"

Sample Depth: 41 to 51 ft. Percent Passing No. 4 Sieve: 97.2%

Sample Type: SS Percent Passing No. 200 Sieve: 56.5%

Specific gravity of soil solids (ASTM D854)			
Sample No.	SB62-Comp4		
Pycnometer No.	2		
Temp. of Water & Soil, T, ºC	23.5		
Correction Factor, **(K)** from Table 2 ASTM D 854	0.99921		
Tare No.	231		
Wt. of Tare & Dry Soil	99.47		
Wt. of Tare	49.03		
Wt. of Dry Soil **(M_s)**	50.44		
Wt. of Calibrated Pycnometer, dry **(M_p)**	133.50		
Wt. of Pycnometer and Water at Test Temp **($M_{pw,t}$)**	631.59		
Vol. of Pycnometer, ml **(V_p)**	500		
Density of Water at Test Temp **($P_{w,t}$)**	0.99742		
Wt. of Pycnometer, Water and Soil **($M_{pws,t}$)**	662.94		
Specific Gravity, $G_t=M_s/(M_{pw,t}-(M_{pws,t}-M_s))$	2.642		
Specific Gravity @ 20ºC=K*G_t	2.64		

Sample Obtained By: Geotechnics Date: 2/3/2021

Tested By Technician: NAS Date: 2/17/2021

Checked By Project Engineer: BJS Date: 3/26/2021

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Lean Clay (CL/CH), Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **G-54C** SAMPLE NO. **14-16**

SAMPLE TYPE **ST** DEPTH **14-16 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **22.2%** INITIAL DRY DENSITY **104.0 P.C.F.**

FINAL WATER CONTENT **23.9%** FINAL DRY DENSITY **103.0 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
14:18		0.200	7.818	42.077		1.49	8.10	33.050	210.9		243.950		
14:18	15:10	0.200	7.818	42.077	3120	1.78	7.80	30.100	210.9	1.03	241.000	7.25E-08	7.35E-08
15:10	15:44	0.200	7.818	42.077	2040	1.96	7.62	28.300	210.9	1.00	239.200	6.83E-08	6.93E-08
15:44	16:36	0.200	7.818	42.077	3120	2.23	7.35	25.600	210.9	1.00	236.500	6.76E-08	6.86E-08
													7.06E-08

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 7.06 E-08 CM/SEC

REMARKS: Testing Completed 2/17/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/4/2021**

SAMPLE DESCRIPTION **Sandy Lean Clay (CL), Light Brown mottled Light Gray, Reddish Brown Oxidation, Silty, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **G-54C** SAMPLE NO. **32-34**

SAMPLE TYPE **ST** DEPTH **32-34 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **21.9%** INITIAL DRY DENSITY **105.1 P.C.F.**

FINAL WATER CONTENT **21.4%** FINAL DRY DENSITY **106.7 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
8:33		0.200	7.523	40.438		3.65	5.72	10.350	210.9		221.250		
8:33	10:02	0.200	7.523	40.438	5340	7.87	1.44	-32.150	210.9	1.01	178.750	7.43E-07	7.54E-07
10:02	10:25	0.200	7.523	40.438	1380	8.80	0.52	-41.400	210.9	0.99	169.500	7.16E-07	7.27E-07
10:25	10:36	0.200	7.523	40.438	660	9.22	0.08	-45.700	210.9	1.05	165.200	7.24E-07	7.35E-07
													7.47E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 7.47 E-07 CM/SEC

REMARKS: Testing Completed 2/19/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/4/2021**

SAMPLE DESCRIPTION **Silty Sand (SM), Light Gray to Gray, Clayey, With Sandy Lean Clay Seams and Sand Pockets, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **G-54C** SAMPLE NO. **44-46**

SAMPLE TYPE **ST** DEPTH **44-46 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **12.2%** INITIAL DRY DENSITY **126.1 P.C.F.**

FINAL WATER CONTENT **12.3%** FINAL DRY DENSITY **127.4 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
9:12		0.200	7.752	41.447		7.21	2.54	-23.350	210.9		187.550		
9:12	9:15	0.200	7.752	41.447	180	8.15	1.58	-32.850	210.9	1.02	178.050	5.40E-06	5.48E-06
9:15	9:18	0.200	7.752	41.447	180	9.02	0.69	-41.650	210.9	1.02	169.250	5.27E-06	5.35E-06
9:18	9:20	0.200	7.752	41.447	120	9.58	0.13	-47.250	210.9	1.00	163.650	5.24E-06	5.32E-06
													5.39E-06

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 5.39 E-06 CM/SEC

REMARKS: Testing Completed 2/22/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/4/2021**

SAMPLE DESCRIPTION **Sandy Lean Clay (CL), Light Gray, Silty, With Fat Clay Seam, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **G-54C** SAMPLE NO. **76-78**

SAMPLE TYPE **ST** DEPTH **76-78 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **12.6%** INITIAL DRY DENSITY **123.2 P.C.F.**

FINAL WATER CONTENT **13.9%** FINAL DRY DENSITY **122.0 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
7:13		0.200	7.660	41.592		5.75	3.85	-9.500	210.9		201.400		
7:13	9:36	0.200	7.660	41.592	8580	6.13	3.48	-13.250	210.9	0.97	197.650	4.03E-08	4.09E-08
9:36	11:26	0.200	7.660	41.592	6600	6.41	3.20	-16.050	210.9	1.00	194.850	3.98E-08	4.04E-08
11:26	11:59	0.200	7.660	41.592	1980	6.50	3.11	-16.950	210.9	1.00	193.950	4.31E-08	4.37E-08
													4.11E-08

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 4.11 E-08 CM/SEC

REMARKS: Testing Completed 2/24/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Soil & Material Testing
A Division of Klingner

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/2/2021**

SAMPLE DESCRIPTION **Silt (ML), Yellow Brown mottled Light Brown/Light Gray, Black Oxidation, Clayey, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **SB-50** SAMPLE NO. **10-12**

SAMPLE TYPE **ST** DEPTH **10-12 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **25.9%** INITIAL DRY DENSITY **98.0 P.C.F.**

FINAL WATER CONTENT **23.4%** FINAL DRY DENSITY **106.1 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
8:44		0.200	7.112	39.443		2.88	6.86	19.900	140.6		160.500		
8:44	10:49	0.200	7.112	39.443	7500	6.52	3.15	-16.850	140.6	1.02	123.750	6.25E-07	6.35E-07
10:49	11:56	0.200	7.112	39.443	4020	8.14	1.52	-33.100	140.6	1.01	107.500	6.31E-07	6.41E-07
11:56	13:09	0.200	7.112	39.443	4380	9.63	0.02	-48.050	140.6	1.01	92.550	6.16E-07	6.26E-07
													6.34E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 6.34 E-07 CM/SEC

REMARKS: Testing Completed 2/15/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/2/2021**

SAMPLE DESCRIPTION **Lean Clay with Sand (CL), Light Gray/Gray mottled Yellow Brown, Silty, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **SB-50** SAMPLE NO. **22-24**

SAMPLE TYPE **ST** DEPTH **22-24 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **21.8%** INITIAL DRY DENSITY **106.3 P.C.F.**

FINAL WATER CONTENT **21.7%** FINAL DRY DENSITY **106.2 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
9:25		0.200	7.391	41.931		1.68	7.91	31.150	210.9		242.050		
9:25	10:45	0.200	7.391	41.931	4800	3.30	6.23	14.650	210.9	1.04	225.550	2.59E-07	2.63E-07
10:45	12:50	0.200	7.391	41.931	7500	5.58	3.88	-8.500	210.9	1.03	202.400	2.55E-07	2.58E-07
12:50	13:54	0.200	7.391	41.931	3840	6.64	2.80	-19.200	210.9	1.02	191.700	2.49E-07	2.53E-07
													2.59E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 2.59 E-07 CM/SEC

REMARKS: Testing Completed 2/16/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Fill: Lean Clay (CL), Light Brown mottled Gray, Silty, Trace Sand, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **SB-62** SAMPLE NO. **12-14**

SAMPLE TYPE **ST** DEPTH **12-14 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **21.1%** INITIAL DRY DENSITY **105.5 P.C.F.**

FINAL WATER CONTENT **24.5%** FINAL DRY DENSITY **102.7 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
15:45		0.200	7.264	42.028		5.07	4.80	-1.350	210.9		209.550		
15:45	16:53	0.200	7.264	42.028	4080	6.01	3.83	-10.900	210.9	1.03	200.000	1.98E-07	2.01E-07
16:53	17:27	0.200	7.264	42.028	2040	6.44	3.40	-15.200	210.9	1.00	195.700	1.84E-07	1.87E-07
17:27	17:53	0.200	7.264	42.028	1560	6.76	3.08	-18.400	210.9	1.00	192.500	1.83E-07	1.85E-07
													1.94E-07

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 1.94 E-07 CM/SEC

REMARKS: Testing Completed 3/1/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Lean Clay with Sand (CL), Yellow Brown mottled Reddish Brown and Light Brown, Silty, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **SB-62** SAMPLE NO. **26-28**

SAMPLE TYPE **ST** DEPTH **26-28 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **23.2%** INITIAL DRY DENSITY **105.3 P.C.F.**

FINAL WATER CONTENT **21.5%** FINAL DRY DENSITY **108.1 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
14:11		0.200	7.574	41.689		3.25	6.63	16.900	105.5		122.400		
14:11	14:36	0.200	7.574	41.689	1500	5.33	4.54	-3.950	105.5	1.00	101.550	2.26E-06	2.30E-06
14:36	15:11	0.200	7.574	41.689	2100	7.64	2.24	-27.000	105.5	1.00	78.500	2.23E-06	2.26E-06
15:11	15:28	0.200	7.574	41.689	1020	8.59	1.30	-36.450	105.5	0.99	69.050	2.28E-06	2.32E-06
													2.28E-06

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 2.28 E-06 CM/SEC

REMARKS: Testing Completed 2/25/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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Geotechnics Form No. 17-FW

PERMEABILITY TEST REPORT
ASTM D 5084-10

PROJECT No. **21-1004**

PROJECT **Duck Creek Power Station GMF** LOCATION
CLIENT **Hanson Professional Services, Inc.** SAMPLING DATE **2/3/2021**

SAMPLE DESCRIPTION **Sandy Lean Clay (CL), Light Gray, Silty, With Silt Seam, Moist**

LIQUID LIMIT PLASTIC LIMIT P.I.

BORING NO. **SB-62** SAMPLE NO. **38-40**

SAMPLE TYPE **ST** DEPTH **38-40 ft.**

SPECIFIC GRAVITY, Gs TEST METHOD **ASTM D 5084-10**

INITIAL WATER CONTENT **15.6%** INITIAL DRY DENSITY **118.4 P.C.F.**

FINAL WATER CONTENT **16.4%** FINAL DRY DENSITY **116.5 P.C.F.**

t_1	t_2	a	L	A	t	head	tail	h_w	h_a	dt/dh	h_a+h_w	k	k_{20}
15:45		0.200	7.620	41.834		4.33	5.50	5.850	210.9		216.750		
15:45	16:03	0.200	7.620	41.834	1080	5.68	4.14	-7.700	210.9	1.01	203.200	1.09E-06	1.11E-06
16:03	16:26	0.200	7.620	41.834	1380	7.27	2.54	-23.650	210.9	1.01	187.250	1.08E-06	1.10E-06
16:26	16:44	0.200	7.620	41.834	1080	8.41	1.40	-35.050	210.9	1.00	175.850	1.06E-06	1.08E-06
													1.09E-06

COEFFICIENT OF VERTICAL PERMEABILITY
K_{20} = 1.09 E-06 CM/SEC

REMARKS: Testing Completed 2/26/2021

TESTED BY: **BJS**

COMPUTED BY: **BJS**

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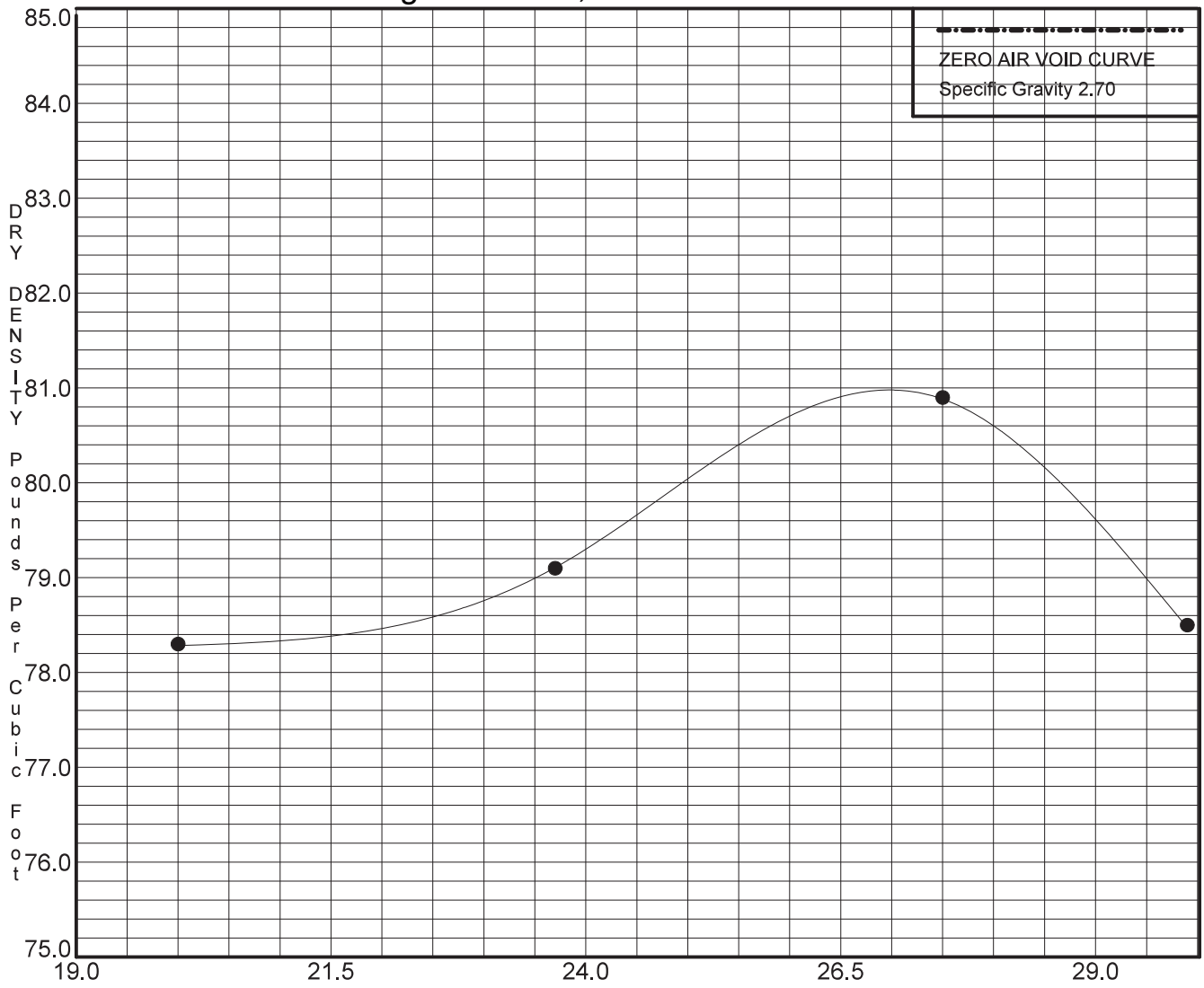

SPECIMEN IDENTIFICATION	CLASSIFICATION
Gypsum	Gypsum

MOISTURE/DENSITY RELATIONSHIP	
Standard ASTM D698/AASHTO T99	
Modified ASTM D1557/AASHTO T180	
Maximum Dry Density (PCF)	**81.0**
Optimum Water Content (%)	**27.0**

NOTES :

PROJECT **Duck Creek Bottom Ash Basins** JOB NO. **21-026**

LOCATION **Fulton County, Illinois** DATE **March 18, 2021**

Gypsum

MOISTURE-DENSITY RELATIONSHIP

Ramsey Geotechnical Engineering

Bloomington, IL 61701

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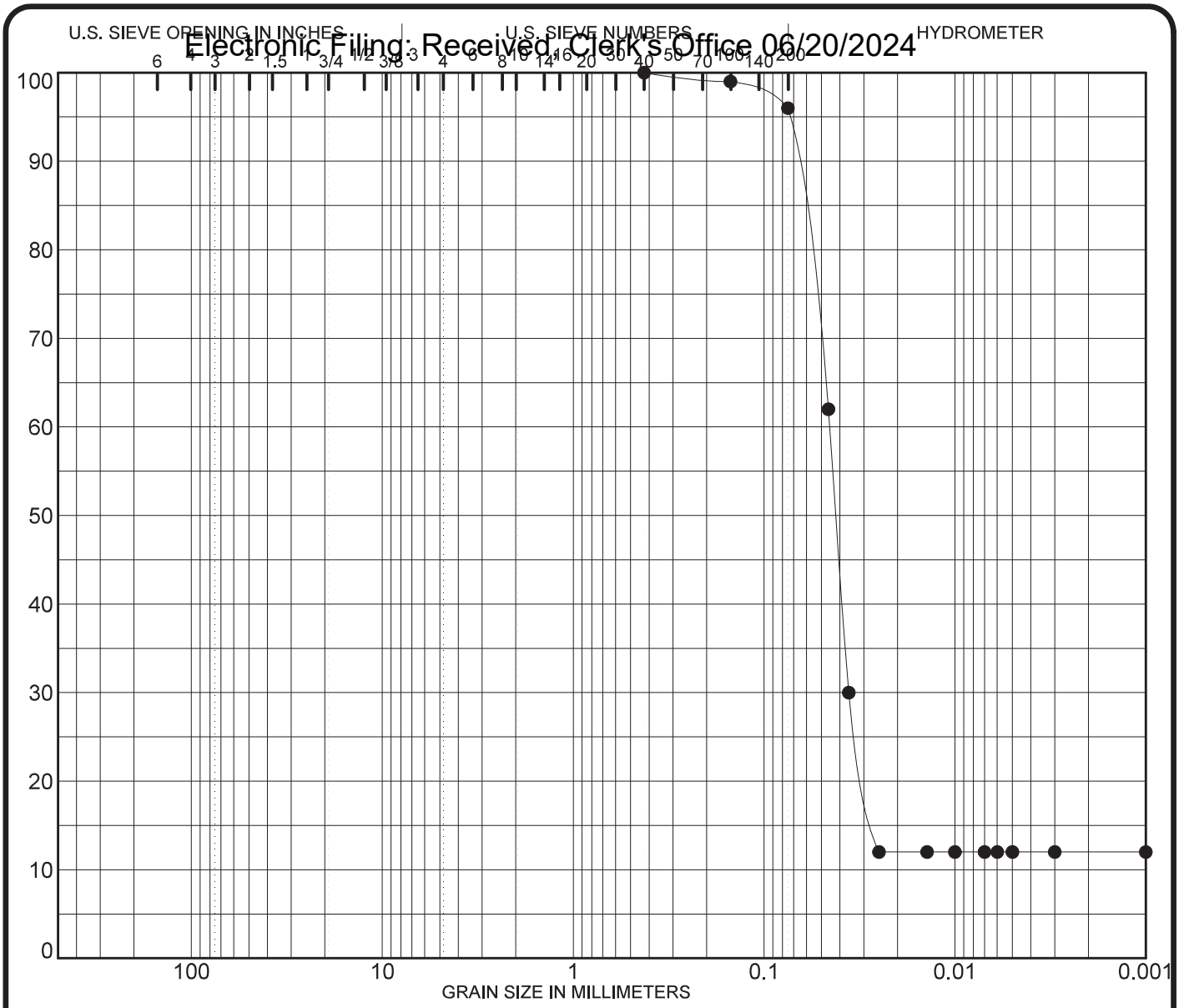

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

SPECIMEN IDENTIFICATION	SIEVE	% PASS	CLASSIFICATION
Gypsum	3/8	100.0	Gypsum
	#4	100.0	
	#8	100.0	
	#10	100.0	
NOTES:	# 16	100.0	
Specific Gravity - 2.31	# 30	100.0	
	# 40	100.0	
	# 50		
	# 80		
	# 100	99.0	
	# 200	96.0	

%GRAVEL	%SAND	%SILT	%CLAY
0	4		

MC%	γdry (pcf)	LL	PL	PI
32.5				

Density/Moisture Relationship: Standard

Max PCF	81.0	Opt. WC%	27.0

PROJECT **Duck Creek Bottom Ash Basins - Fulton County, Illinois**

JOB NO. **21-026**

DATE March 18, 2021

Gypsum

SOIL DATA SHEET

Ramsey Geotechnical Engineering

Bloomington, IL 61701

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX D
GROUNDWATER CONTOUR MAPS AND ELEVATIONS

Electronic Filing: Received, Clerk's Office 06/20/2024

GROUNDWATER CONTOUR MAPS

R002588

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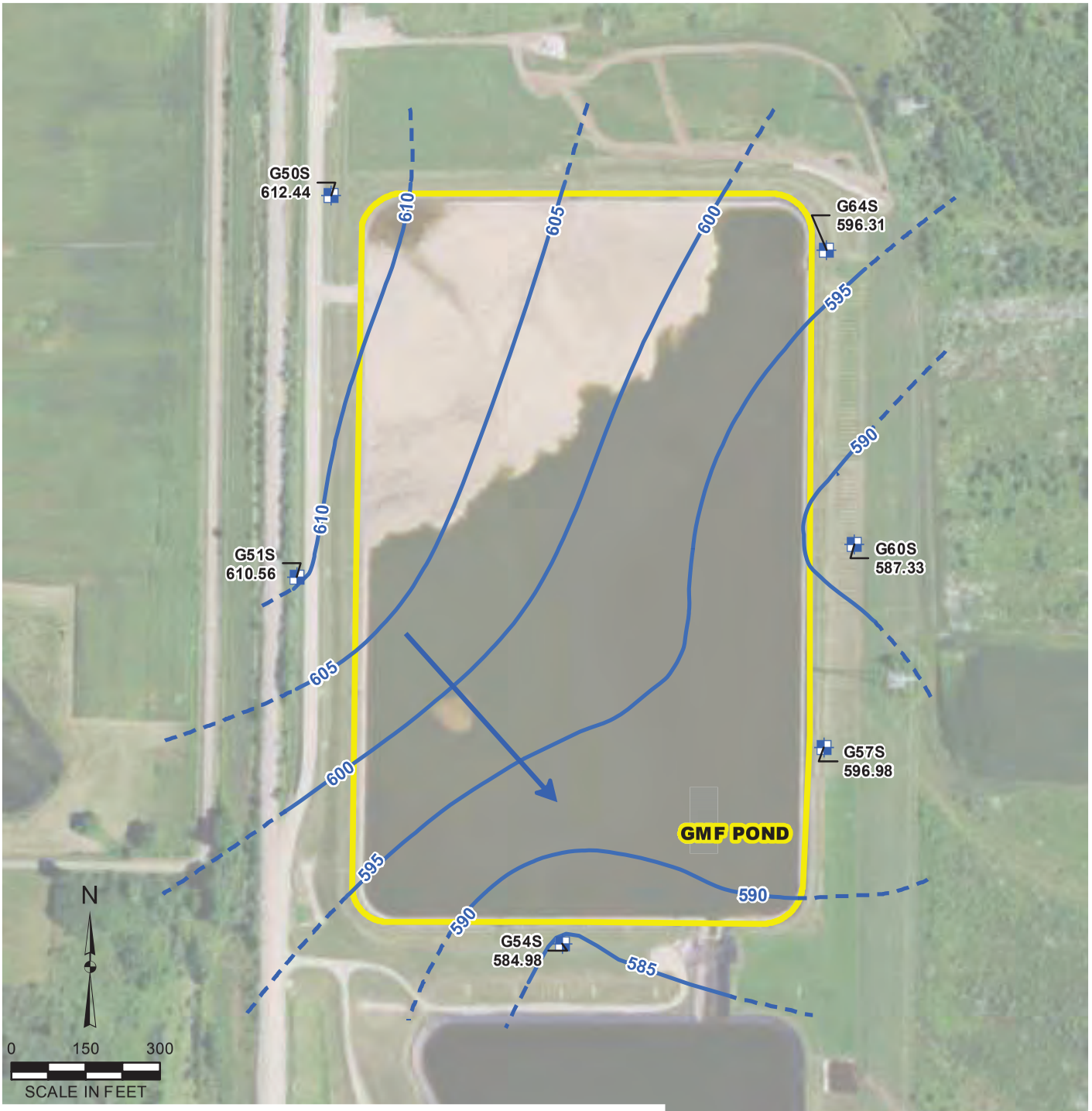


Y:\Mapping\Projects\2212285\MXD\GW_Contours\Round_01\R1_DuckCr

DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/7/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 1: DECEMBER 2, 2015

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

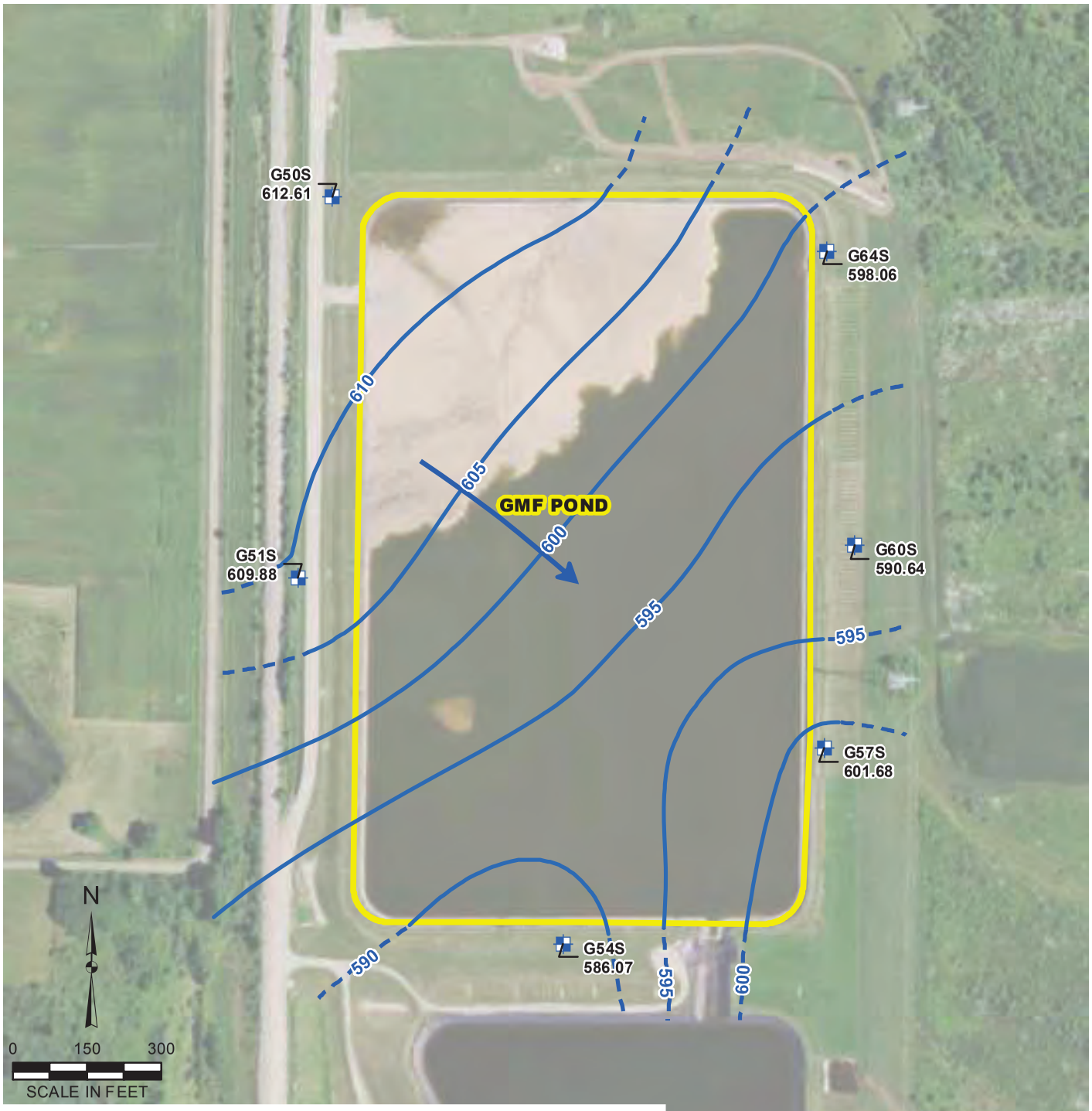
PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

R002589

Electronic Filing: Received, Clerk's Office 06/20/2024



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SDS 1/23/17
REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 2: JANUARY 25, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2212285\MXD\GW_Contours\Round_02\R2_Duck Cr

R002590

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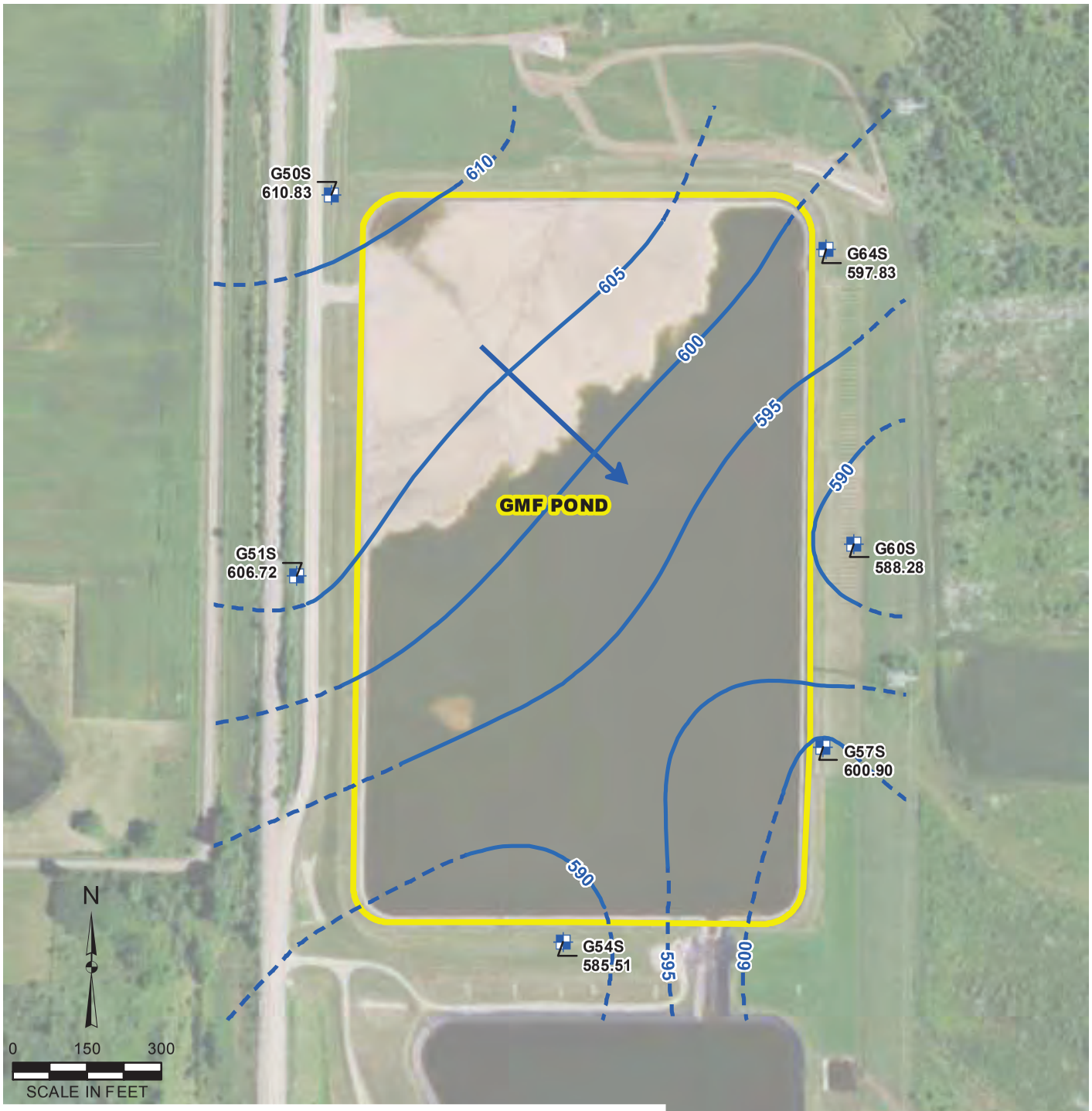

DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 3: APRIL 18, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

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R002591

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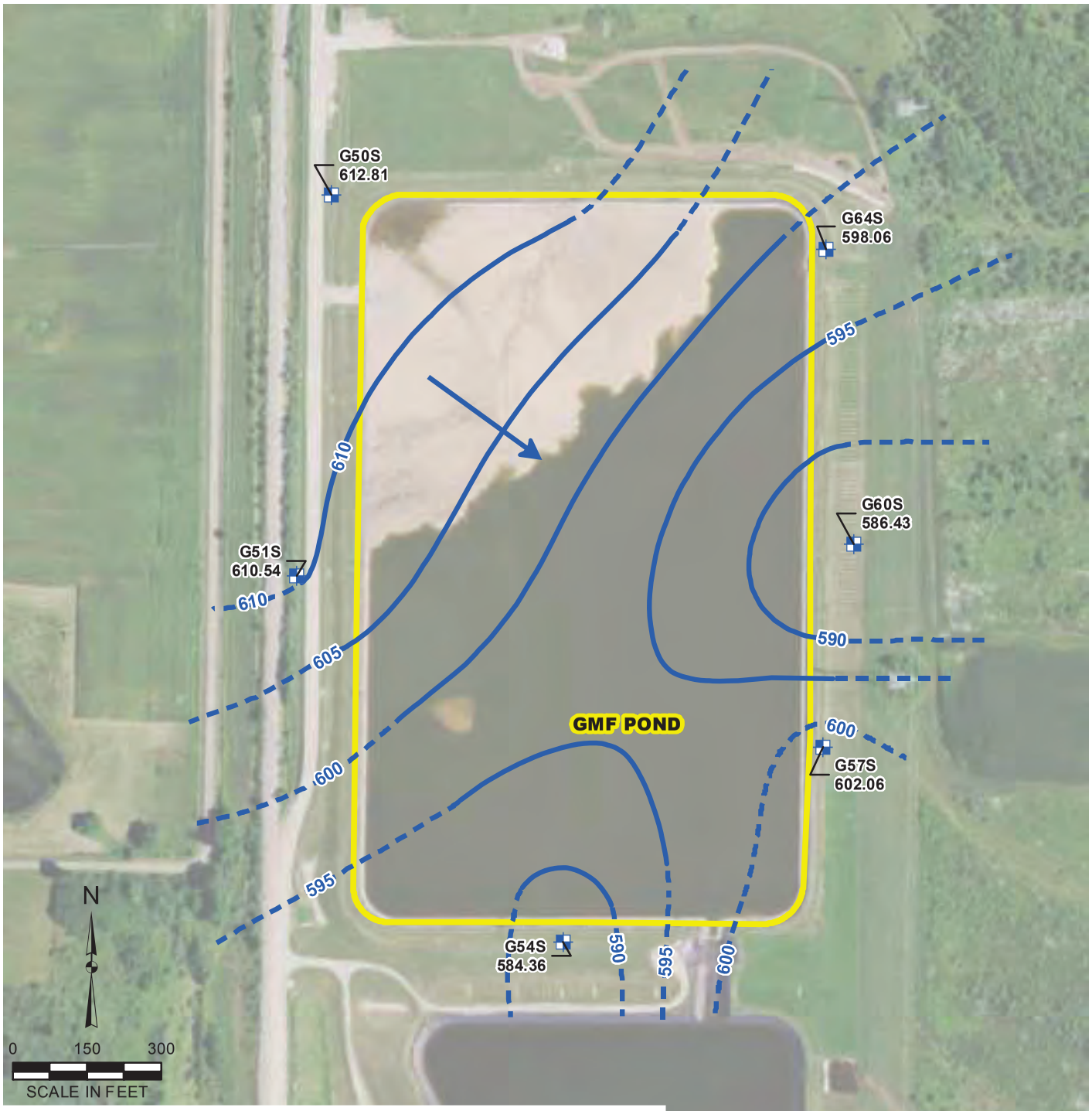

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SDS 1/23/17
REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 4: AUGUST 9, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

R002592

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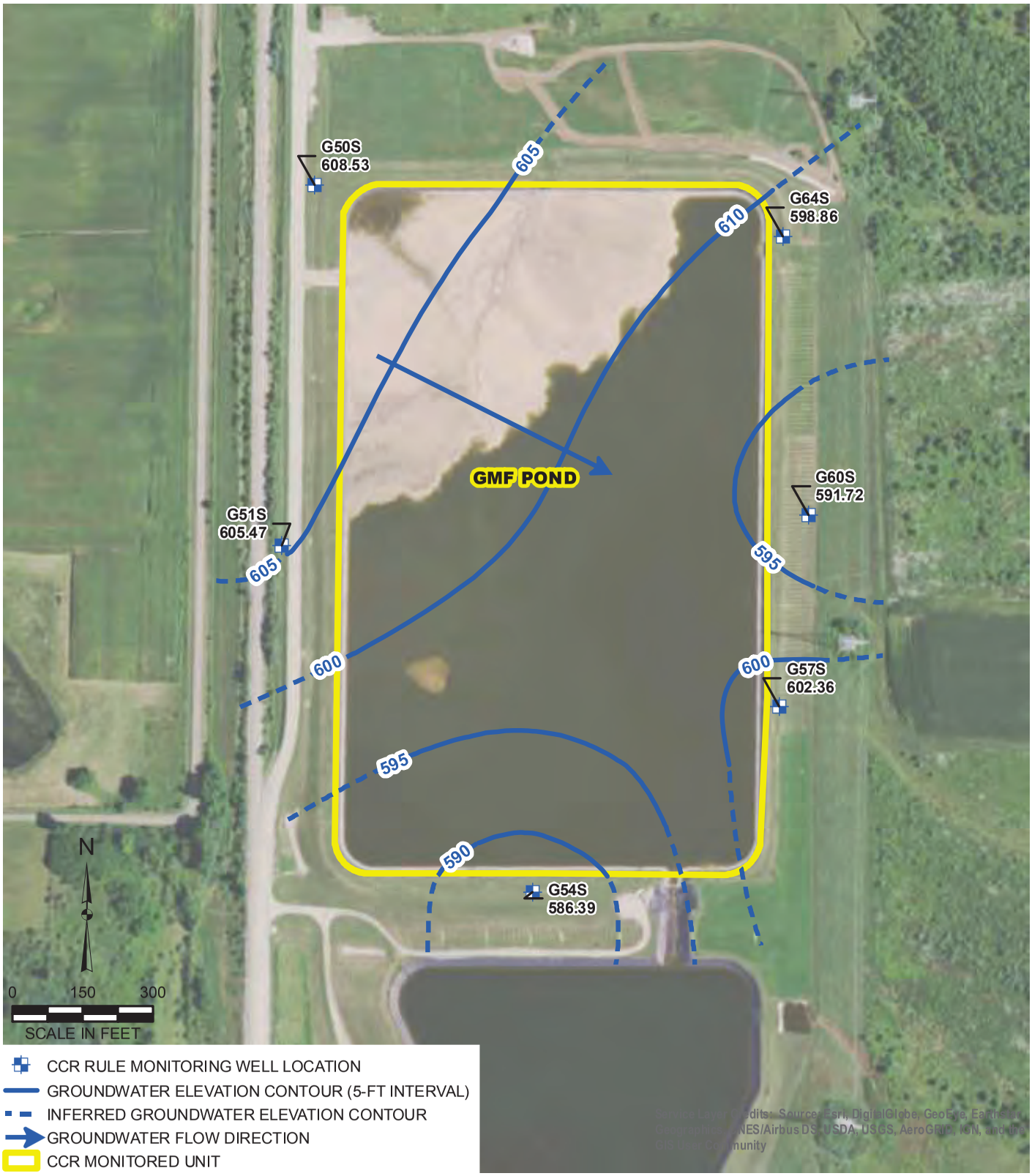

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SDS 3/6/17
REVIEWED BY/DATE:
ANS 3/6/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 5: OCTOBER 14, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\2212285\MXD\GW_Contours\Round_05\R5_DuckCr

R002593

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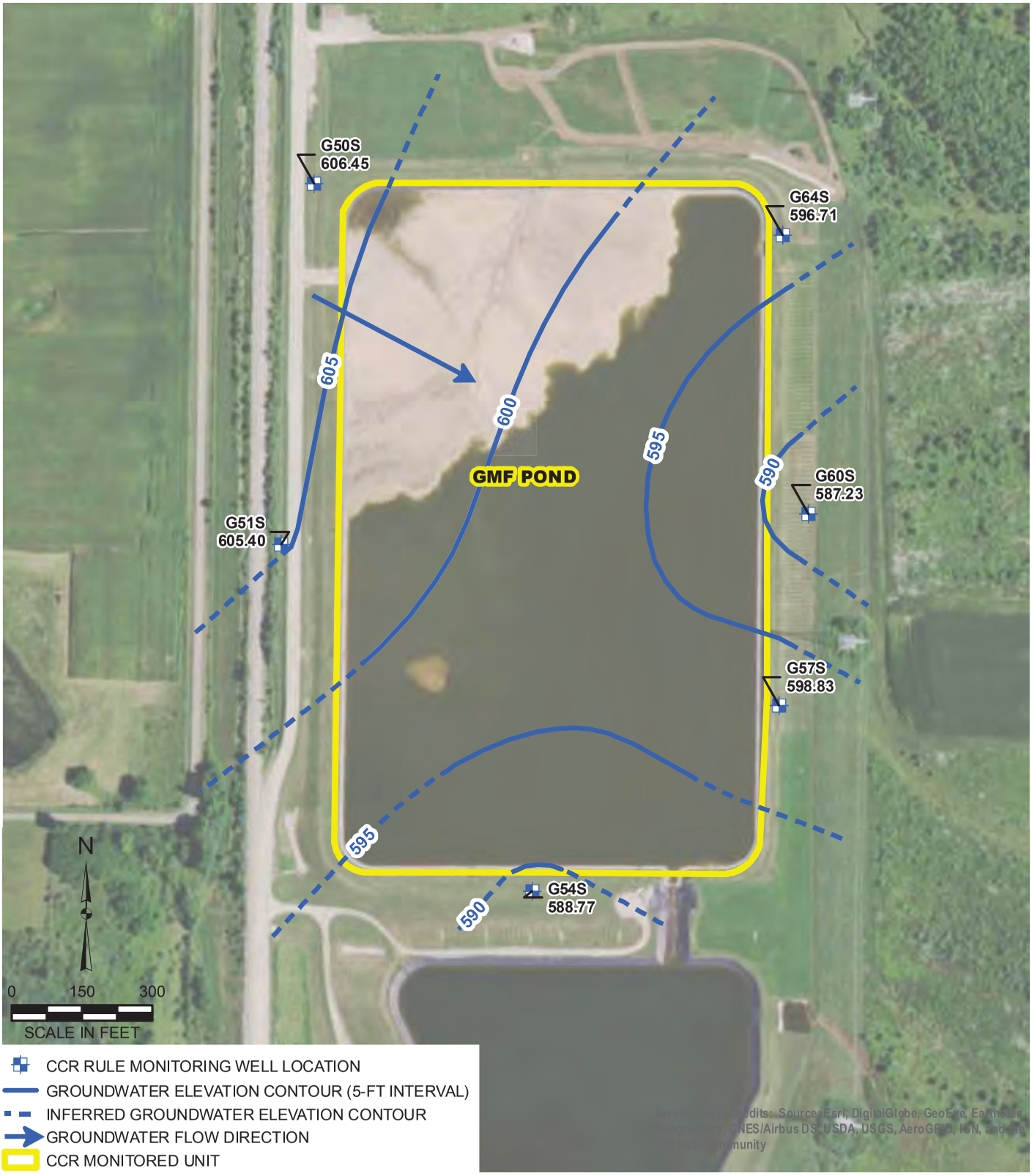

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SDS 3/6/17
REVIEWED BY/DATE:
ANS 3/6/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 6: JANUARY 9, 2017

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

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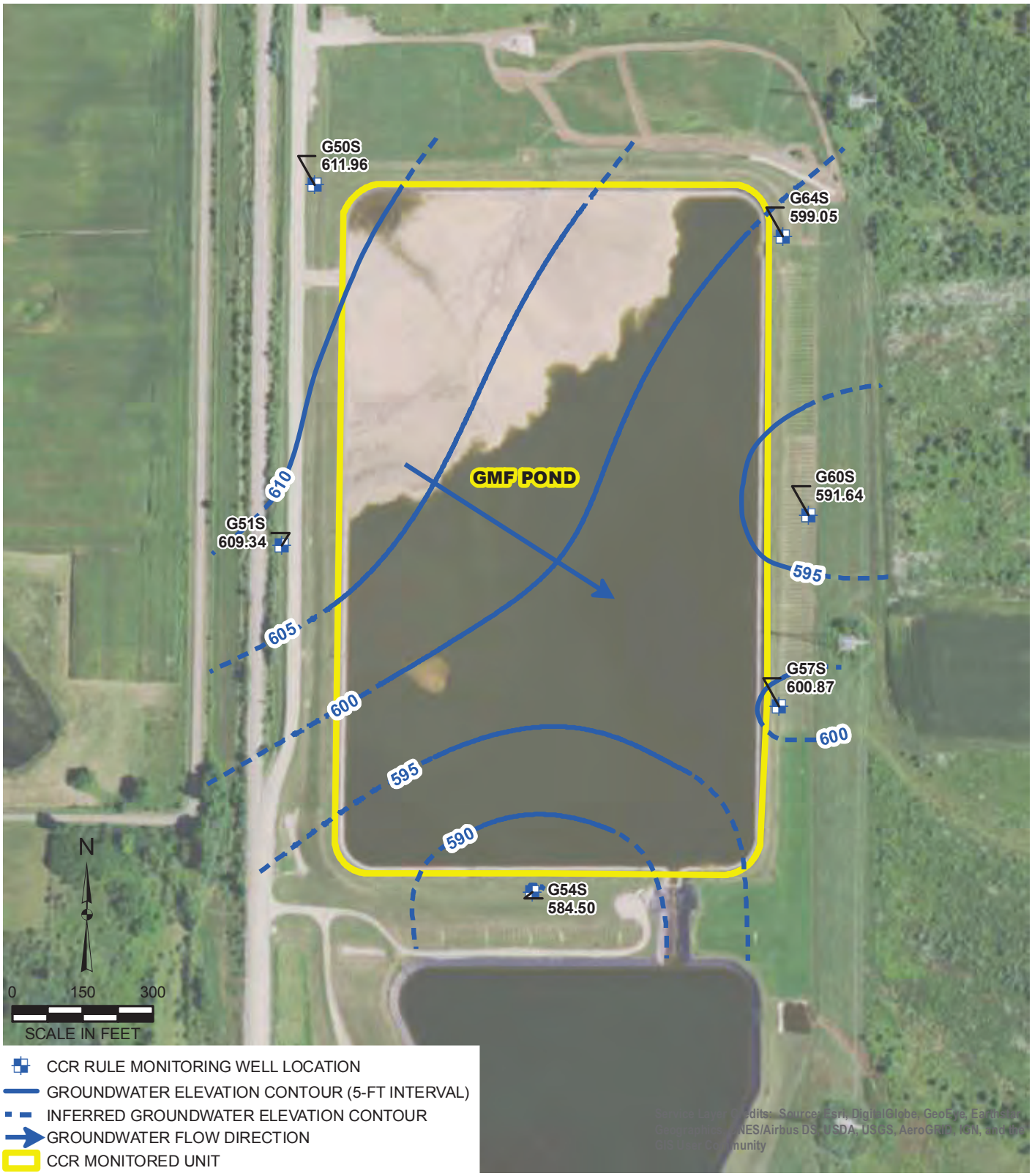

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DRAWN BY/DATE:
SDS 5/25/17
REVIEWED BY/DATE:
ANS 5/25/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 7: APRIL 2, 2017

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

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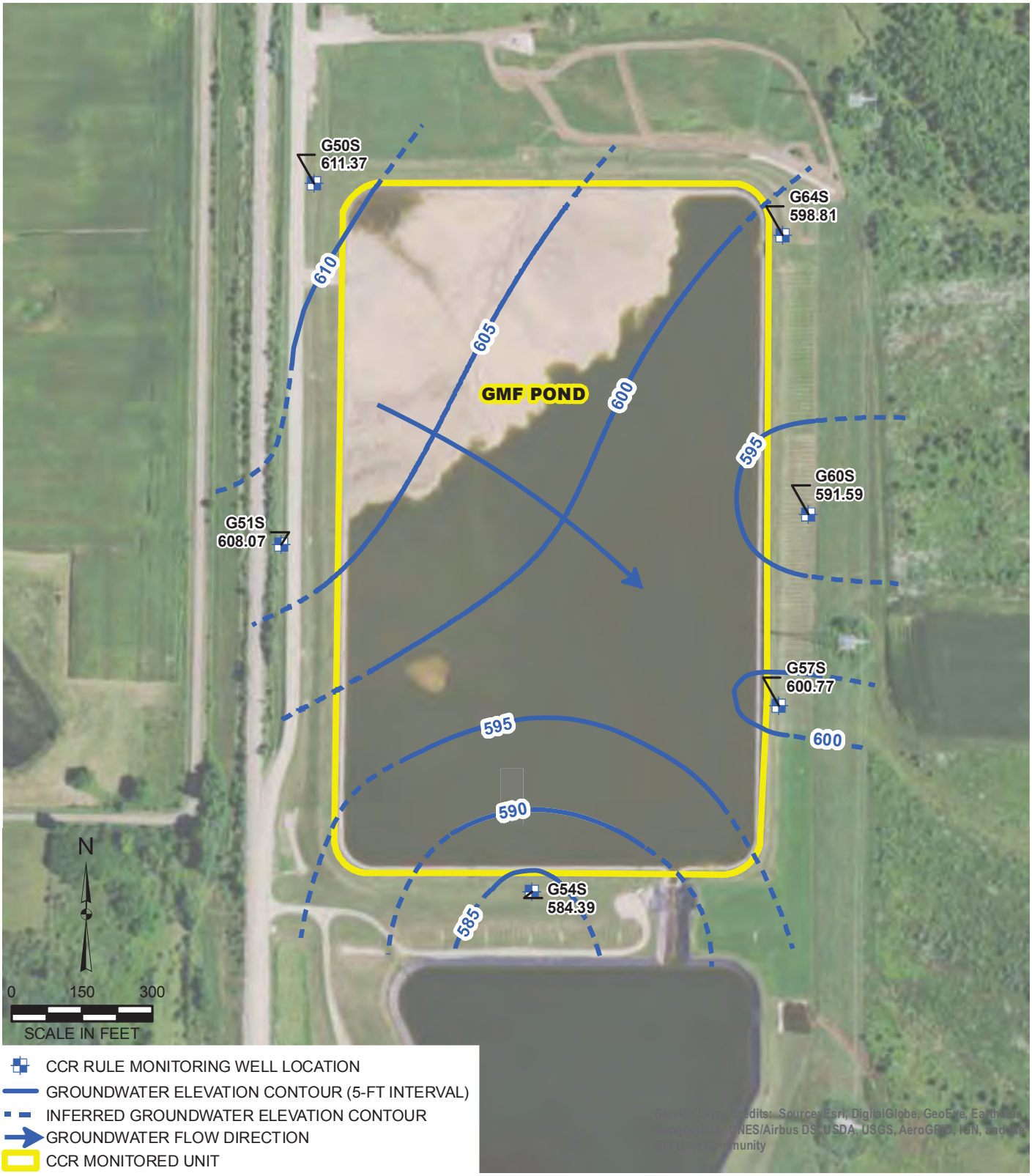

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DRAWN BY/DATE:
SDS 7/26/17
REVIEWED BY/DATE:
ANS 7/28/17
APPROVED BY/DATE:
JJW 9/1/17

DUCK CREEK GMF POND (UNIT ID: 203)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 8: JUNE 28, 2017

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY

R002596

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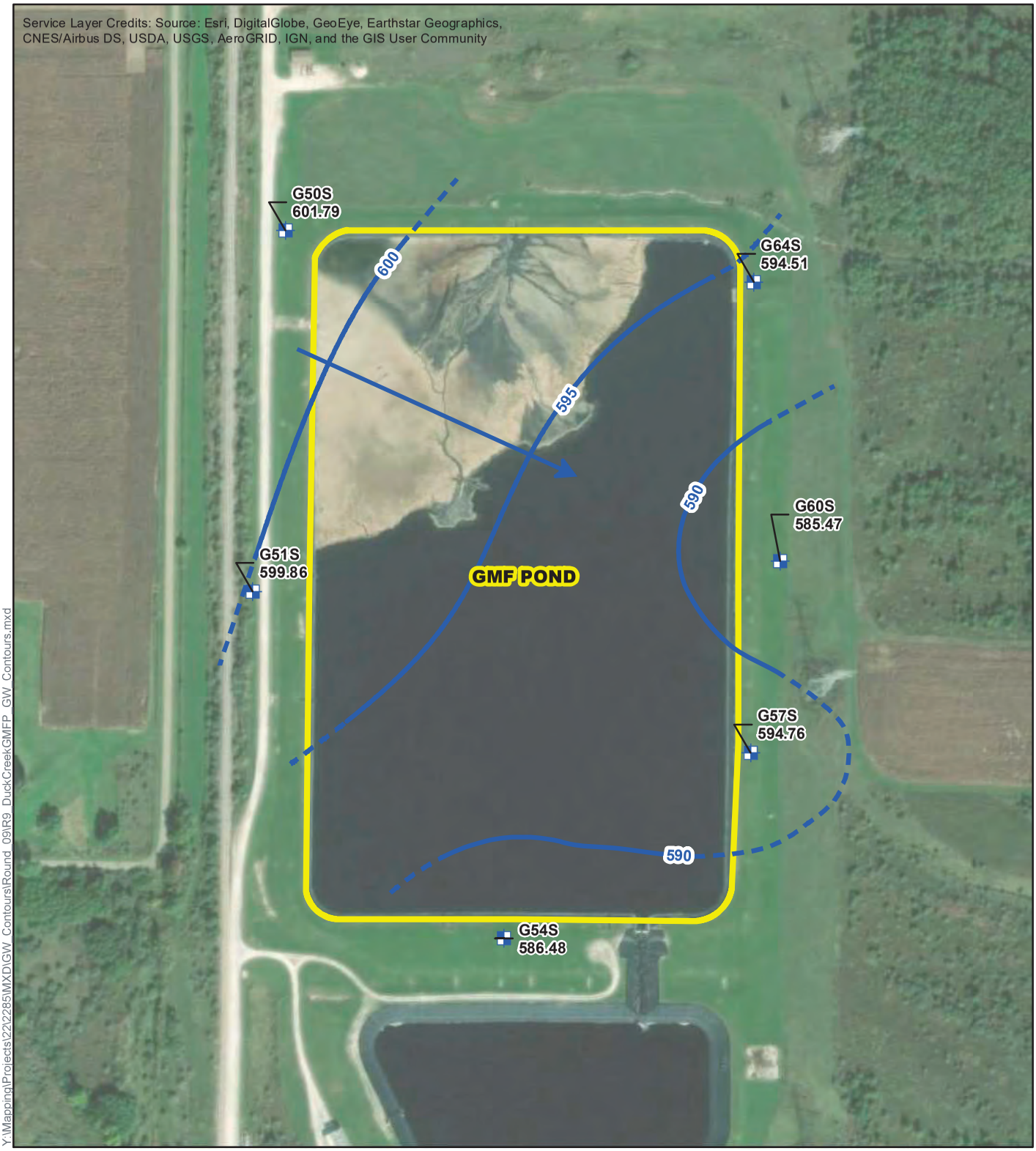

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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
NOVEMBER 8, 2017

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

R002597

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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
APRIL 10, 2018

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

R002598

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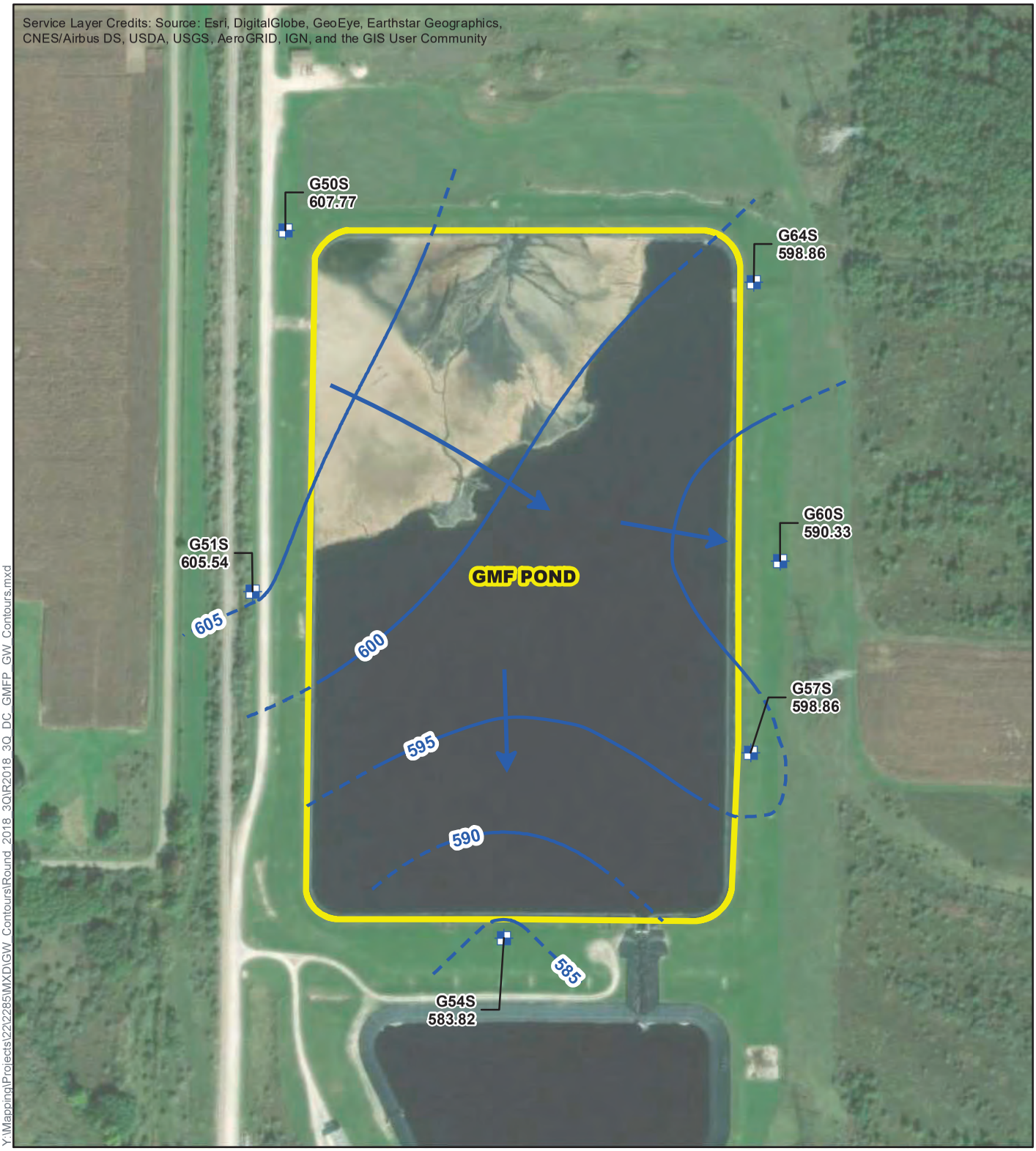

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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
JULY 2, 2018

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

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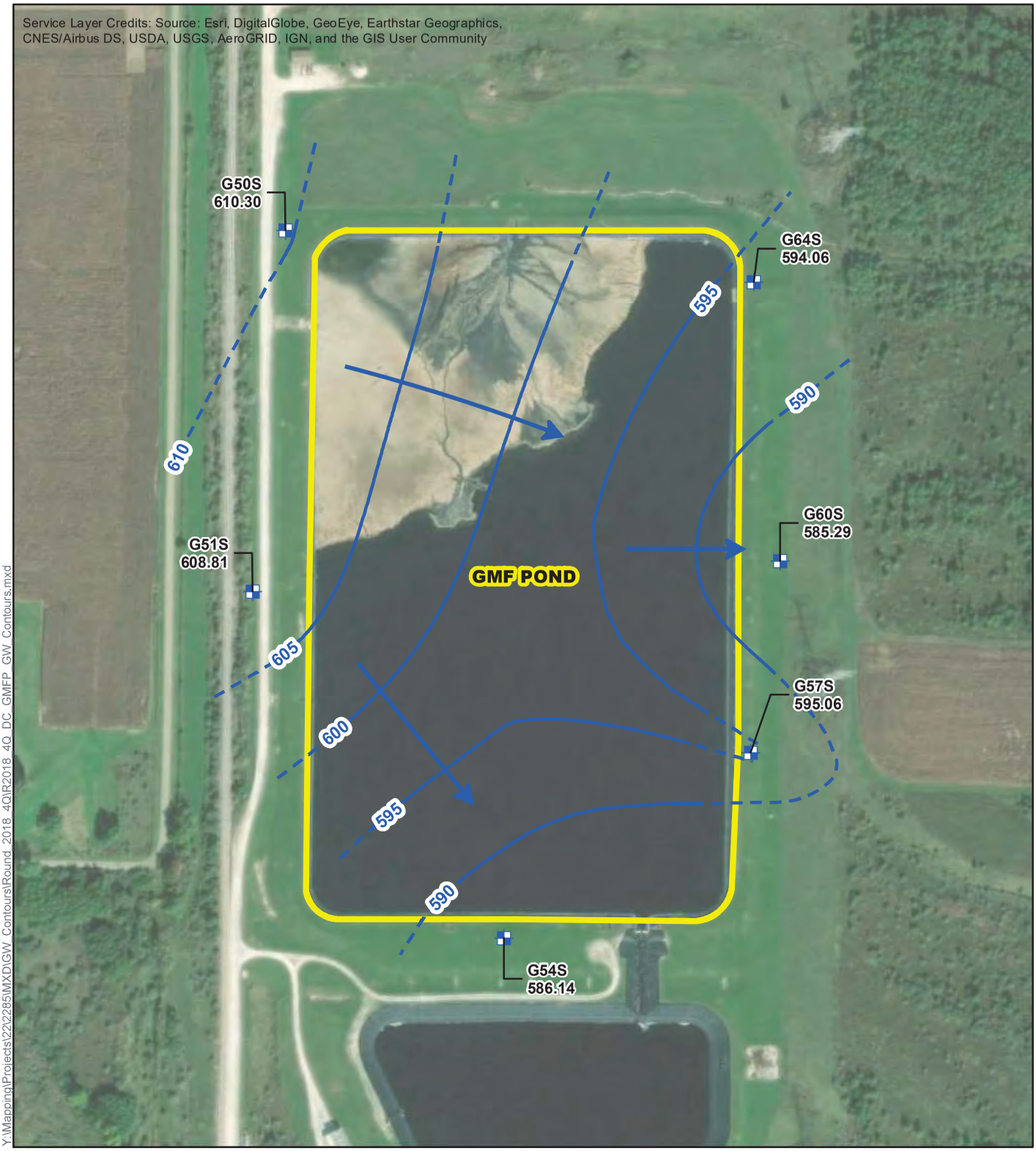

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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
OCTOBER 2, 2018

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

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R002600

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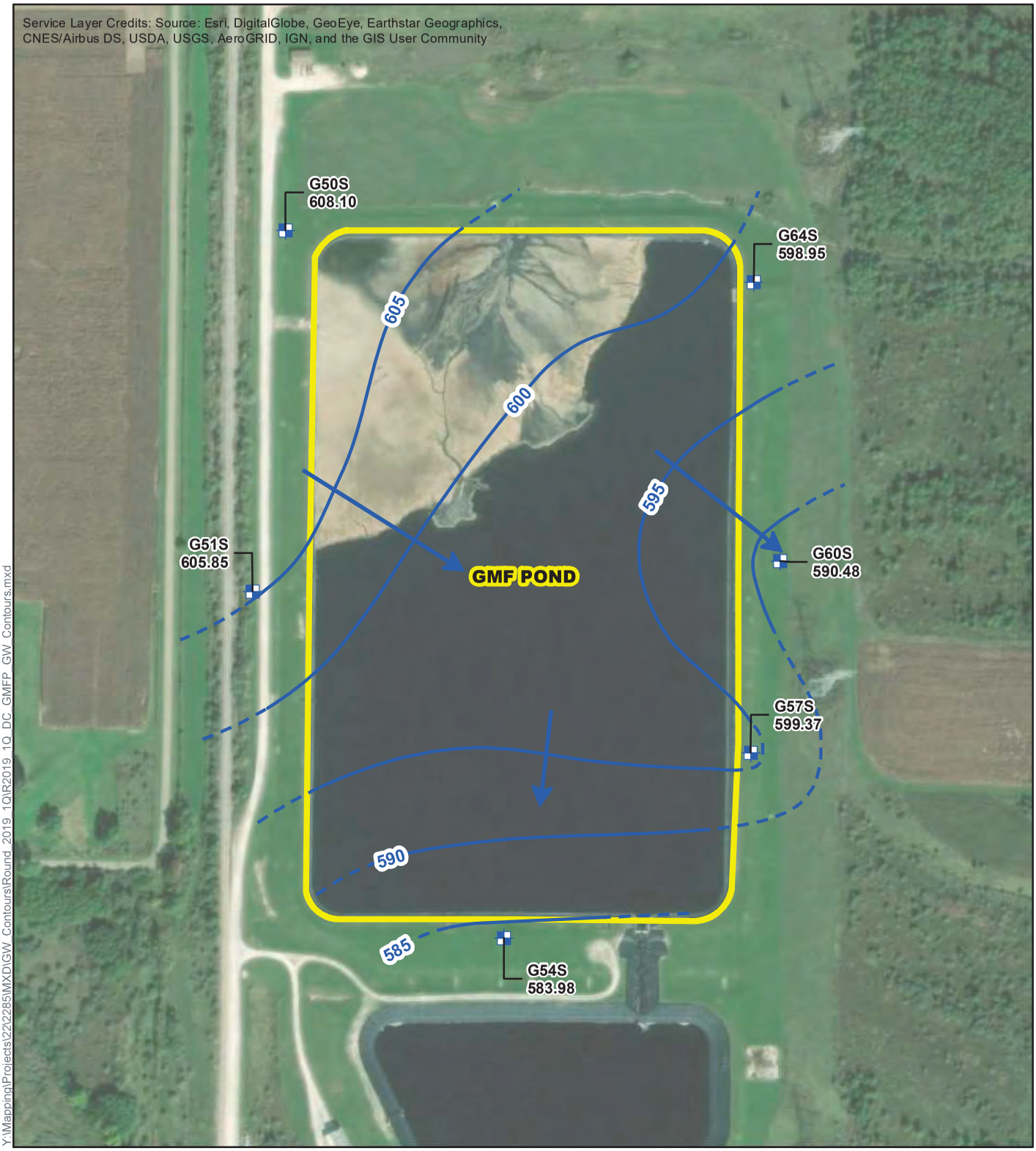

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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
JANUARY 7, 2019

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

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R002601

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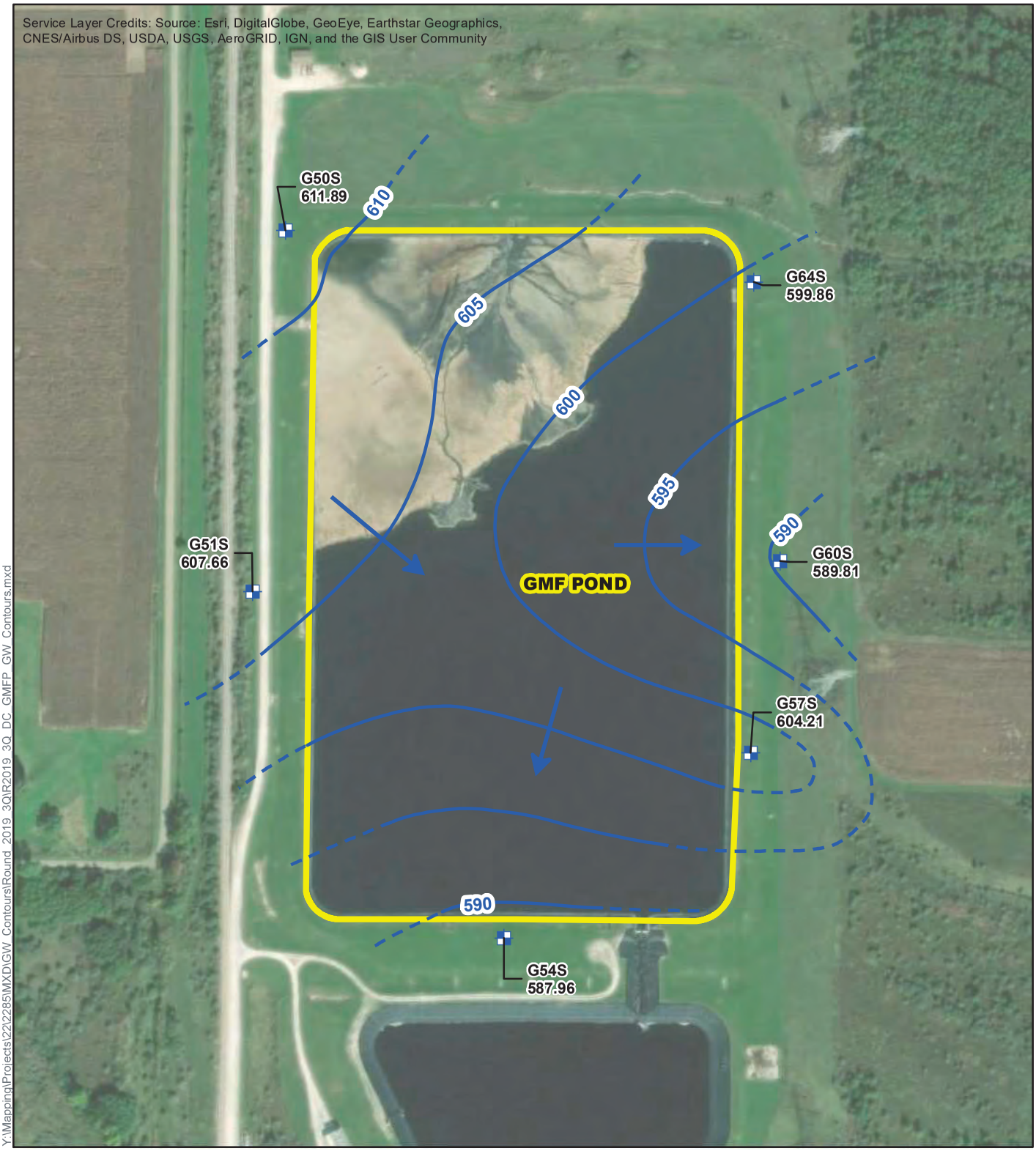

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CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK GMF POND (UNIT ID: 203)
GROUNDWATER ELEVATION CONTOUR MAP
JULY 1, 2019

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

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PROJECT: 169000XXXX | DATED: 8/28/2020 | DESIGNER: STOLZSD
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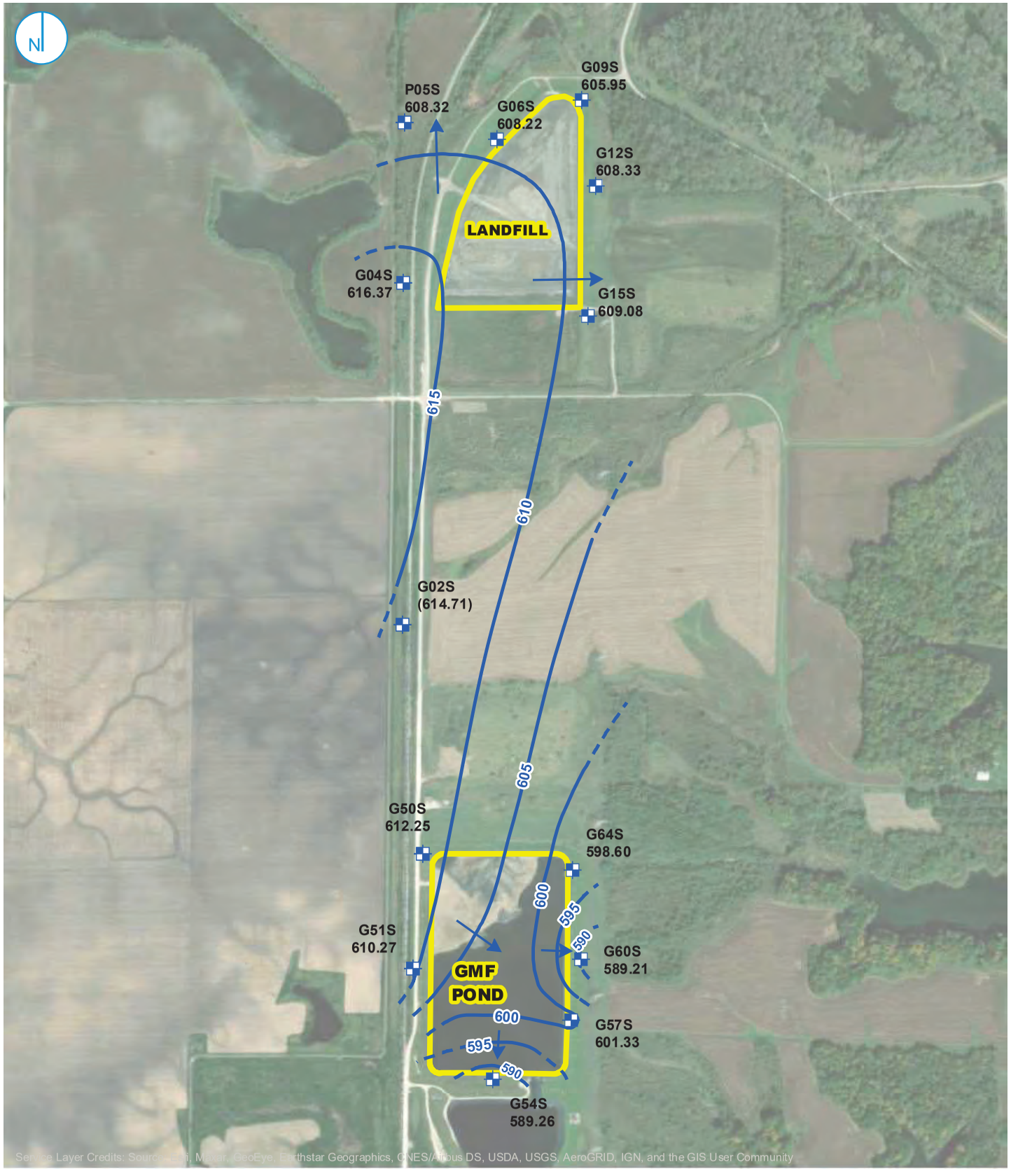

CCR RULE MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
CCR MONITORED UNIT

0 450 900 Feet

GROUNDWATER ELEVATION CONTOUR MAP
JANUARY 2-3, 2020

DUCK CREEK GMF POND (UNIT ID: 203)
AND LANDFILL (UNIT ID: 204)
VISTRA ENERGY
DUCK CREEK POWER STATION
CANTON, ILLINOIS

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

RAMBOLL

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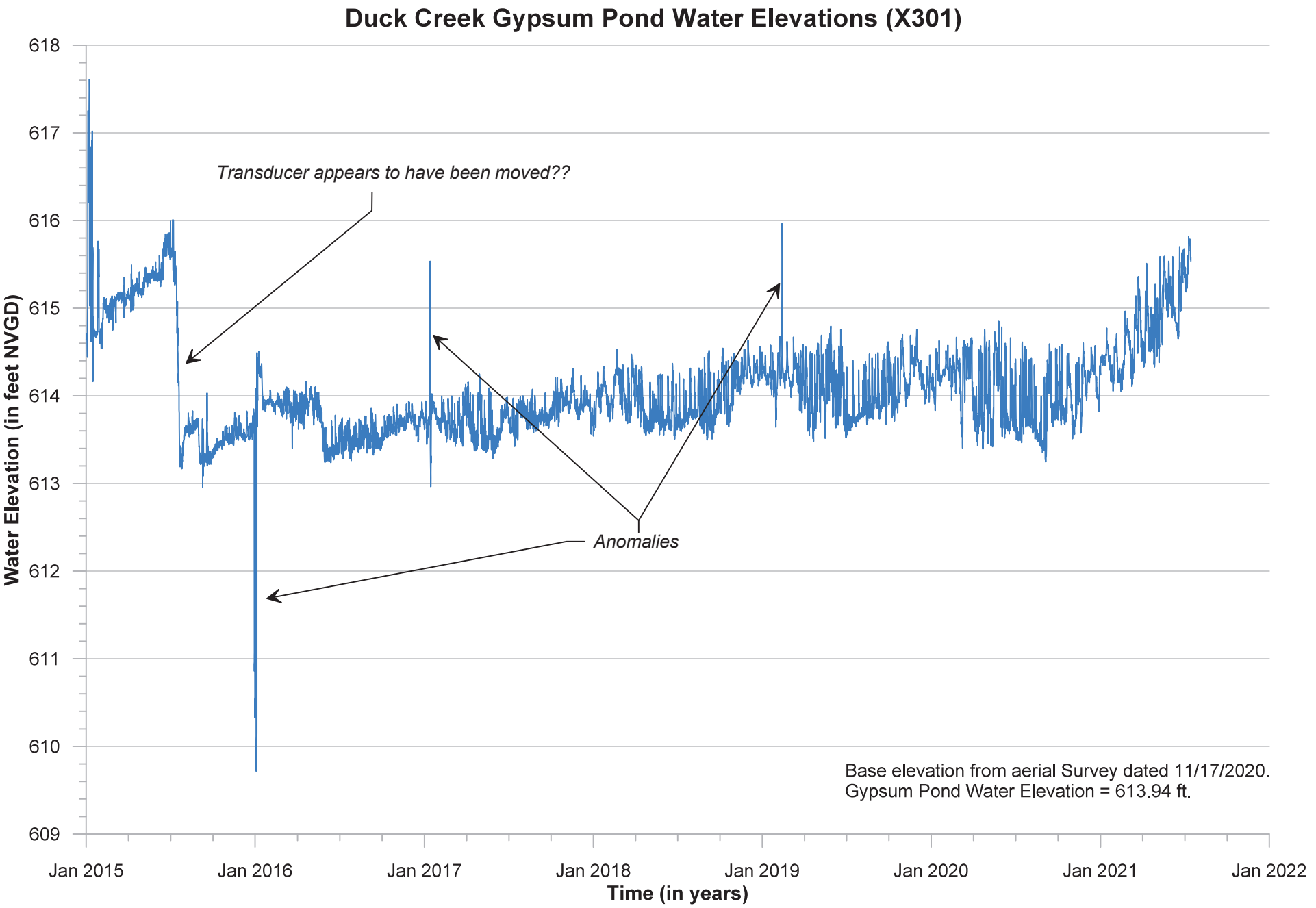

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TABLE D-1. GROUNDWATER ELEVATION RESULTS

R002605

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G02L	02/18/2021	613.08
G02L	05/10/2021	616.01
G02L	08/05/2021	613.14
G02S	12/02/2015	615.45
G02S	01/25/2016	615.35
G02S	04/18/2016	611.81
G02S	08/09/2016	612.03
G02S	10/14/2016	611.55
G02S	01/09/2017	612.30
G02S	04/02/2017	614.75
G02S	06/28/2017	614.07
G02S	11/10/2017	606.10
G02S	01/17/2018	610.75
G02S	04/10/2018	614.73
G02S	07/02/2018	612.82
G02S	10/02/2018	609.88
G02S	01/07/2019	613.19
G02S	07/01/2019	611.06
G02S	01/03/2020	614.71
G02S	08/06/2020	610.89
G02S	11/16/2020	607.52
G02S	02/18/2021	612.97
G02S	02/19/2021	613.24
G02S	04/14/2021	614.98
G02S	04/28/2021	613.94
G02S	04/29/2021	614.65
G02S	05/10/2021	615.30
G02S	05/12/2021	614.97
G02S	06/01/2021	613.85
G02S	06/10/2021	613.50
G02S	06/15/2021	613.10
G02S	06/21/2021	613.84
G02S	07/12/2021	614.73
G02S	07/26/2021	613.93
G02S	07/28/2021	613.80
G02S	08/05/2021	613.30
G50L	11/18/2020	606.44
G50L	02/18/2021	611.14
G50L	02/19/2021	611.31
G50L	04/14/2021	614.31
G50L	04/28/2021	612.60
G50L	04/29/2021	612.43
G50L	05/10/2021	613.80
G50L	05/13/2021	613.27
G50L	06/01/2021	612.96

R002606

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G50L	06/10/2021	612.33
G50L	06/21/2021	612.48
G50L	07/12/2021	614.79
G50L	07/13/2021	616.06
G50L	07/26/2021	613.07
G50L	07/28/2021	612.78
G50L	08/05/2021	612.25
G50S	12/02/2015	612.44
G50S	01/25/2016	612.61
G50S	04/18/2016	610.83
G50S	08/09/2016	612.81
G50S	10/14/2016	608.53
G50S	01/09/2017	606.45
G50S	04/02/2017	611.96
G50S	06/28/2017	611.37
G50S	11/08/2017	601.79
G50S	04/10/2018	607.45
G50S	07/02/2018	607.77
G50S	10/02/2018	610.30
G50S	01/07/2019	608.10
G50S	07/01/2019	611.89
G50S	01/02/2020	612.25
G50S	08/06/2020	608.32
G50S	11/16/2020	605.58
G50S	11/18/2020	605.85
G50S	02/18/2021	610.30
G50S	02/19/2021	610.30
G50S	04/14/2021	612.98
G50S	04/28/2021	611.54
G50S	04/29/2021	614.22
G50S	05/10/2021	612.71
G50S	05/13/2021	612.15
G50S	06/01/2021	611.87
G50S	06/10/2021	611.15
G50S	06/21/2021	611.57
G50S	07/12/2021	613.25
G50S	07/13/2021	614.03
G50S	07/26/2021	612.06
G50S	07/28/2021	611.81
G50S	08/05/2021	611.21
G51L	11/18/2020	602.35
G51L	02/18/2021	606.81
G51L	02/19/2021	606.96
G51L	04/14/2021	610.50
G51L	04/28/2021	609.12

R002607

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G51L	05/10/2021	610.72
G51L	06/01/2021	609.14
G51L	06/10/2021	606.57
G51L	06/21/2021	608.97
G51L	07/12/2021	610.66
G51L	07/26/2021	608.51
G51L	08/05/2021	605.95
G51S	12/02/2015	610.56
G51S	01/25/2016	609.88
G51S	04/18/2016	606.72
G51S	08/09/2016	610.54
G51S	10/14/2016	605.47
G51S	01/09/2017	605.40
G51S	04/02/2017	609.34
G51S	06/28/2017	608.07
G51S	11/08/2017	599.86
G51S	04/10/2018	611.01
G51S	07/02/2018	605.54
G51S	10/02/2018	608.81
G51S	01/07/2019	605.85
G51S	07/01/2019	607.66
G51S	01/02/2020	610.27
G51S	08/06/2020	603.64
G51S	11/16/2020	602.10
G51S	11/18/2020	602.40
G51S	02/18/2021	607.04
G51S	02/19/2021	607.04
G51S	04/14/2021	610.69
G51S	04/28/2021	609.35
G51S	04/29/2021	610.56
G51S	05/10/2021	610.93
G51S	05/13/2021	610.39
G51S	06/01/2021	609.44
G51S	06/10/2021	606.98
G51S	06/15/2021	605.80
G51S	06/21/2021	609.37
G51S	07/12/2021	610.91
G51S	07/26/2021	608.84
G51S	07/27/2021	608.29
G51S	08/05/2021	606.34
G52L	11/18/2020	591.84
G52L	02/18/2021	593.43
G52L	02/19/2021	593.53
G52L	04/14/2021	596.93
G52L	04/28/2021	596.16

R002608

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G52L	05/10/2021	596.82
G52L	06/01/2021	597.15
G52L	06/10/2021	596.04
G52L	06/21/2021	595.09
G52L	07/12/2021	597.20
G52L	07/26/2021	596.89
G52L	08/05/2021	595.67
G52S	02/18/2021	589.65
G52S	05/10/2021	596.45
G52S	08/05/2021	589.39
G53L	11/18/2020	605.53
G53L	02/18/2021	607.98
G53L	02/22/2021	608.43
G53L	05/10/2021	613.90
G53L	08/05/2021	612.79
G53S	11/18/2020	603.70
G53S	02/18/2021	606.48
G53S	02/22/2021	606.81
G53S	05/10/2021	610.80
G53S	08/05/2021	610.14
G54C	04/14/2021	581.99
G54C	04/28/2021	581.10
G54C	04/29/2021	580.28
G54C	05/10/2021	580.11
G54C	05/12/2021	580.11
G54C	06/01/2021	581.00
G54C	06/10/2021	580.47
G54C	06/21/2021	579.83
G54C	07/12/2021	582.36
G54C	07/26/2021	581.64
G54C	08/05/2021	578.99
G54L	11/17/2020	592.43
G54L	02/18/2021	591.36
G54L	02/22/2021	591.69
G54L	04/14/2021	591.47
G54L	04/28/2021	591.11
G54L	04/29/2021	591.30
G54L	05/10/2021	591.22
G54L	05/12/2021	591.22
G54L	06/01/2021	591.52
G54L	06/10/2021	591.78
G54L	06/14/2021	591.77
G54L	06/21/2021	592.11
G54L	07/12/2021	592.97
G54L	07/13/2021	594.53

R002609

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G54L	07/26/2021	592.50
G54L	07/27/2021	592.51
G54L	08/05/2021	592.79
G54S	12/02/2015	584.98
G54S	01/25/2016	586.07
G54S	04/18/2016	585.51
G54S	08/09/2016	584.36
G54S	10/14/2016	586.39
G54S	01/09/2017	588.77
G54S	04/02/2017	584.50
G54S	06/28/2017	584.39
G54S	11/08/2017	586.48
G54S	01/18/2018	585.43
G54S	04/10/2018	586.40
G54S	07/02/2018	583.82
G54S	10/02/2018	586.14
G54S	01/07/2019	583.98
G54S	07/01/2019	587.96
G54S	01/02/2020	589.26
G54S	08/06/2020	591.39
G54S	11/16/2020	591.47
G54S	11/17/2020	591.31
G54S	02/18/2021	590.52
G54S	02/22/2021	590.52
G54S	04/14/2021	590.44
G54S	04/28/2021	590.52
G54S	05/10/2021	590.53
G54S	06/01/2021	590.80
G54S	06/10/2021	591.07
G54S	06/21/2021	591.23
G54S	07/12/2021	591.76
G54S	07/26/2021	591.98
G54S	08/05/2021	592.55
G55L	11/17/2020	597.65
G55L	02/18/2021	595.73
G55L	02/22/2021	596.28
G55L	05/10/2021	597.38
G55L	08/05/2021	599.54
G55S	11/17/2020	597.42
G55S	02/18/2021	595.68
G55S	02/22/2021	596.14
G55S	05/10/2021	597.41
G55S	08/05/2021	599.57
G56L	11/17/2020	598.87
G56L	02/18/2021	597.50

R002610

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G56L	02/22/2021	598.01
G56L	04/14/2021	602.88
G56L	04/28/2021	603.24
G56L	05/10/2021	603.44
G56L	06/01/2021	602.48
G56L	06/10/2021	604.14
G56L	06/21/2021	603.64
G56L	07/12/2021	605.23
G56L	07/26/2021	605.31
G56L	08/05/2021	604.62
G56S	11/17/2020	598.37
G56S	02/18/2021	598.06
G56S	02/22/2021	598.38
G56S	05/10/2021	603.62
G56S	08/05/2021	604.42
G57L	11/17/2020	596.17
G57L	02/18/2021	595.73
G57L	02/22/2021	595.88
G57L	04/14/2021	603.07
G57L	04/28/2021	602.15
G57L	05/10/2021	604.41
G57L	06/01/2021	603.88
G57L	06/10/2021	603.17
G57L	06/21/2021	602.45
G57L	07/12/2021	604.81
G57L	07/26/2021	604.43
G57L	08/05/2021	603.00
G57S	12/02/2015	596.98
G57S	01/25/2016	601.68
G57S	04/18/2016	600.90
G57S	08/09/2016	602.06
G57S	10/14/2016	602.36
G57S	01/09/2017	598.83
G57S	04/02/2017	600.87
G57S	06/28/2017	600.77
G57S	11/08/2017	594.76
G57S	01/18/2018	602.07
G57S	04/10/2018	601.87
G57S	07/02/2018	598.86
G57S	10/02/2018	595.06
G57S	01/07/2019	599.37
G57S	07/01/2019	604.21
G57S	01/02/2020	601.33
G57S	08/06/2020	600.65
G57S	11/16/2020	596.28

R002611

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G57S	11/17/2020	596.21
G57S	02/18/2021	596.21
G57S	02/22/2021	596.21
G57S	04/14/2021	601.83
G57S	04/28/2021	601.99
G57S	05/10/2021	602.61
G57S	06/01/2021	603.89
G57S	06/10/2021	603.20
G57S	06/21/2021	602.52
G57S	07/12/2021	604.68
G57S	07/26/2021	604.41
G57S	08/05/2021	603.51
G58L	11/18/2020	591.87
G58L	02/18/2021	591.24
G58L	02/22/2021	591.55
G58L	05/10/2021	597.62
G58L	08/05/2021	598.92
G58S	11/18/2020	591.87
G58S	02/18/2021	591.54
G58S	02/22/2021	592.02
G58S	05/10/2021	597.67
G58S	08/05/2021	598.87
G59L	11/18/2020	590.59
G59L	02/18/2021	588.96
G59L	02/22/2021	589.09
G59L	05/10/2021	599.77
G59L	08/05/2021	601.28
G59S	11/18/2020	587.04
G59S	02/18/2021	586.43
G59S	02/22/2021	586.88
G59S	05/10/2021	588.40
G59S	08/05/2021	598.43
G60L	11/17/2020	593.09
G60L	02/18/2021	593.56
G60L	02/23/2021	594.34
G60L	04/14/2021	606.78
G60L	04/28/2021	603.75
G60L	04/29/2021	604.10
G60L	05/10/2021	606.16
G60L	05/13/2021	605.30
G60L	06/01/2021	605.20
G60L	06/10/2021	603.76
G60L	06/15/2021	602.71
G60L	06/21/2021	603.43
G60L	07/12/2021	609.27

R002612

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TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G60L	07/26/2021	605.97
G60L	07/28/2021	605.54
G60L	08/05/2021	604.40
G60S	12/02/2015	587.33
G60S	01/25/2016	590.64
G60S	04/18/2016	588.28
G60S	08/09/2016	586.43
G60S	10/14/2016	591.72
G60S	01/09/2017	587.23
G60S	04/02/2017	591.64
G60S	06/29/2017	591.59
G60S	11/08/2017	585.47
G60S	01/19/2018	599.93
G60S	04/10/2018	591.83
G60S	07/02/2018	590.33
G60S	10/02/2018	585.29
G60S	01/07/2019	590.48
G60S	07/01/2019	589.81
G60S	01/02/2020	589.21
G60S	08/06/2020	588.88
G60S	11/16/2020	587.66
G60S	11/17/2020	587.47
G60S	02/18/2021	587.35
G60S	02/23/2021	587.35
G60S	04/14/2021	590.16
G60S	04/28/2021	589.76
G60S	05/10/2021	590.34
G60S	06/01/2021	590.54
G60S	06/10/2021	590.02
G60S	06/21/2021	589.48
G60S	07/12/2021	591.02
G60S	07/26/2021	590.71
G60S	08/05/2021	590.05
G61S	11/18/2020	595.85
G61S	02/18/2021	594.19
G61S	02/23/2021	594.48
G61S	05/10/2021	601.73
G61S	08/05/2021	604.46
G62L	11/18/2020	597.59
G62L	02/18/2021	595.63
G62L	02/24/2021	595.51
G62L	05/10/2021	603.44
G62L	08/05/2021	603.85
G63L	11/18/2020	596.38
G63L	02/18/2021	595.23

R002613

Electronic Filing: Received, Clerk's Office 06/20/2024

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G63L	02/24/2021	595.10
G63L	05/10/2021	599.58
G63L	08/05/2021	600.87
G63S	11/18/2020	595.43
G63S	02/18/2021	595.11
G63S	02/24/2021	595.53
G63S	05/10/2021	599.17
G63S	08/05/2021	601.78
G64L	11/18/2020	596.89
G64L	02/18/2021	596.41
G64L	02/25/2021	596.23
G64L	04/14/2021	600.43
G64L	04/28/2021	600.87
G64L	05/10/2021	601.22
G64L	06/01/2021	602.41
G64L	06/10/2021	601.95
G64L	06/21/2021	601.21
G64L	07/12/2021	602.32
G64L	07/26/2021	602.40
G64L	08/05/2021	601.70
G64S	12/02/2015	596.31
G64S	01/25/2016	598.06
G64S	04/18/2016	597.83
G64S	08/09/2016	598.06
G64S	10/14/2016	598.86
G64S	01/09/2017	596.71
G64S	04/02/2017	599.05
G64S	06/29/2017	598.81
G64S	11/08/2017	594.51
G64S	01/19/2018	600.88
G64S	04/10/2018	599.30
G64S	07/02/2018	598.86
G64S	10/02/2018	594.06
G64S	01/07/2019	598.95
G64S	07/01/2019	599.86
G64S	01/02/2020	598.60
G64S	08/06/2020	598.72
G64S	11/16/2020	596.27
G64S	11/18/2020	596.42
G64S	02/18/2021	596.13
G64S	02/24/2021	596.13
G64S	04/14/2021	599.04
G64S	04/28/2021	599.38
G64S	05/10/2021	599.64
G64S	06/01/2021	600.28

R002614

Electronic Filing: Received, Clerk's Office 06/20/2024

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
G64S	06/10/2021	599.97
G64S	06/21/2021	599.51
G64S	07/12/2021	600.50
G64S	07/26/2021	600.60
G64S	08/05/2021	600.04
P60	02/24/2021	591.82
P60	03/24/2021	593.80
P60	05/10/2021	598.86
P60	08/05/2021	601.39
P61	05/10/2021	606.78
P61	08/05/2021	603.86
P62	05/10/2021	602.28
P62	08/05/2021	603.46
P63	05/10/2021	601.64
P63	08/05/2021	601.91
P64	05/10/2021	605.52
P64	08/05/2021	603.10
R61L	11/18/2020	596.19
R61L	02/18/2021	594.59
R61L	02/23/2021	594.27
R61L	05/10/2021	601.43
R61L	08/05/2021	614.47

Notes:
ft NAVD88 = feet relative to the North American Vertical Datum 1988, GEOID 12A

generated 10/06/2021, 3:08:25 PM CDT

Electronic Filing: Received, Clerk's Office 06/20/2024

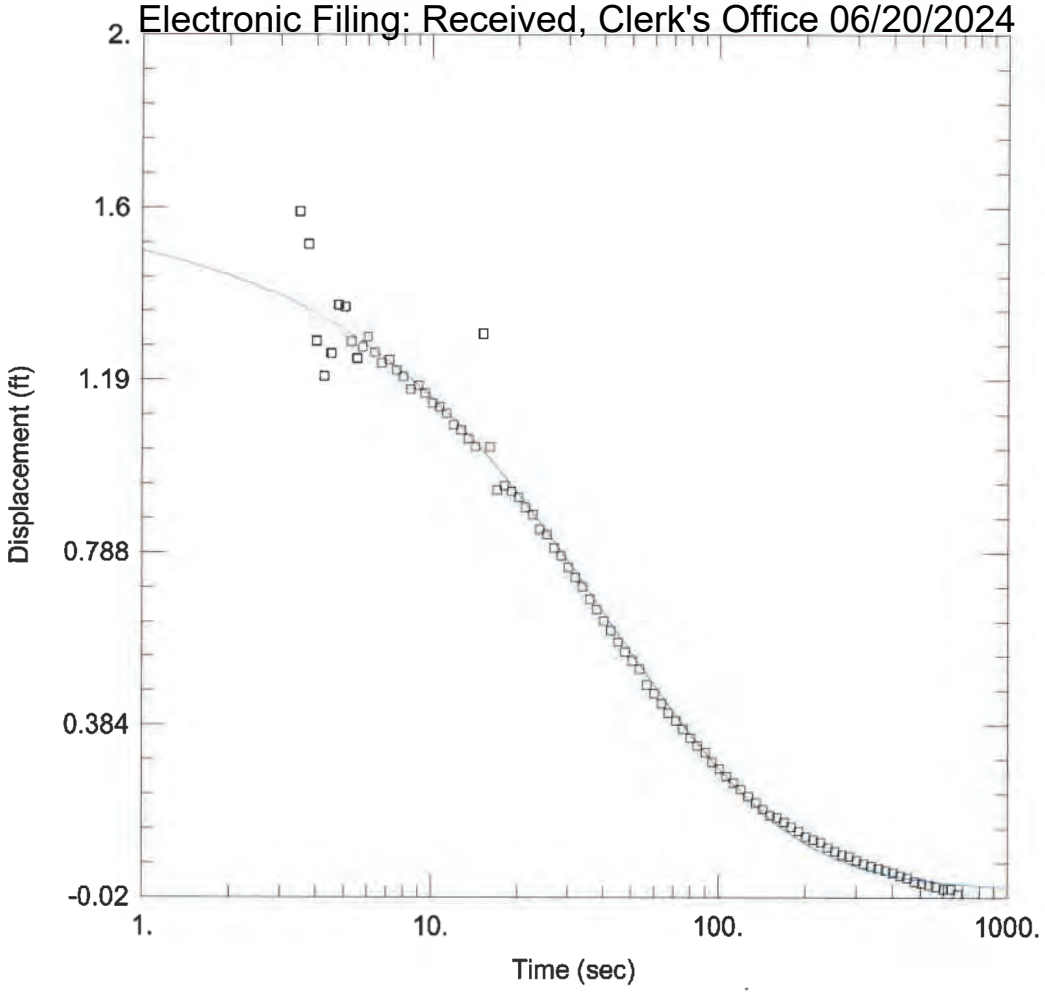
APPENDIX E
HYDRAULIC CONDUCTIVITY TEST DATA

Electronic Filing: Received, Clerk's Office 06/20/2024

Slug Test data summary - Duck Creek Gypsum Management Facility

Well ID	Falling Head k (cm/sec)	Specific Storage (1/ft)	FH Solution	Rising Head k (cm/sec)	Specific Storage (1/ft)	RH Solution	Average	Geo. Mean
G50L	2.30E-03	6.00E-03	KGS Model	2.10E-03	5.00E-03	KGS Model	2.20E-03	2.20E-03
G50S	6.50E-05	7.00E-03	KGS Model	1.50E-04	1.40E-05	KGS Model	1.08E-04	9.87E-05
G51L	3.00E-05	1.10E-03	KGS Model	*No test results*			3.00E-05	3.00E-05
G51S	7.20E-05	n/a	Bouwer-Rice	1.10E-04	1.50E-03	KGS Model	9.10E-05	8.90E-05
G53L	1.10E-04	2.90E-04	KGS Model	1.10E-04	1.10E-03	KGS Model	1.10E-04	1.10E-04
G53S	3.80E-03	2.00E-03	KGS Model	3.20E-03	1.00E-03	KGS Model	3.50E-03	3.49E-03
G54C	1.60E-04	n/a	Hvorslev	1.40E-04	n/a	Hvorslev	1.50E-04	1.50E-04
G54L	4.90E-05	n/a	Bouwer-Rice	2.20E-04	n/a	Bouwer-Rice	1.35E-04	1.04E-04
G54S	1.20E-04	n/a	Bouwer-Rice	2.10E-04	n/a	Bouwer-Rice	1.65E-04	1.59E-04
G57S	2.60E-03	7.00E-05	KGS Model	6.80E-04	2.20E-03	KGS Model	1.64E-03	1.33E-03
G60L	2.30E-04	6.00E-02	KGS Model	2.60E-04	3.50E-02	KGS Model	2.45E-04	2.45E-04
G60S	3.90E-03	7.10E-06	KGS Model	3.50E-03	7.00E-05	KGS Model	3.70E-03	3.69E-03
G63S	3.00E-04	2.00E-02	KGS Model	2.90E-04	2.00E-02	KGS Model	2.95E-04	2.95E-04

Electronic Filing: Received, Clerk's Office 06/20/2024



G50L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50L-fh.aqt
Date: 06/02/21 Time: 16:26:20

AQUIFER DATA

Saturated Thickness: 5.04 ft

WELL DATA (G50L)

Initial Displacement: 1.6 ft
Total Well Penetration Depth: 7.64 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 5.04 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

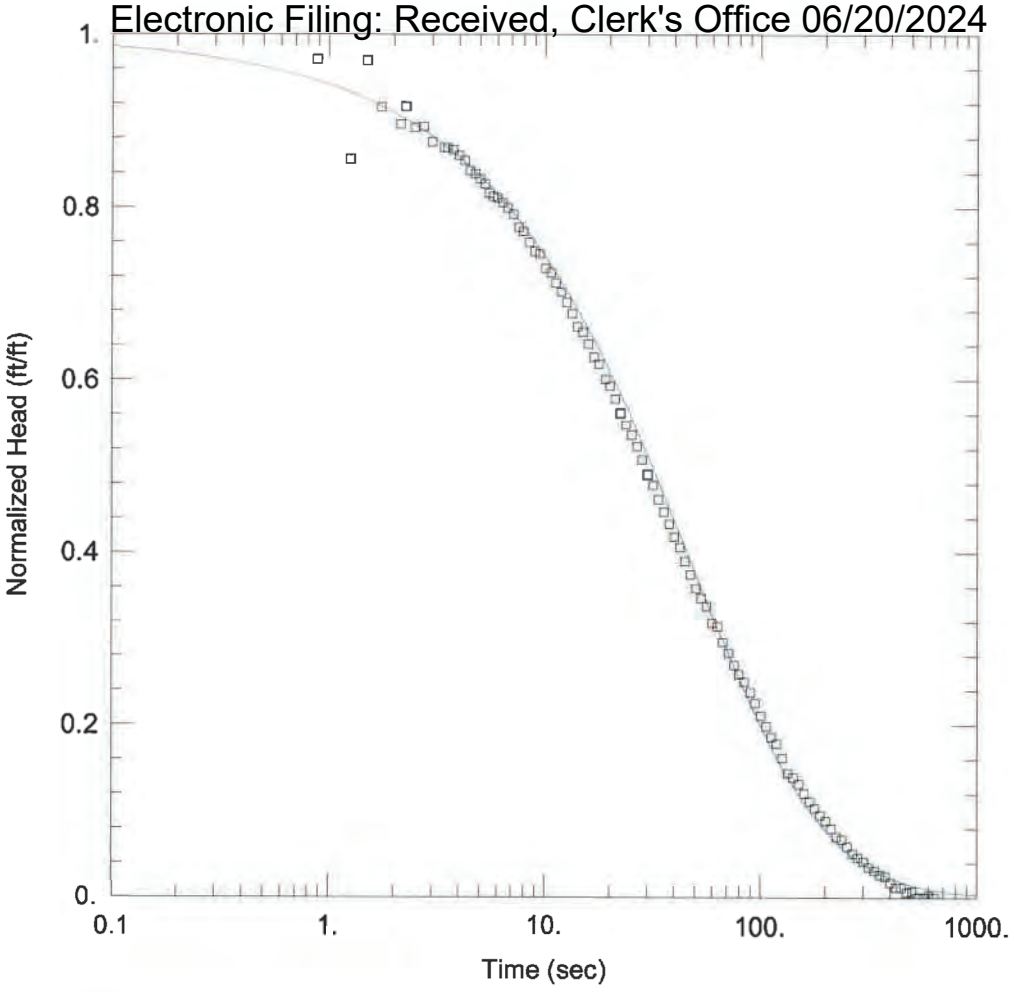
Aquifer Model: Unconfined

Kr = 0.0023 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.006 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G50L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50L-rh.aqt
Date: 06/02/21 Time: 16:26:22

AQUIFER DATA

Saturated Thickness: 5.04 ft

WELL DATA (G50L)

Initial Displacement: 1.625 ft
Total Well Penetration Depth: 7.64 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 5.04 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

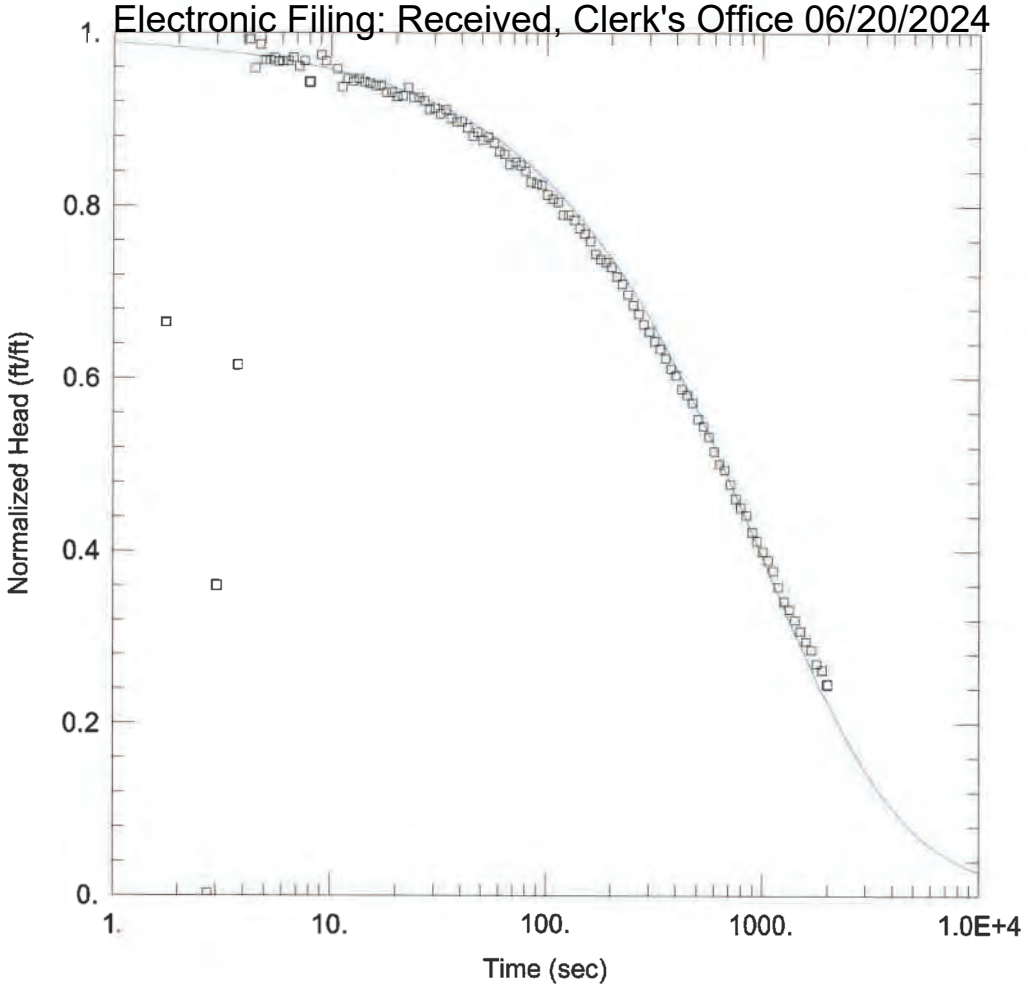
Aquifer Model: Unconfined

Kr = 0.0021 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.005 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G50S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50S-fh.aqt
Date: 06/02/21 Time: 16:26:23

PROJECT INFORMATION

Client: Duck Creek Power Statin
Project: 20E0111A
Location: Canton, IL
Test Well: G50S
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 4.3 ft

WELL DATA (G50S)

Initial Displacement: 1.07 ft
Total Well Penetration Depth: 22.57 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 20.03 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

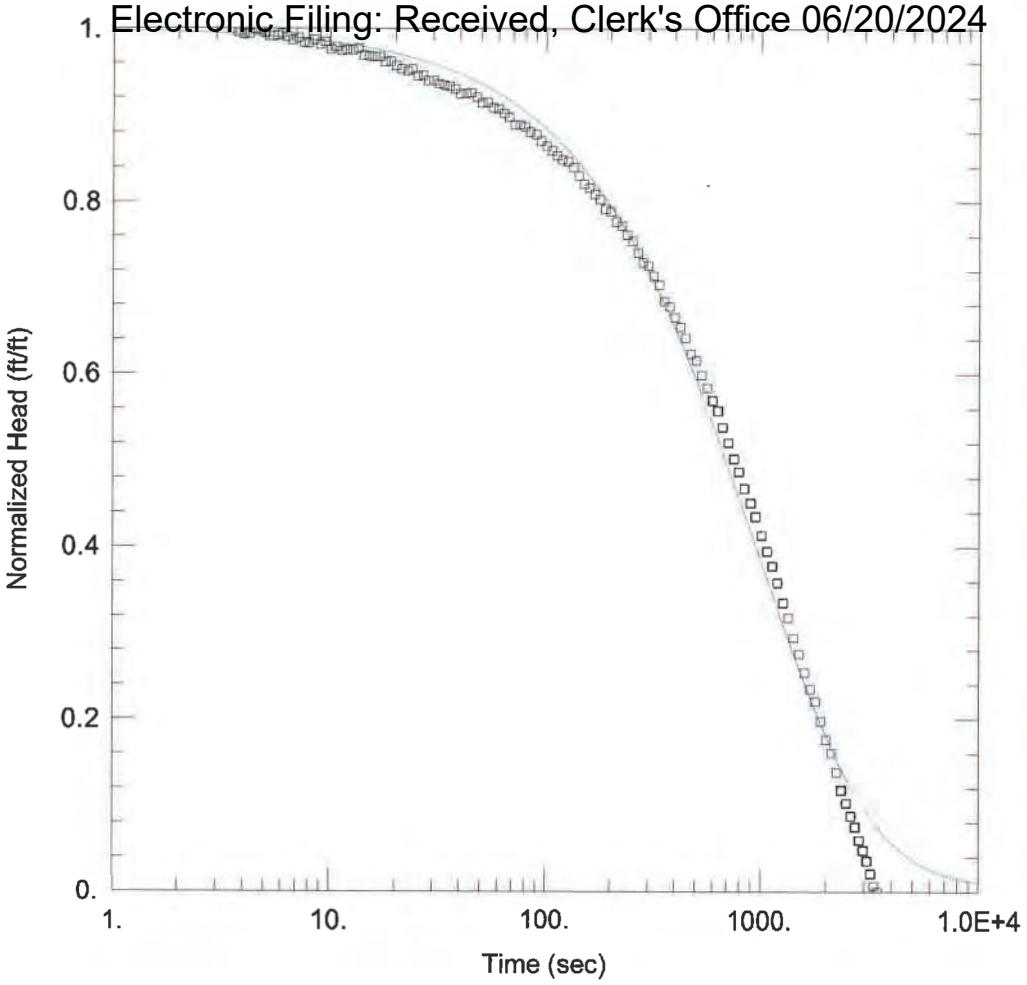
Aquifer Model: Confined

Kr = 6.5E-5 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.007 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G50S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G50S-rh.aqt
Date: 06/02/21 Time: 16:26:25

AQUIFER DATA

Saturated Thickness: 4.3 ft

WELL DATA (G50S)

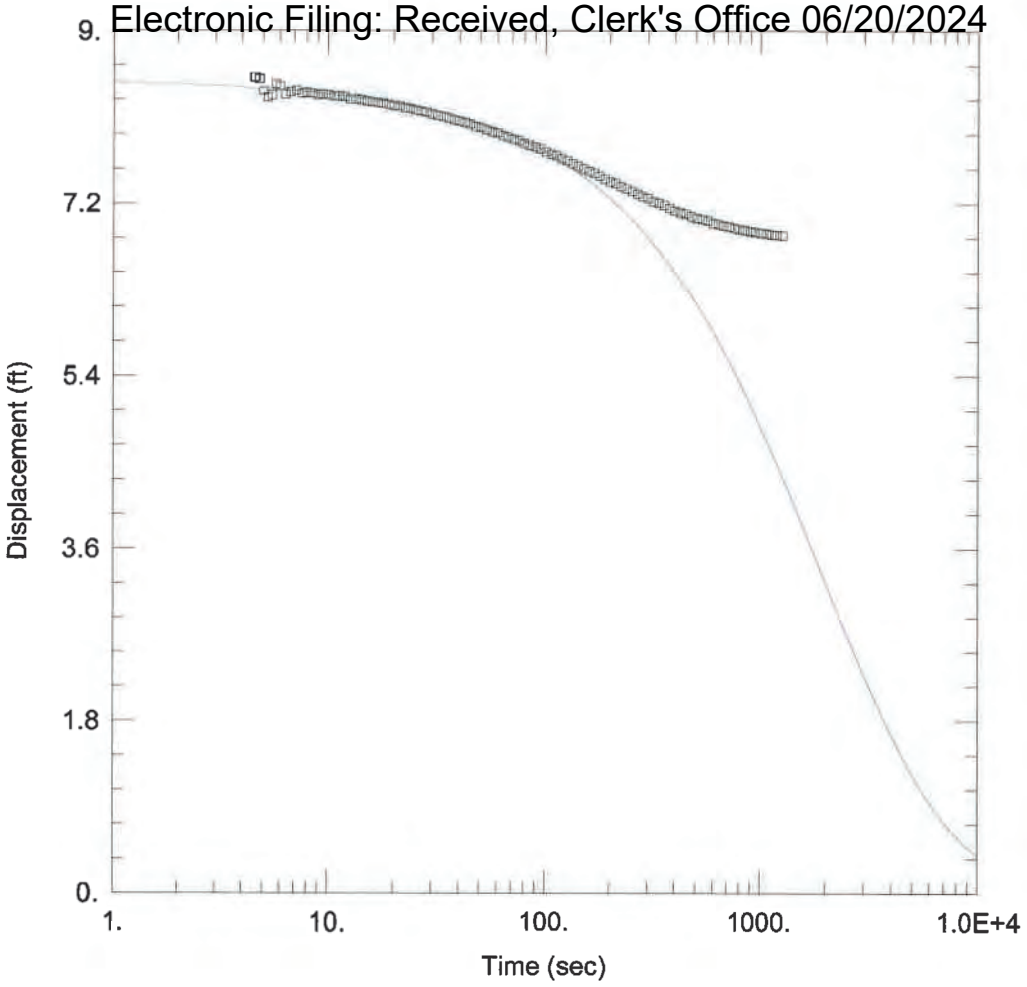
Initial Displacement: 1.35 ft
Total Well Penetration Depth: 22.57 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 20.03 ft
Screen Length: 4.71 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.00015 cm/sec
Kz/Kr = 1.
Ss = 1.4E-5 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G51L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G51L-fh.aqt
Date: 06/02/21 Time: 16:26:26

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G51L
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 8.5 ft

WELL DATA (G51L)

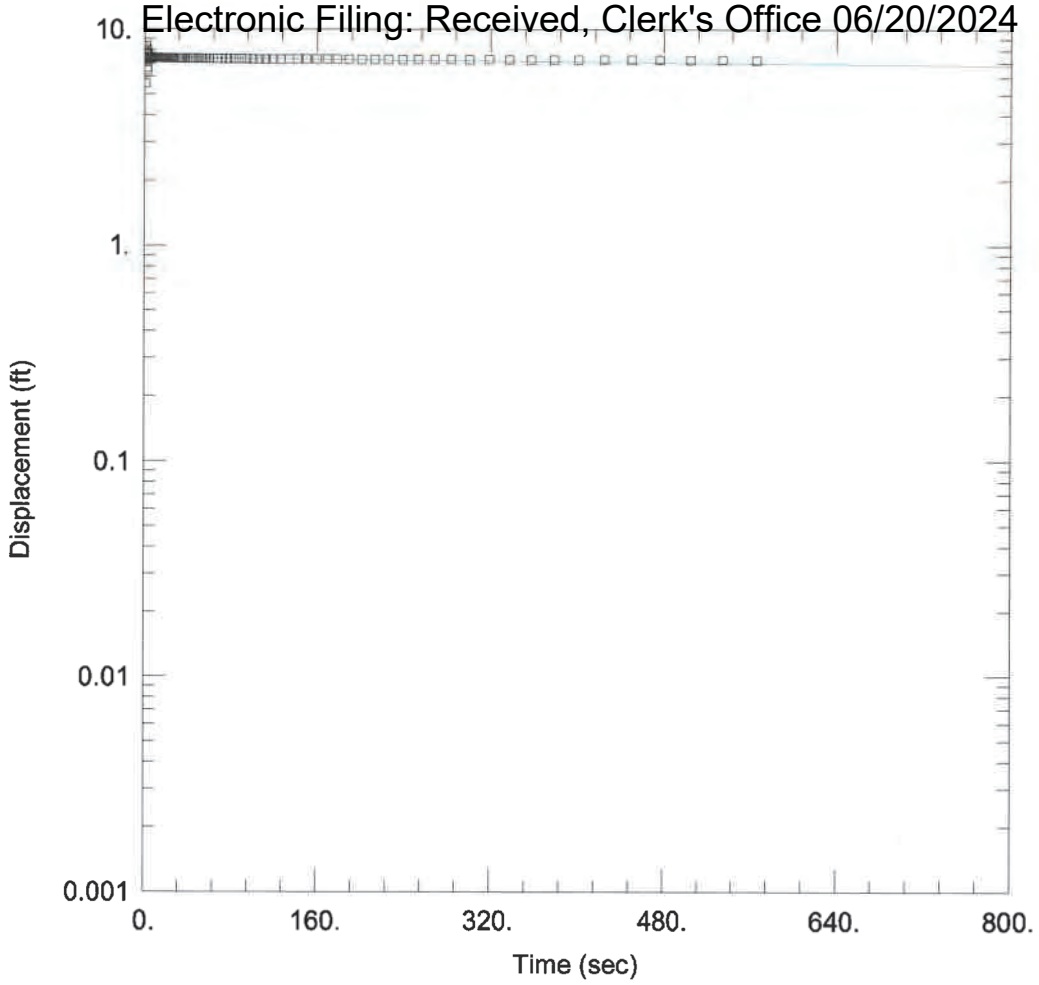
Initial Displacement: 8.5 ft
Total Well Penetration Depth: 14.11 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.32 ft
Screen Length: 4.79 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 3.0E-5 cm/sec
Kz/Kr = 1.
Ss = 0.0011 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G51S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G51S-fh.aqt
Date: 06/02/21 Time: 16:26:27

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G51S
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 0.4 ft
Anisotropy Ratio (Kz/Kr): 1.

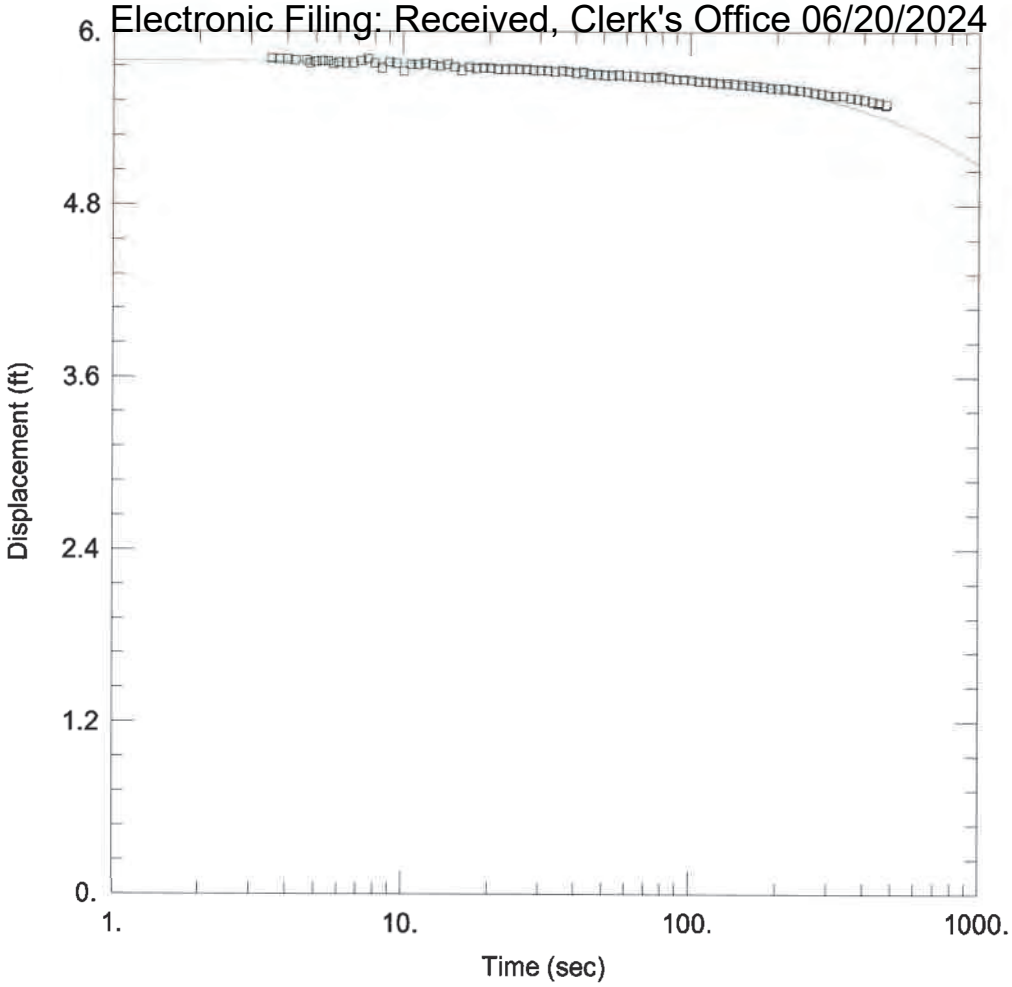
WELL DATA (G51S)

Initial Displacement: 7.4 ft
Total Well Penetration Depth: 20.04 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.4 ft
Screen Length: 4.78 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
K = 7.2E-5 cm/sec
Solution Method: Bouwer-Rice
y0 = 7.35 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G51S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G51S-rh.aqt
Date: 06/02/21 Time: 16:26:29

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G51S
Test Date: 4 Mar 2021

AQUIFER DATA

Saturated Thickness: 0.4 ft

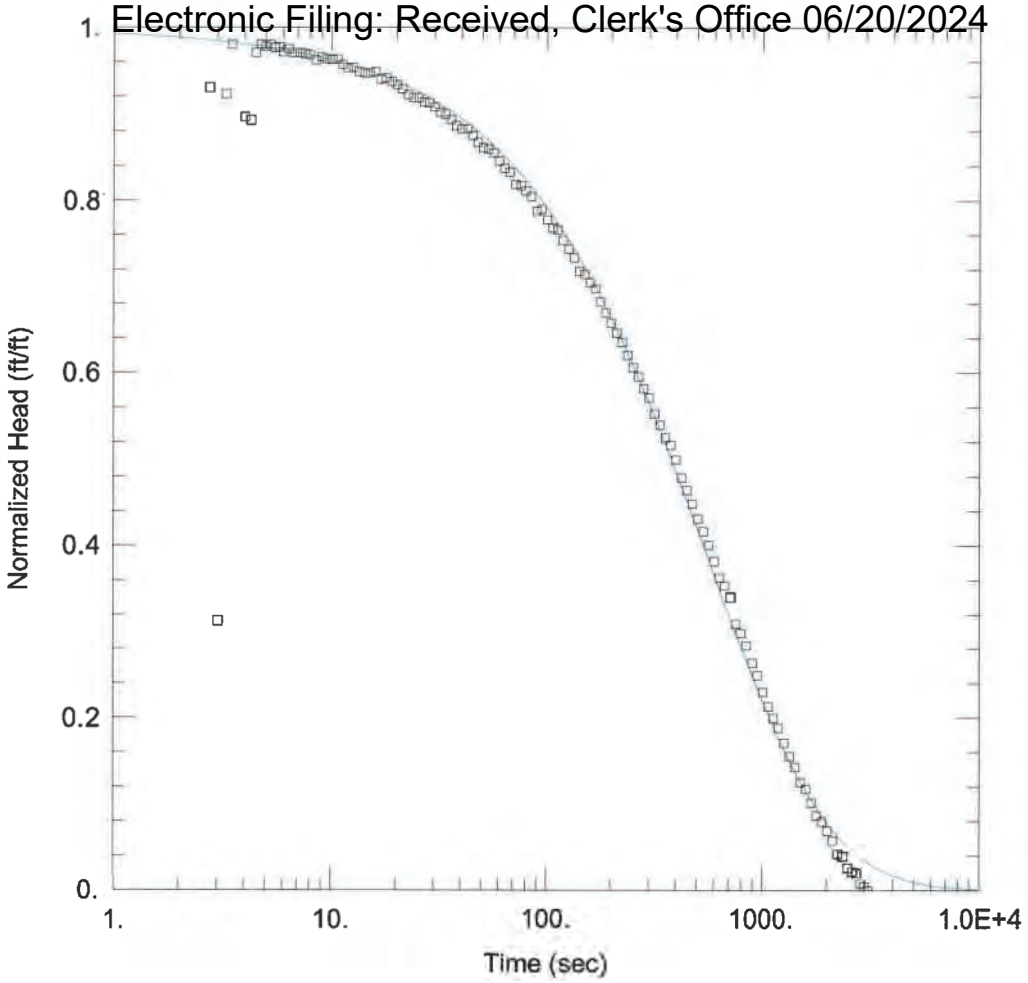
WELL DATA (G51S)

Initial Displacement: 5.8 ft
Total Well Penetration Depth: 20.04 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.4 ft
Screen Length: 4.78 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.00011 cm/sec
Kz/Kr = 1.
Ss = 0.0015 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G53L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53L-fh.aqt
Date: 06/02/21 Time: 16:26:30

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 11.48 ft

WELL DATA (G53L)

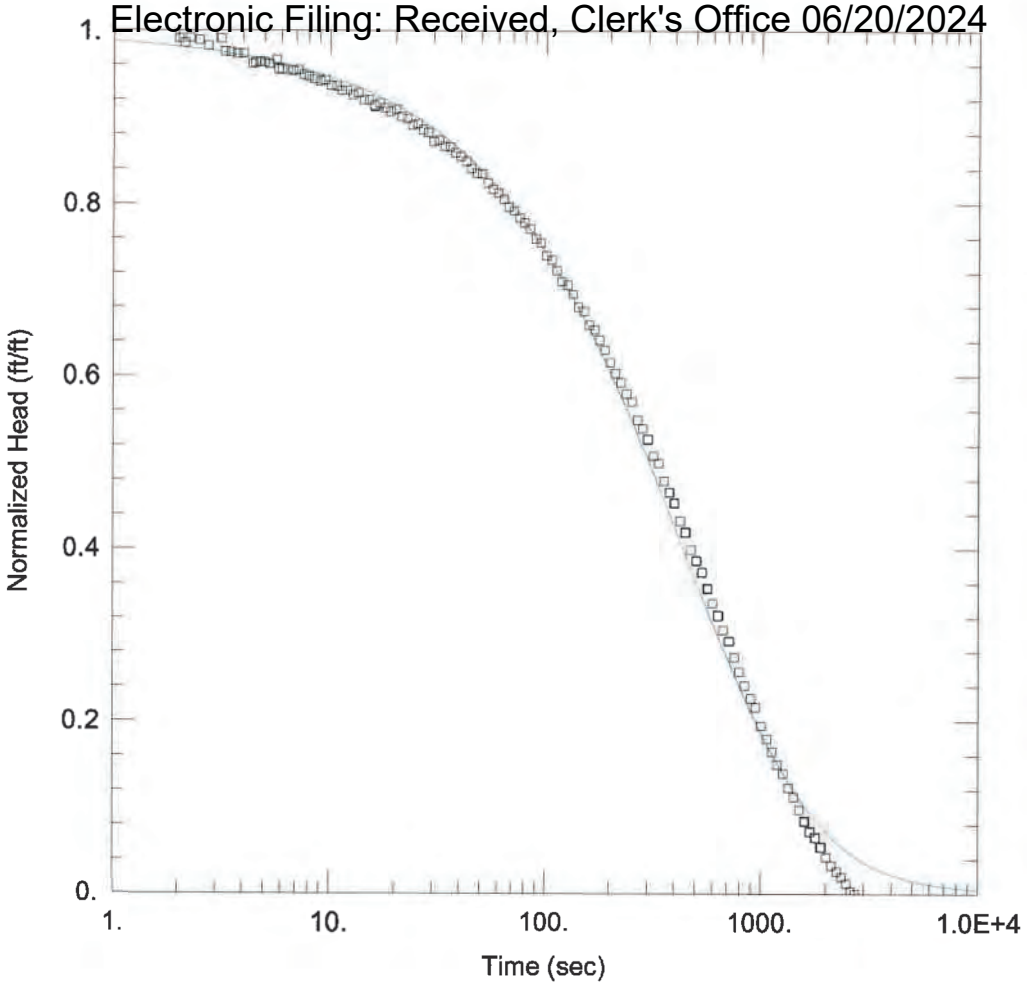
Initial Displacement: 1.4 ft
Total Well Penetration Depth: 14.33 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.48 ft
Screen Length: 9.35 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00011 cm/sec
Kz/Kr = 1.
Ss = 0.00029 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G53L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53L-rh.aqt
Date: 06/02/21 Time: 16:26:32

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 11.48 ft

WELL DATA (G53L)

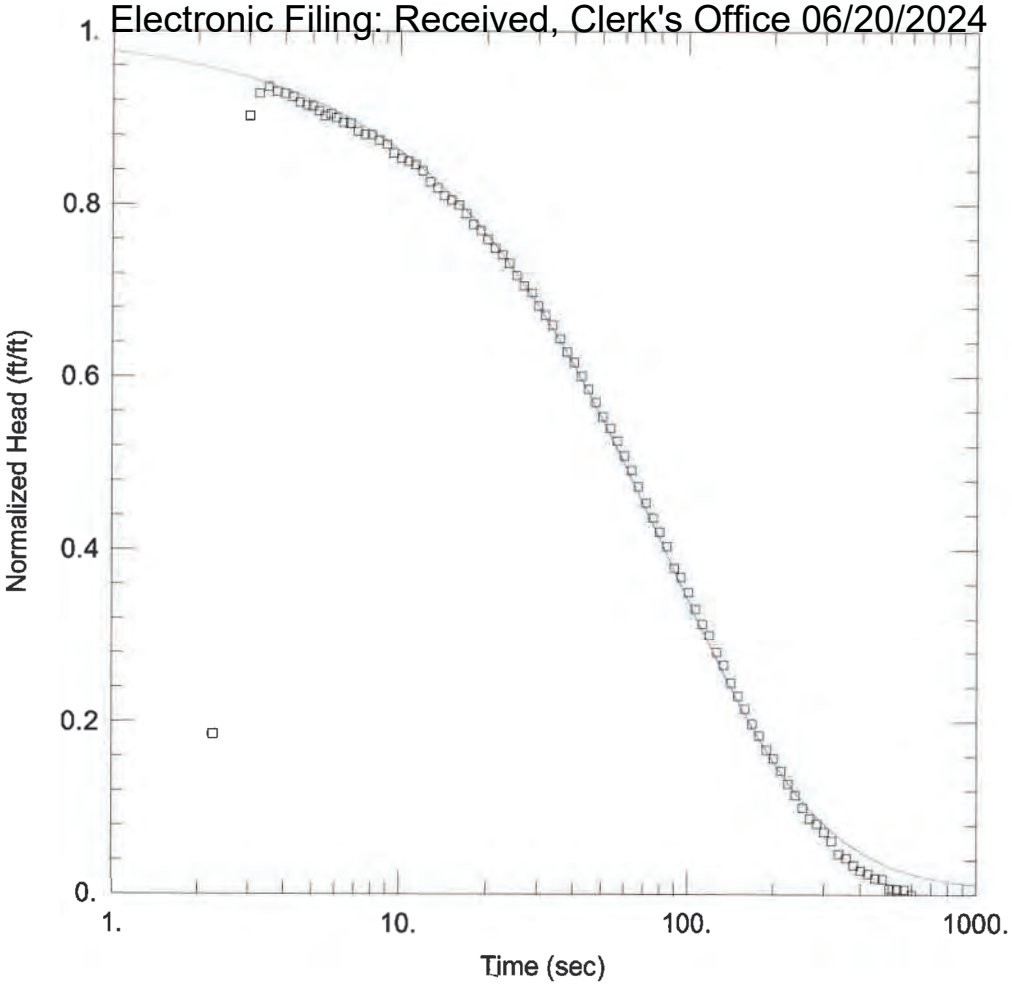
Initial Displacement: 1.5 ft
Total Well Penetration Depth: 14.33 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.48 ft
Screen Length: 9.35 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00011 cm/sec
Kz/Kr = 1.
Ss = 0.0011 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G53S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53S-fh.aqt
Date: 06/02/21 Time: 16:26:33

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.6 ft

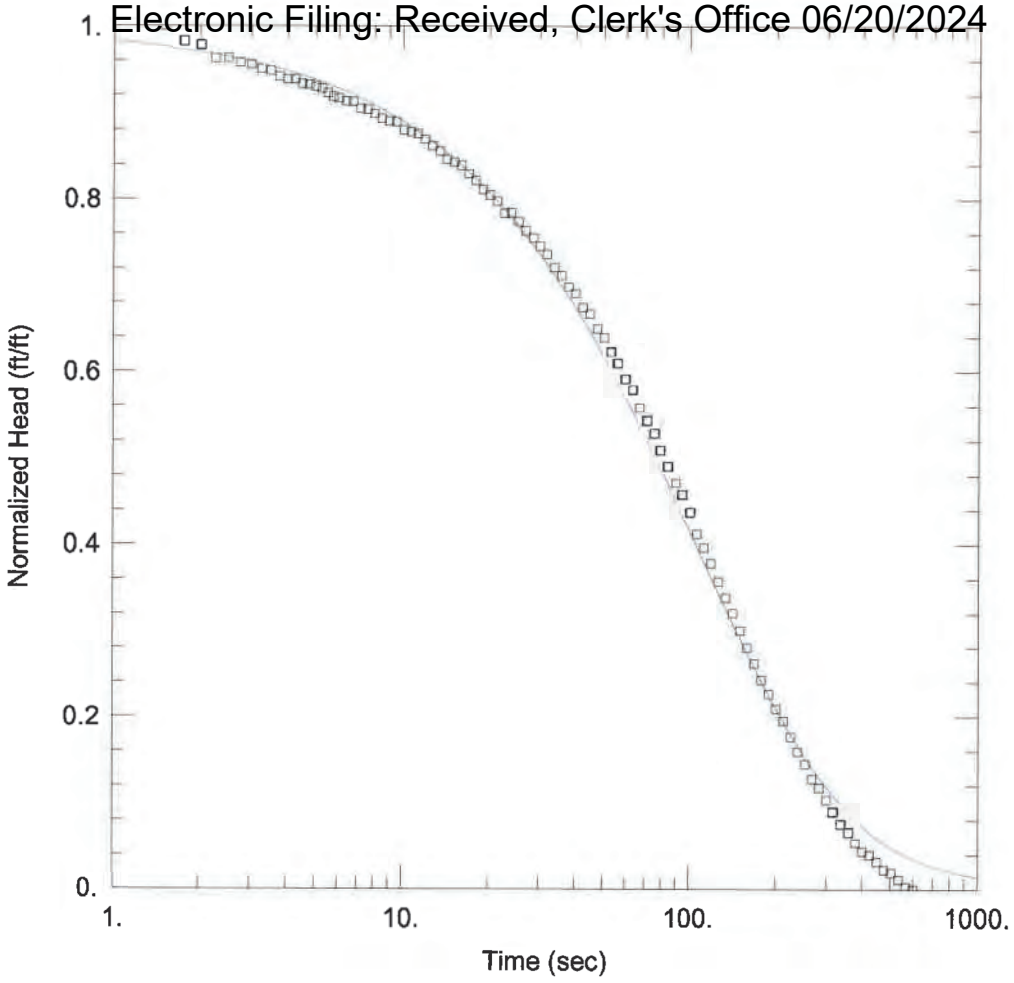
WELL DATA (G53S)

Initial Displacement: 1.6 ft
Total Well Penetration Depth: 21.38 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.77 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.0038 cm/sec
Kz/Kr = 1.
Ss = 0.002 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G53S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G53S-rh.aqt
Date: 06/02/21 Time: 16:26:35

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G53S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.6 ft

WELL DATA (G53S)

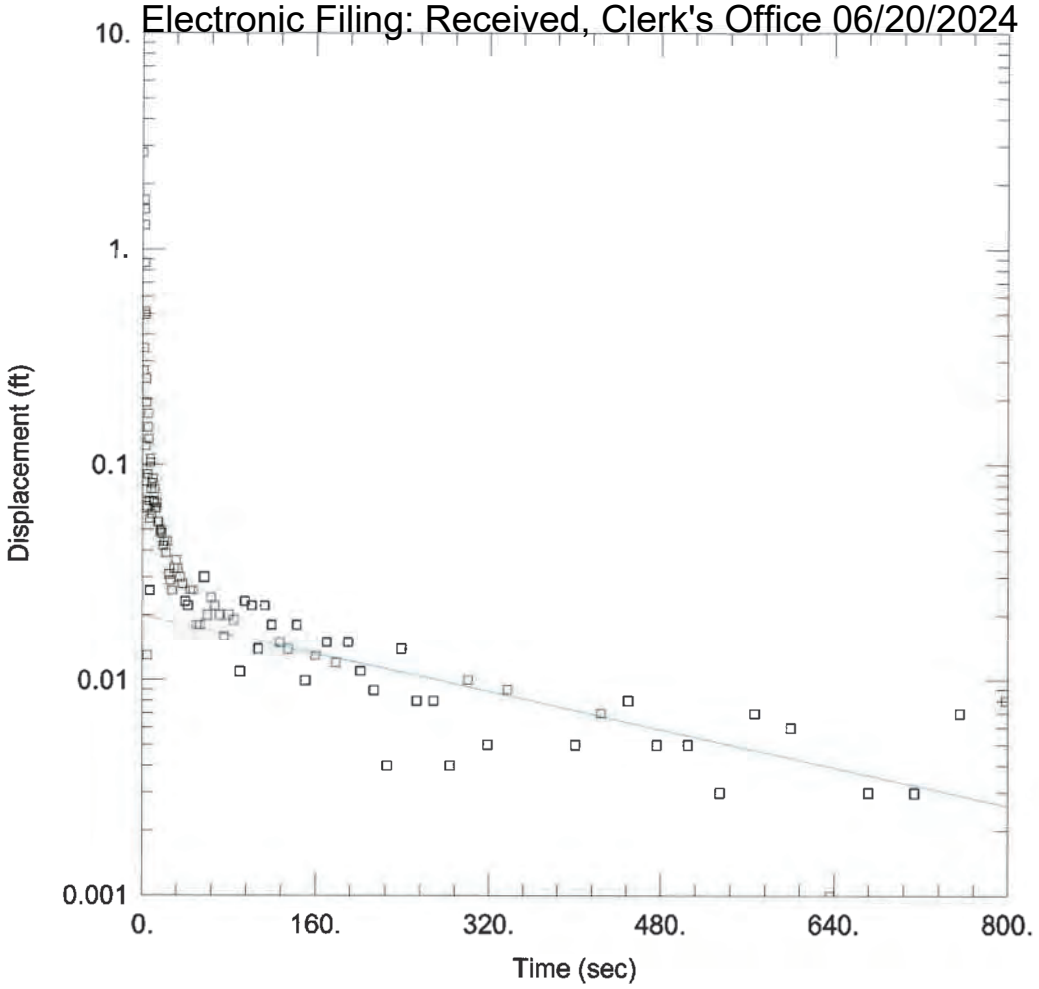
Initial Displacement: 1.75 ft
Total Well Penetration Depth: 21.38 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.77 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.0032 cm/sec
Kz/Kr = 1.
Ss = 0.001 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G54C FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54C-fh.aqt
Date: 06/02/21 Time: 16:26:36

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54C
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 42.2 ft
Anisotropy Ratio (Kz/Kr): 1.

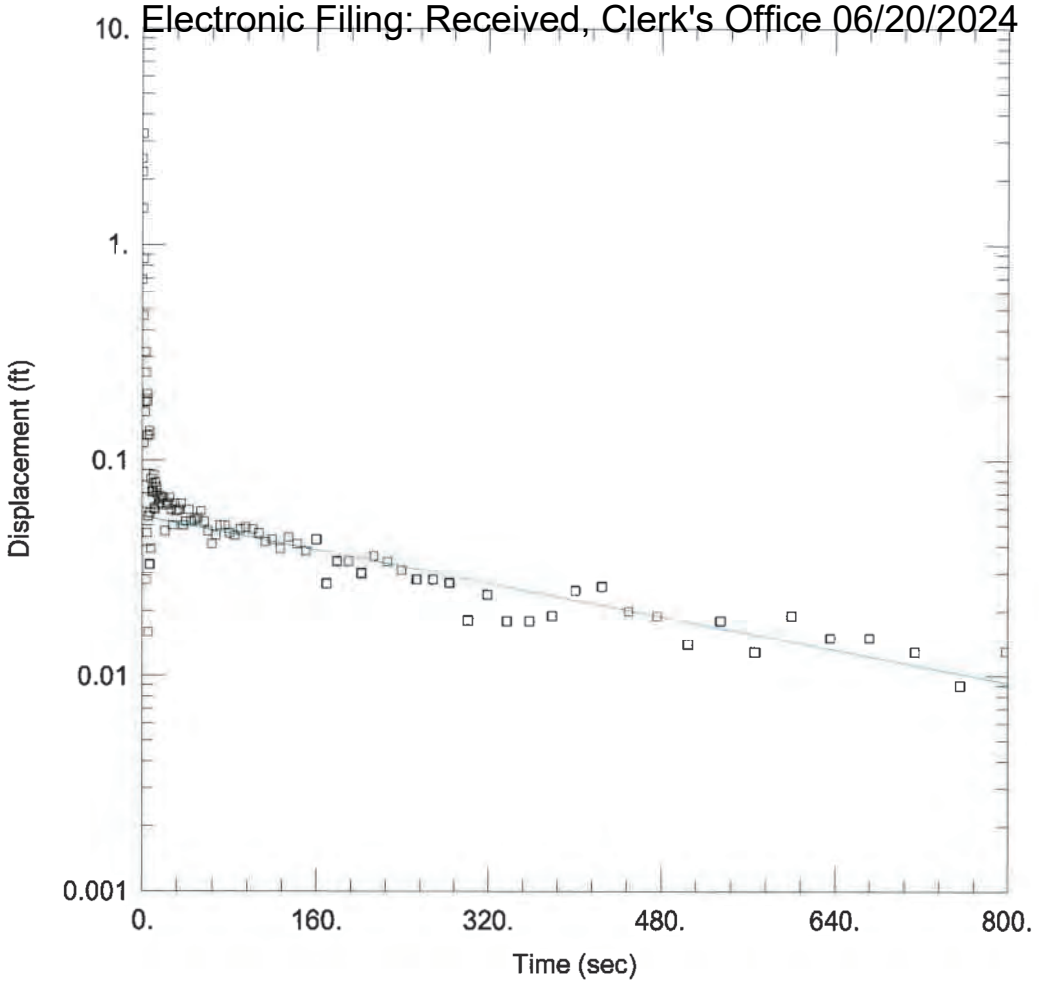
WELL DATA (G54C)

Initial Displacement: 2.8 ft
Total Well Penetration Depth: 44.3 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 42.2 ft
Screen Length: 9.07 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 0.00016 cm/sec
y0 = 0.02 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54C RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54C-rh.aqt
Date: 06/02/21 Time: 16:26:38

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54C
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 42.2 ft
Anisotropy Ratio (Kz/Kr): 1.

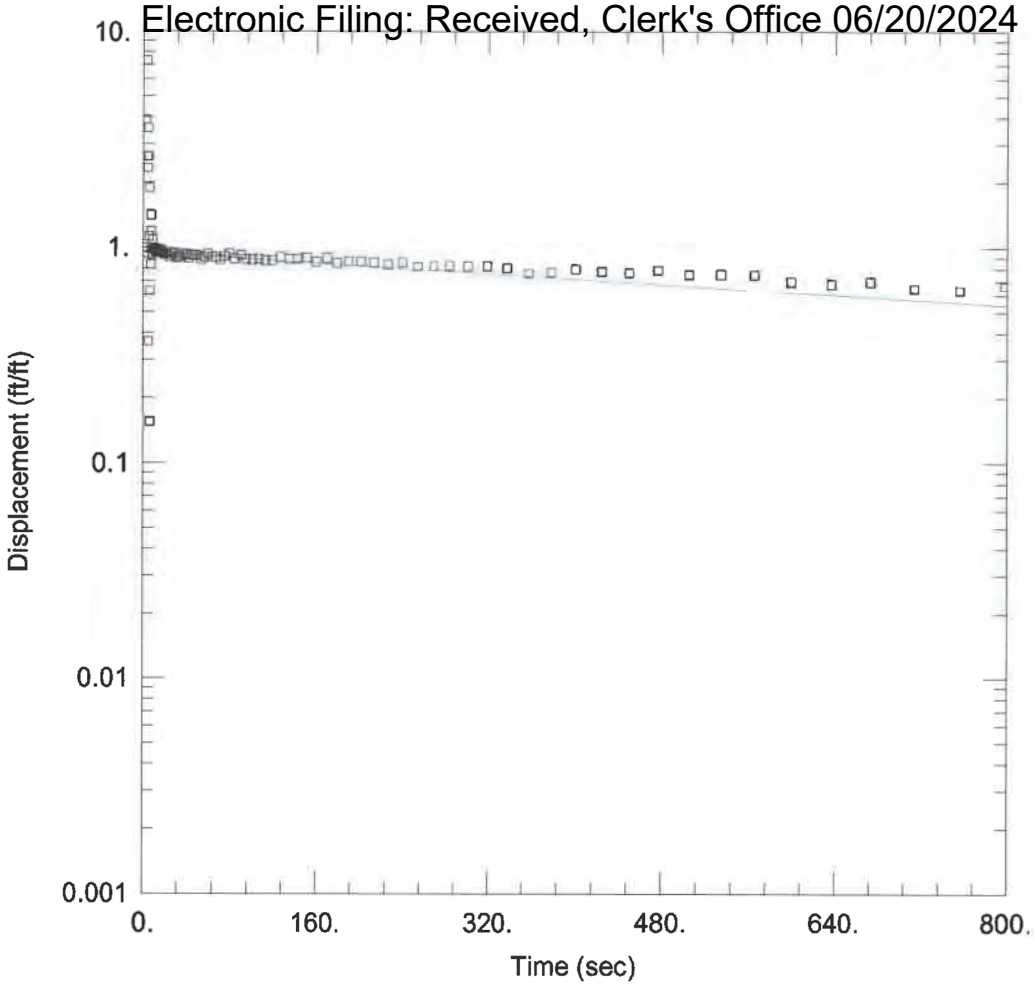
WELL DATA (G54C)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 44.3 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 42.2 ft
Screen Length: 9.07 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
K = 0.00014 cm/sec
Solution Method: Hvorslev
y0 = 0.055 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54L-fh.aqt
Date: 06/02/21 Time: 16:27:18

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54L
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 5.59 ft
Anisotropy Ratio (Kz/Kr): 1.

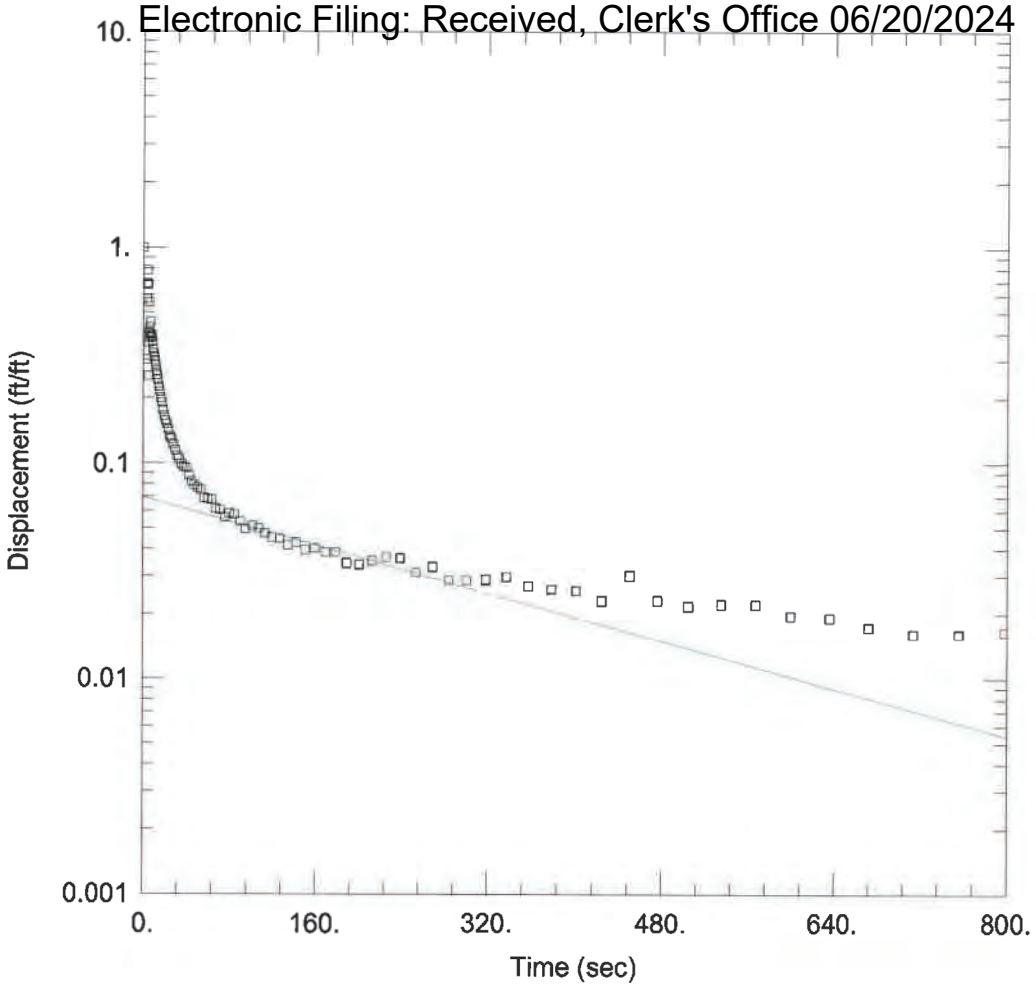
WELL DATA (G54L)

Initial Displacement: 0.2 ft
Total Well Penetration Depth: 10.65 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 5.59 ft
Screen Length: 9.43 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
K = 4.9E-5 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.19 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54L-rh.aqt
Date: 06/02/21 Time: 16:27:20

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54L
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 5.59 ft
Anisotropy Ratio (Kz/Kr): 0.001

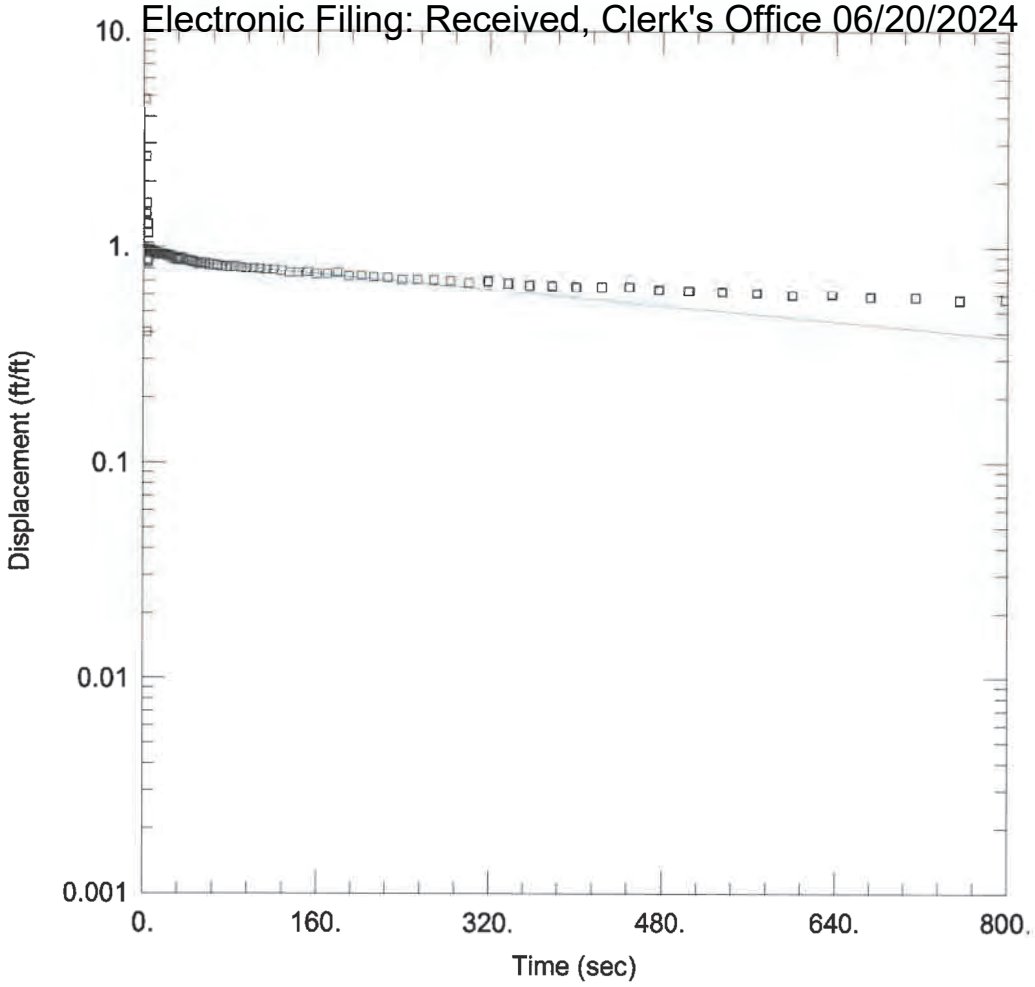
WELL DATA (G54L)

Initial Displacement: 2.3 ft
Total Well Penetration Depth: 10.65 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 5.59 ft
Screen Length: 9.43 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
K = 0.00022 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.16 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54S-fh.aqt
Date: 06/02/21 Time: 16:27:22

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54S
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 3.6 ft
Anisotropy Ratio (Kz/Kr): 0.001

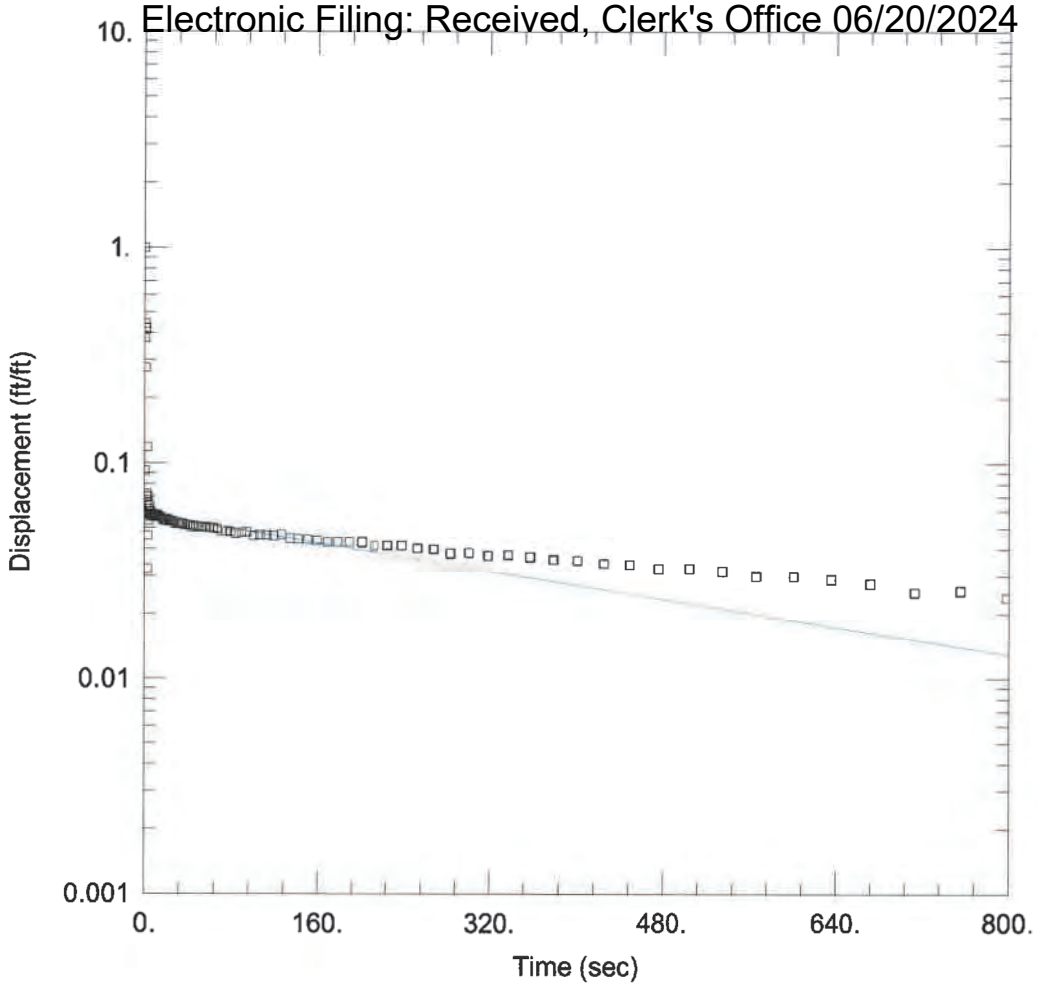
WELL DATA (G54S)

Initial Displacement: 0.525 ft
Total Well Penetration Depth: 17.18 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 14.36 ft
Screen Length: 4.47 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
K = 0.00012 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.47 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G54S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G54S-rh.aqt
Date: 06/02/21 Time: 16:27:23

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G54S
Test Date: 8 Mar 2021

AQUIFER DATA

Saturated Thickness: 3.6 ft
Anisotropy Ratio (Kz/Kr): 1.

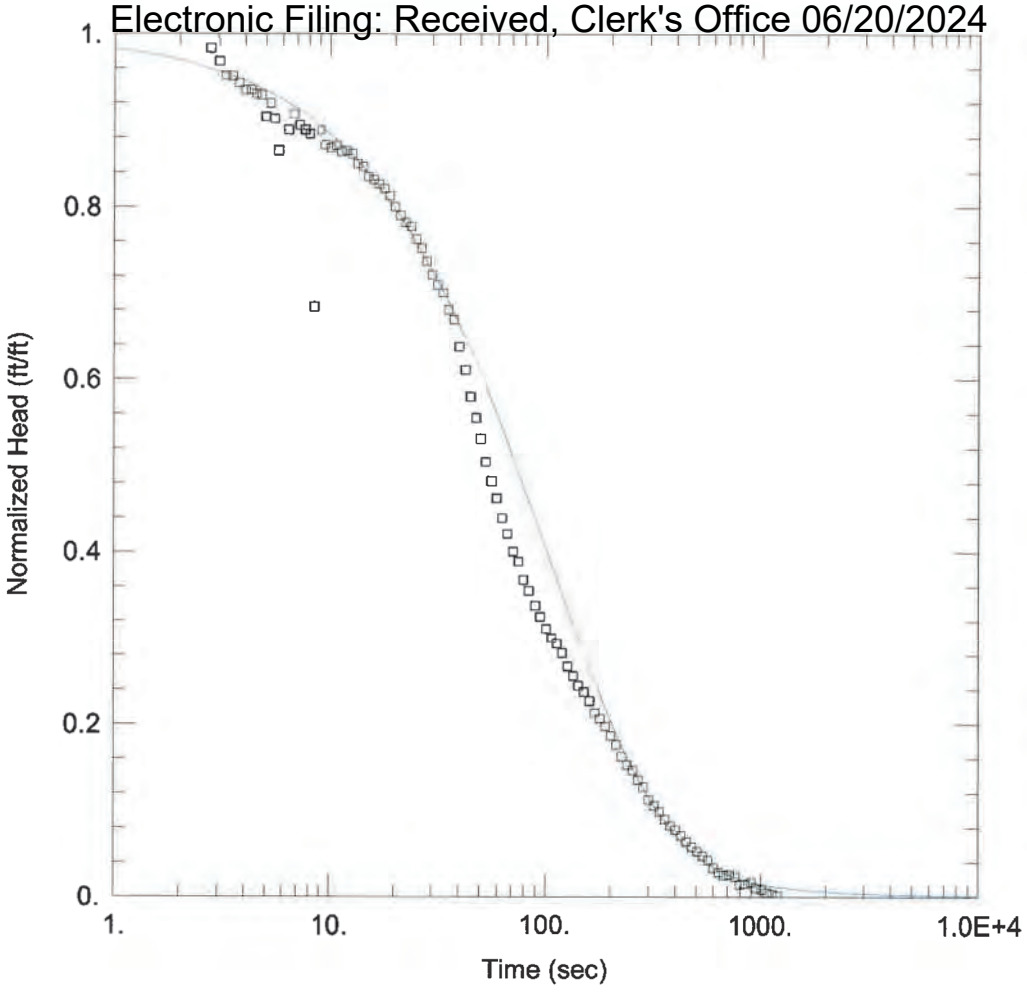
WELL DATA (G54S)

Initial Displacement: 7.8 ft
Total Well Penetration Depth: 17.18 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 14.36 ft
Screen Length: 4.47 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
K = 0.00021 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.45 ft

Electronic Filing: Received, Clerk's Office 06/20/2024



G57S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G57S-fh.aqt
Date: 06/02/21 Time: 16:27:25

AQUIFER DATA

Saturated Thickness: 1.9 ft

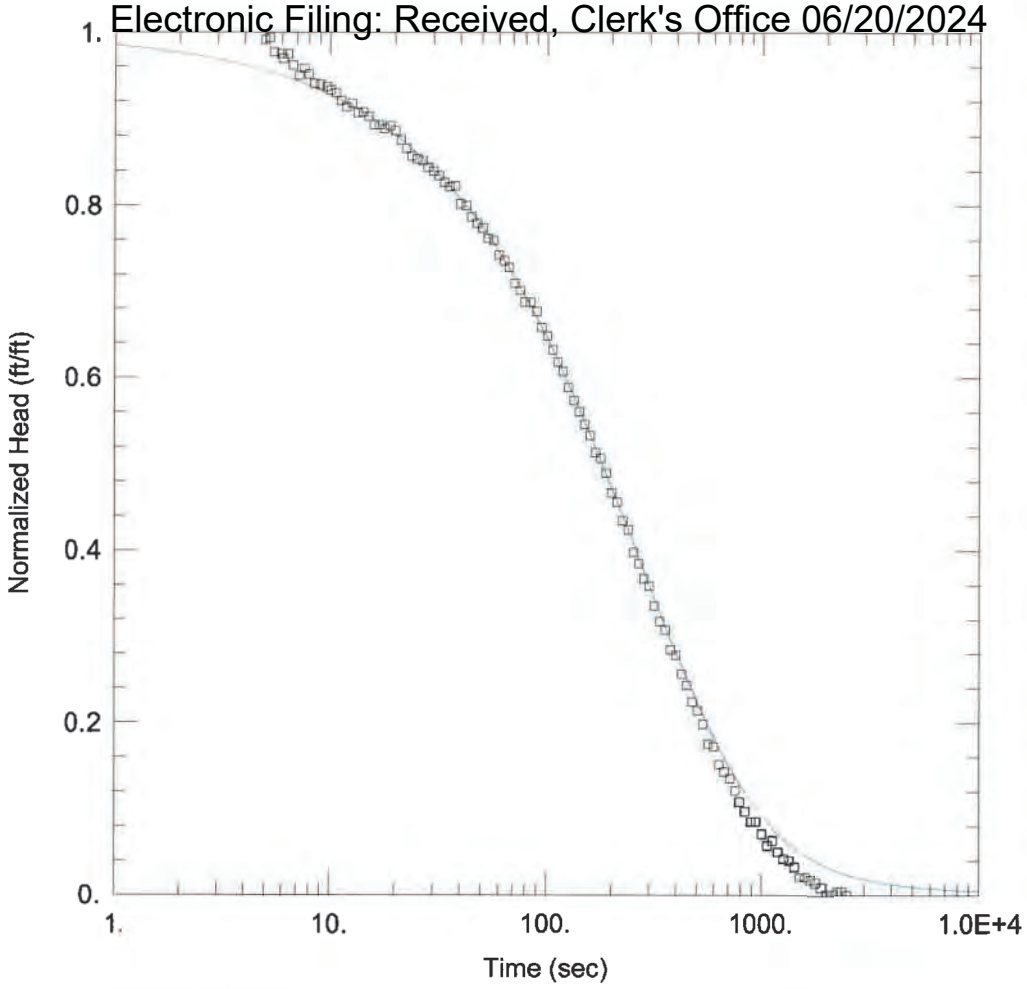
WELL DATA (G57S)

Initial Displacement: 1.55 ft
Total Well Penetration Depth: 10.16 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.62 ft
Screen Length: 4.53 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model
Kr = 0.0026 cm/sec
Kz/Kr = 1.
Ss = 7.0E-5 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G57S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G57S-rh.aqt
Date: 06/02/21 Time: 16:27:26

AQUIFER DATA

Saturated Thickness: 1.9 ft

WELL DATA (G57S)

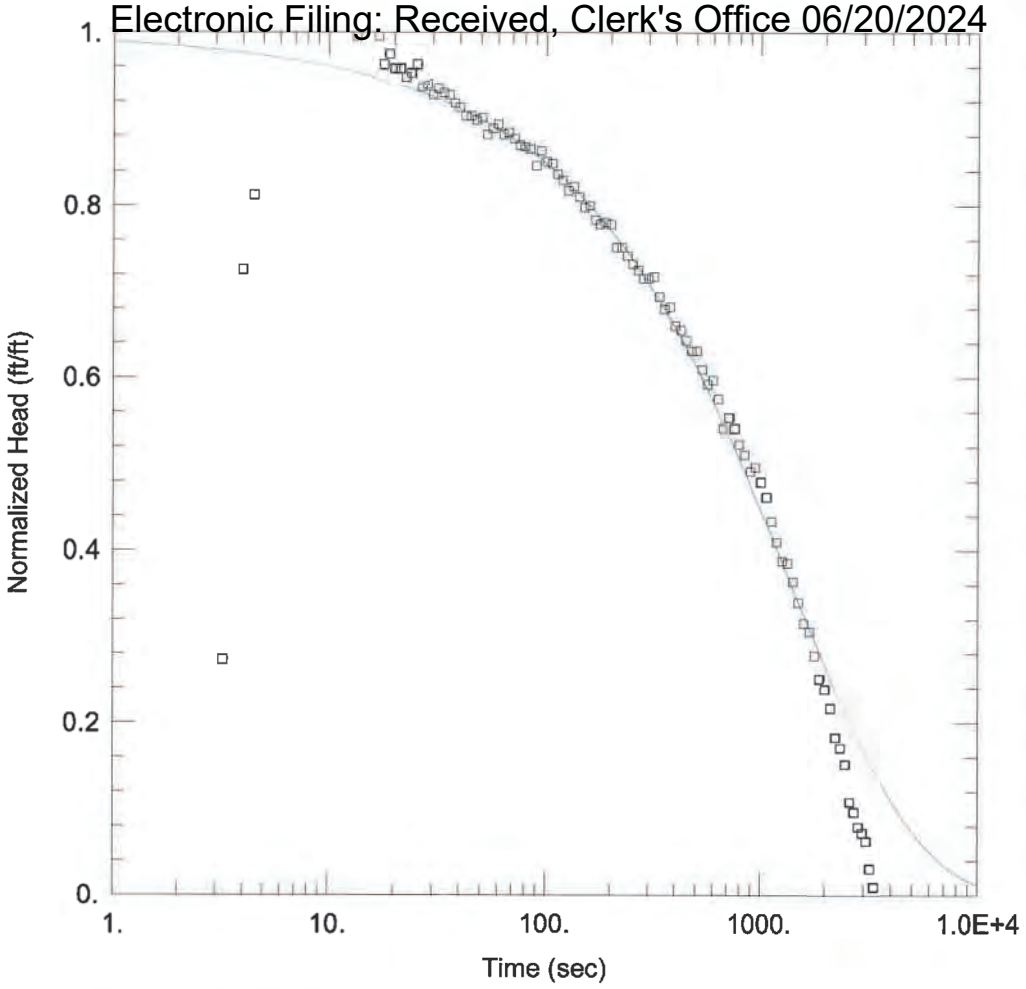
Initial Displacement: 0.925 ft
Total Well Penetration Depth: 10.16 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.62 ft
Screen Length: 4.53 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.00068 cm/sec
Kz/Kr = 0.001
Ss = 0.0022 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60L-fh.aqt
Date: 06/02/21 Time: 16:27:28

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.04 ft

WELL DATA (G60L)

Initial Displacement: 0.415 ft
Total Well Penetration Depth: 5.4 ft
Casing Radius: 0.08333 ft

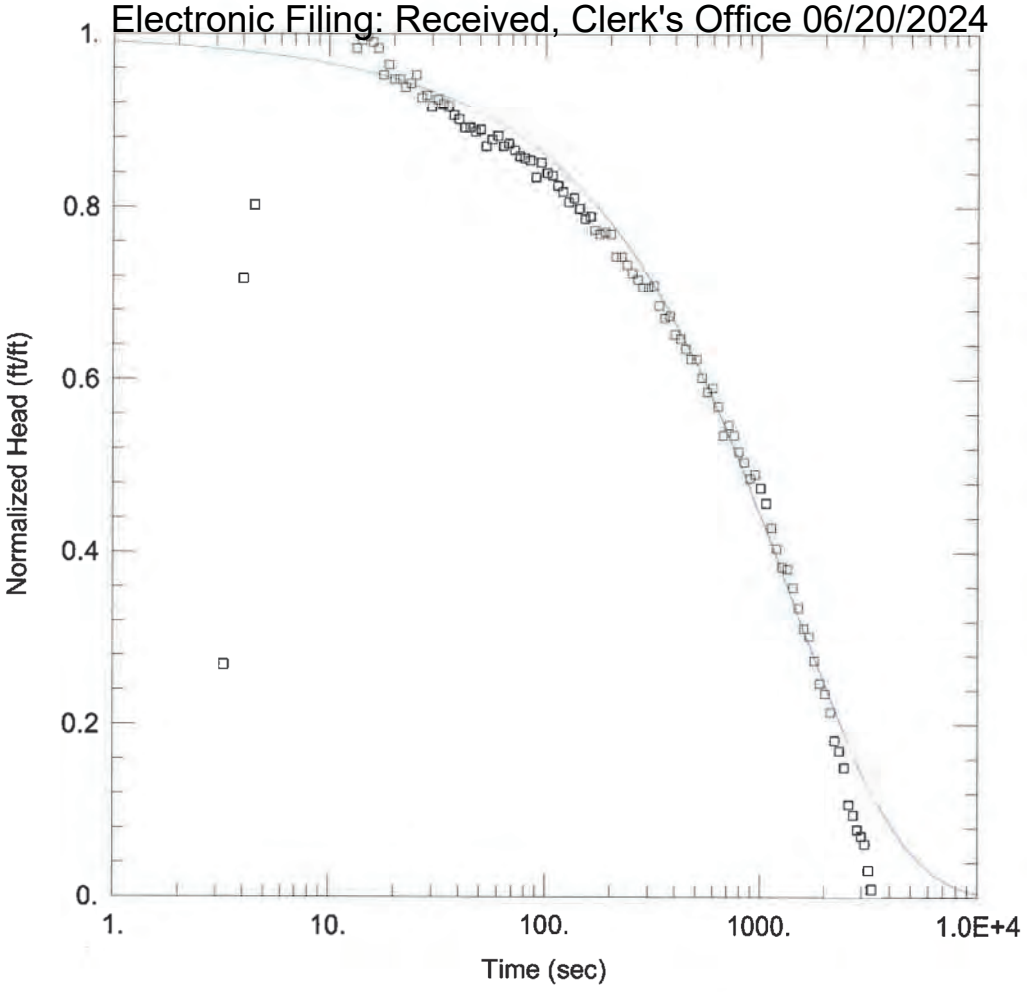
Static Water Column Height: 1.04 ft
Screen Length: 4.74 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Kr = 0.00023 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.06 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60L-rh.aqt
Date: 06/02/21 Time: 16:27:30

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60L
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.04 ft

WELL DATA (G60L)

Initial Displacement: 0.42 ft
Total Well Penetration Depth: 5.4 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 1.04 ft
Screen Length: 4.74 ft
Well Radius: 0.08333 ft

SOLUTION

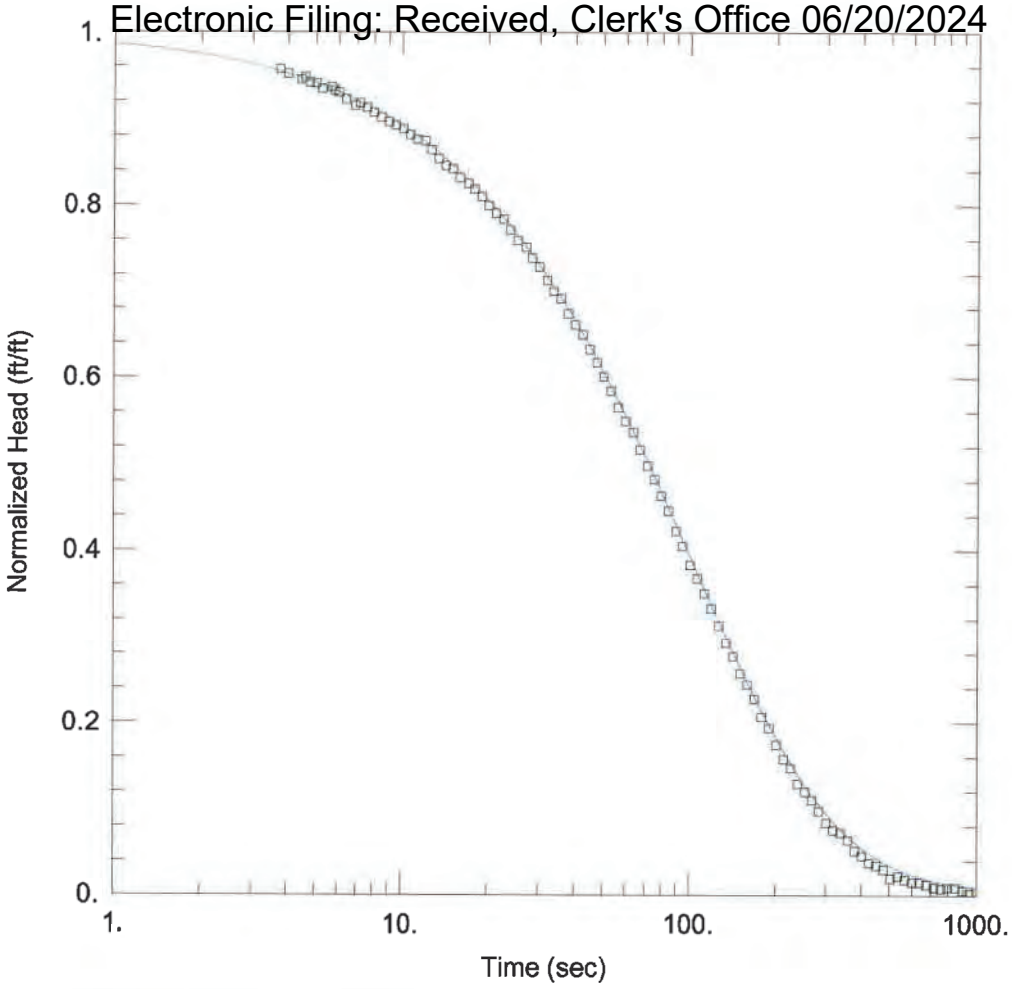
Aquifer Model: Unconfined

Kr = 0.00026 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.035 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60S-fh.aqt
Date: 06/02/21 Time: 16:27:31

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.9 ft

WELL DATA (G60S)

Initial Displacement: 1.55 ft
Total Well Penetration Depth: 7.23 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 3.91 ft
Screen Length: 3.95 ft
Well Radius: 0.08333 ft

SOLUTION

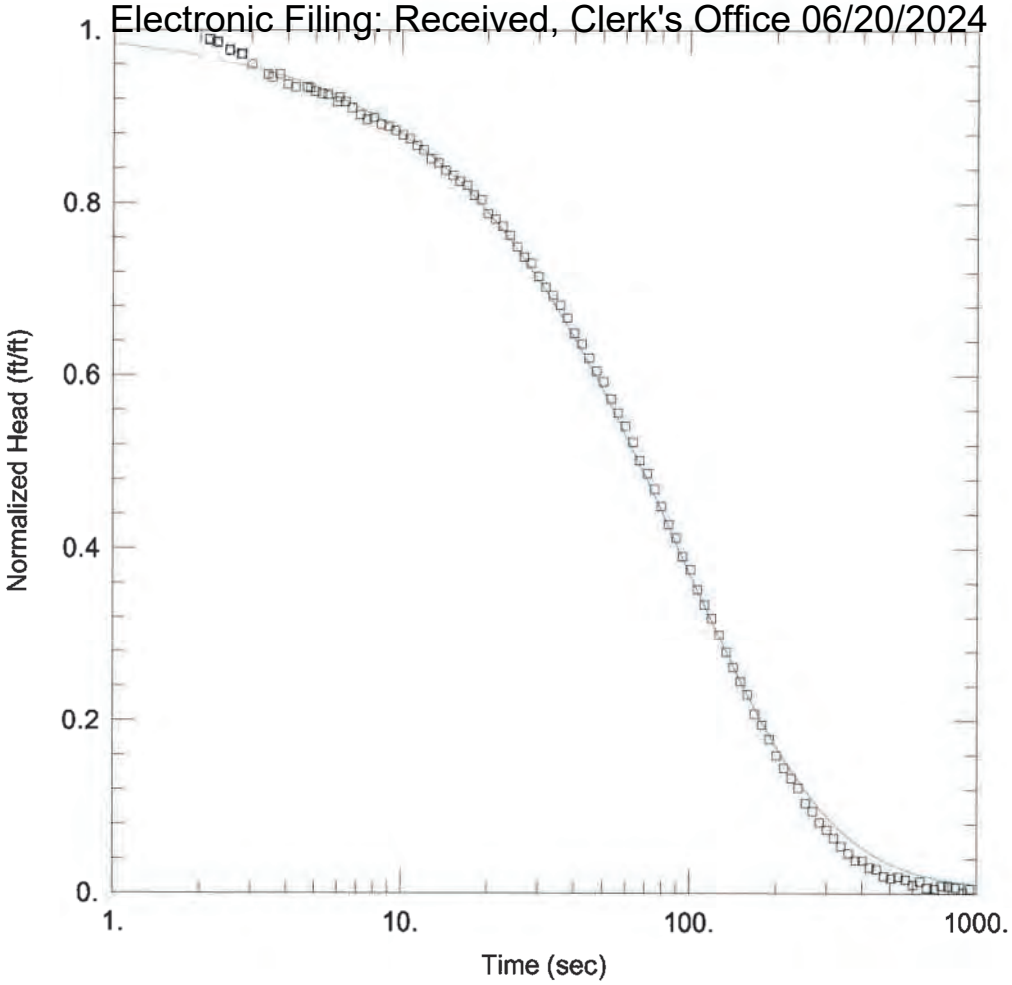
Aquifer Model: Confined

Kr = 0.0039 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 7.1E-6 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G60S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G60S-rh.aqt
Date: 06/02/21 Time: 16:27:33

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G60S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 1.9 ft

WELL DATA (G60S)

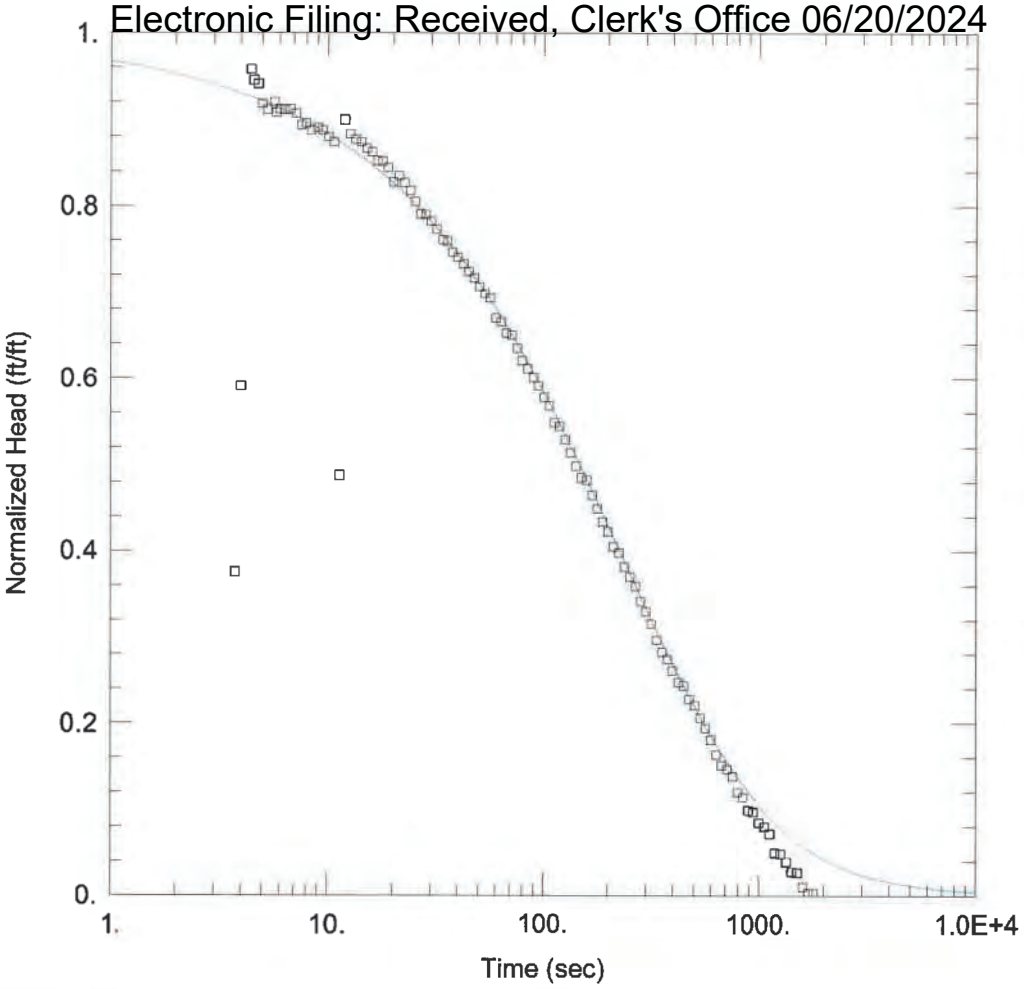
Initial Displacement: 1.85 ft
Total Well Penetration Depth: 7.23 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 3.91 ft
Screen Length: 3.95 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.0035 cm/sec
Kz/Kr = 1.
Ss = 7.0E-5 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G63S FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G63S-fh.aqt
Date: 06/02/21 Time: 16:27:35

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G63L
Test Date: 5 May 2021

AQUIFER DATA

Saturated Thickness: 10.8 ft

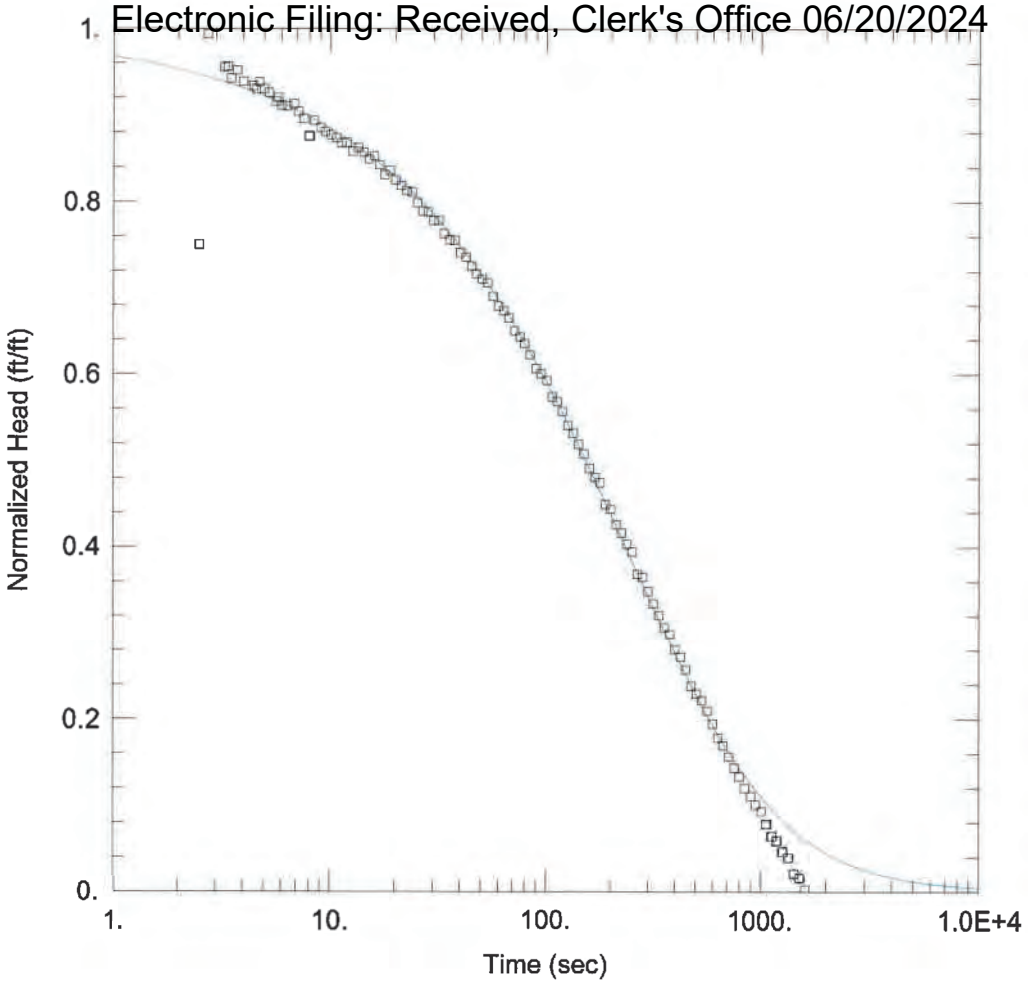
WELL DATA (G63S)

Initial Displacement: 0.975 ft
Total Well Penetration Depth: 13.54 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.84 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model
Kr = 0.0003 cm/sec
Kz/Kr = 1.
Ss = 0.02 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024



G63S RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\G63S-rh.aqt
Date: 06/02/21 Time: 16:27:37

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: G63S
Test Date: 5 Mar 2021

AQUIFER DATA

Saturated Thickness: 10.8 ft

WELL DATA (G63S)

Initial Displacement: 1.15 ft
Total Well Penetration Depth: 13.54 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.84 ft
Screen Length: 4.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.00029 cm/sec
Kz/Kr = 1.
Ss = 0.02 ft^{-1}

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX F
FEMA FLOOD HAZARD MAP

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown in the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or flood plain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or flood plain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

In the State of Illinois, any portion of a stream or watercourse that lies within the **floodway fringe** of a studied (AE) stream may have a state regulated floodway. The FIRM may not depict these state regulated floodways.

Floodways restricted by anthropogenic features such as bridges and culverts are drawn to reflect natural conditions and may not agree with the model computed widths listed in the Floodway Data table in the Flood Insurance Study report.

Multiple **topographic sources** may have been used in the delineation of Special Flood Hazard Areas. See Flood Insurance Study report for details on source resolution and geographic extent.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 15. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services, NOAA, N/NGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey. Digital orthoimagery with a spatial resolution of 0.5 meter ground sample distance were photogrammetrically compiled from aerial photography acquired during the leaf-off period of spring 2005.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The Special Flood Hazard Areas and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

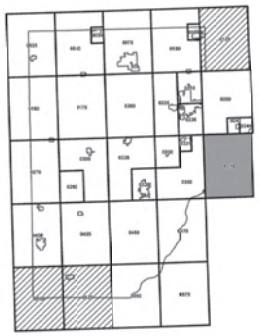
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the Map Service Center (MSC) website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products or the National Flood Insurance Program in general, please visit the **FEMA Map Information eXchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

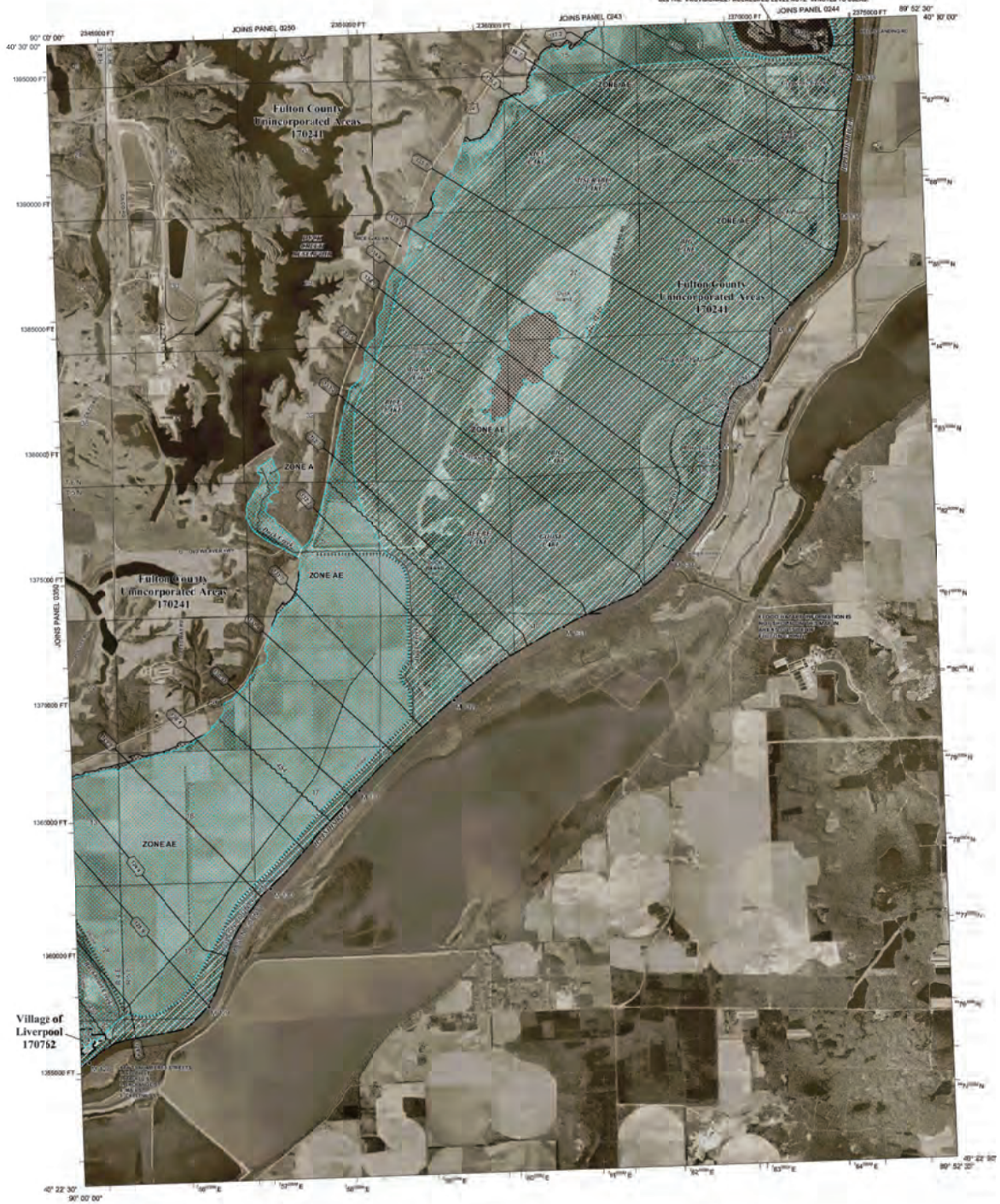
Provisionally Accredited Levee Notes to Users: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations by December 31, 2010. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicate the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA website at http://www.fema.gov/business/nfip/index.shtm.

PANEL INDEX



Panel Not Printed

NOTE: THIS AREA IS SHOWN AS BEING PROTECTED FROM THE 1-PERCENT-ANNUAL-CHANCE OR GREATER FLOOD HAZARD BY A LEVEE SYSTEM THAT HAS BEEN PROVISIONALLY ACCREDITED. OVERTOPPING OR FAILURE OF ANY LEVEE SYSTEM IS POSSIBLE. FOR ADDITIONAL INFORMATION, SEE THE "PROVISIONALLY ACCREDITED LEVEE NOTE" IN NOTES TO USERS.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- **ZONE A** No Base Flood Elevations determined.
- **ZONE AE** Base Flood Elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- **ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- **ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- **ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- **ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- **ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 Base Flood Elevation line and value; elevation in feet*
- (EL. 987) Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- A-A Cross section line
- 23-23 Transect line
- 65° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4000-meter Universal Transverse Mercator grid values, zone 15
- 5000-foot grid ticks: Illinois State Plane West Coordinate System of 1983, 3601 zone (FIPSZONE 1202) Transverse Mercator
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
FEBRUARY 4, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET
300 0 600 1200 METERS

NFIP

PANEL 0375E

FIRM

FLOOD INSURANCE RATE MAP

FULTON COUNTY, ILLINOIS AND INCORPORATED AREAS

PANEL 375 OF 575

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FULTON COUNTY	170241	0375	E
LIVERPOOL, VILLAGE OF	170752	0375	E

Notice to User: The **Map Number** shown below should be used when ordering map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
17057C0375E

EFFECTIVE DATE
FEBRUARY 4, 2011

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

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APPENDIX E

Evaluation of Potential Exceedances of Groundwater Protection Standards

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GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE October 15, 2021 **Project No.** 21454831

TO David Mitchell, Stu Cravens, Vic Modeer
Illinois Power Resources Generating, LLC

CC Brian Hennings - Ramboll

FROM Roberta Russell, Jeffrey Ingram, Pat Behling - Golder

EVALUATION OF POTENTIAL GWPS EXCEEDANCES, GYPSUM MANAGEMENT FACILITY POND, DUCK CREEK POWER PLANT, FULTON COUNTY, ILLINOIS

1.0 INTRODUCTION

Illinois Power Resource Generating, LLC (IPRG) formerly operated the Duck Creek Power Plant (DCPP) located in Fulton County, Illinois. The Gypsum Management Facility Pond (GMFP, Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04) is a surface impoundment used to manage gypsum and related coal combustion residuals (CCRs) at the DCPP. The GMFP is regulated under Part 845 *"Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments"* (State CCR Rule or Part 845) which was promulgated by the Illinois Pollution Control Board (IPCB) on April 21, 2021.

IPRG is currently preparing an Operating Permit application for the GMFP as required under Section 845.230 which requires that known exceedances of groundwater protection standards (GWPS) be documented as a part of the Operating Permit application. In October 2021, Ramboll Americas Engineering Solutions, Inc. (Ramboll) identified potential GWPS exceedances for pH, arsenic, and lead in groundwater samples collected from selected monitoring wells in the vicinity of the GMFP as presented in the Operating Permit application for the GMFP. This Technical Memorandum was developed to further evaluate these potential GWPS exceedances.

1.1 Site Setting, Geology and Hydrogeology

The Duck Creek Power Plant (Site) is an inactive power plant in Fulton County, located in central Illinois, approximately 9 miles southeast of the town of Canton. The GMFP is located north of the power plant (see Figure 1). Agricultural land surrounds the DCPP.

Regionally, the Site is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems (NRT/OBG 2017).

Several large former surface coal mines are present in the vicinity; unlithified materials are present in the excavated strip mine spoils and have been mixed due to the surface mining activities. Mining operations in the area have ceased.

The uppermost bedrock stratum in the area is the Carbondale Formation of the Kewanee Group of the Pennsylvanian System. Bedrock in the area is identified as Pennsylvanian-age shale deposits. Bedrock occurs within approximately 50 feet (ft) of the ground surface in this area.

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The following two unlithified water-bearing units are present beneath the GMF Pond (beginning at the ground surface):

- Loess Zone – Moderate to high permeability silts and clayey silts, including: the Peoria and Roxanna Silt (Loess Units); underlain by the low permeability clayey diamictons of the Berry Clay and upper Radnor Till Members of the Glasford Formation.
- Shallow Sand Unit – Thin to moderately thick (6 to 18 ft), moderate to high permeability, medium-grained sand to silt with intercalated till seams; underlain by till sequences of the lower Radnor Till Member of the Glasford Formation.

The Uppermost Aquifer in the area consists of the Loess and Shallow Sand. These hydraulically connected units are underlain by the lower Radnor Till Member of the Glasford Formation. As shown on Figure 1, groundwater typically flows from northwest to southeast in the Uppermost Aquifer (NRT/OBG 2017).

1.2 Gypsum Management Facility Pond Design and Operation History

The GMFP is a 1,500-foot by 900-foot earthen berm double-lined CCR surface impoundment. Construction of the dual composite liner system and a leak detection system layer was completed in 2007-2009 under a rigorous construction quality assurance program (Hanson, 2009), which is an important determinant of liner system performance. The GMFP consists of the following components from top to bottom:

- Primary Composite Liner
  - SOLMAX 460T-1000 60-mil (0.06-inch thick) textured high-density polyethylene (HDPE) geomembrane
  - 1-foot cushion soil layer (2 feet in selected areas on the side slopes)
- Leak detection layer
  - SKAPS GT-142 4-0z/yd^2 geotextile separator
  - 1-foot granular drainage layer
  - SKAPS FE-110 10-oz/yd^2 geotextile cushion
- Secondary composite liner
  - Solmax 460T-4013 60-mil texture HDPE geomembrane
  - CETCO Bentomat SDN reinforced geosynthetic clay liner (GCL)
  - 3-foot compacted clay layer placed in 8-inch lifts, compacted to at least 95% of the standard Proctor maximum dry density at a moisture content between the standard Proctor optimum moisture content (OMC) and 5% of the wet OMC

The GMFP was used to store gypsum and to clarify gypsum transport water for reuse in the wet scrubber system at the DCPP until the plants retirement in 2019. Gypsum materials are the only waste managed in the GMFP.

2.0 POTENTIAL GWPS EXCEEDANCES REVIEW

As required by Section 845.230 (d)(2)(M), an evaluation of the history of potential GWPS exceedances was competed for the Operating Permit application by Ramboll. Data collected from groundwater samples collected from the GMFP monitoring well network since January 30, 2015, were evaluated and potential exceedances of the GWPSs are summarized below.

- Field pH at monitoring well G52L: A field pH GWPS exceedance was noted in a single sample collected from this well in February 2021. The pH value of 6.4 standard units (s.u.) measured in the sample is outside the Part 845 GWPS pH range of 6.5-9.0 s.u. G52L is located cross-gradient/up-gradient from the GMF pond and the screening interval is completed within the Loess unit.
- Field pH at monitoring well G60L: Field pH GWPS exceedances were noted in this well for each of the nine samples collected from this well from March-July 2021. The average pH for the nine samples was 6.1 s.u., which is outside the Part 845 GWPS pH range of 6.5-9.0 s.u. The well is located down-gradient on the east side of the GMFP and the screening interval is completed within the Loess unit.
- Arsenic at monitoring well P60: A total arsenic GWPS exceedance was noted in a single sample collected from this well in March 2021. The arsenic concentration of 0.02 milligrams per liter (mg/L) measured in the sample slightly exceeds the Part 845 GWPS of 0.01 mg/L. P60 is located down-gradient on the east side of the GMFP and the screening interval is completed within the Loess unit.
- Lead at monitoring well P60: A total lead GWPS exceedance was noted in a single sample collected from this well in March 2021. The lead concentration of 0.036 mg/L measured in the sample slightly exceeds the Part 845 GWPS of 0.015 mg/L. P60 is located down-gradient on the east side of the GMFP and the screening interval is completed within the Loess unit.

3.0 EVIDENCE THAT POTENTIAL GWPS EXCEEDANCES ARE NOT RELATED TO THE GMFP

Groundwater data for samples collected from monitoring wells that exhibited potential GWPS exceedances, background monitoring wells and pore water samples from the GMFP were evaluated. The review of these data indicates that the GWPS exceedances are not related to the GMFP, as described in the lines of evidence (LOE) below:

- **The ionic composition of groundwater collected from G52L, G60L and P60 is similar to groundwater collected from background wells G02S, G50S and G52S.**

A Piper diagram is a graphical technique used to classify and compare different groundwater sources based on their ionic composition in aqueous solution. As shown on the Piper diagram presented as Figure 2, the ionic composition of groundwater samples collected from G52L, G60L and P60 is similar to groundwater samples collected from the background wells – both groups of samples exhibit a calcium-bicarbonate water-type. Pore

and surface water samples collected from the GMFP exhibit a magnesium-chloride water-type, which is distinctly different to the background wells and monitoring wells G52L, G60L and P60. It would be expected that if there were a release from the GMFP, the ionic composition of the monitoring wells would show a mixing pattern towards the pore water ionic composition. However, as shown on Figure 2, the compositions of the monitoring wells are clustered with the background well compositions and distant from the pore and surface water compositions. These data support that the GWPS standard exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP.

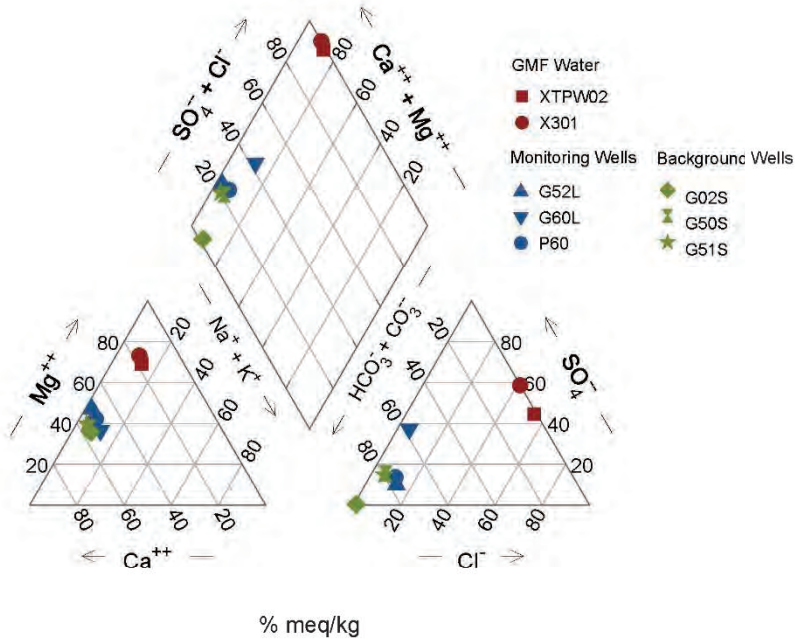


Figure 2: Piper diagram showing water chemistry of GMF Surface and Pore Water, monitoring wells G52L, G60L and P60, and background wells.

- **Concentrations of key GMFP constituents differ significantly in GMFP pore water samples and groundwater samples from monitoring wells G52L, G60L and P60.**

Concentrations of key constituents typically associated with CCR gypsum waste (boron, calcium, chloride, fluoride, sodium and sulfate) differ significantly between pore water/surface water in the GMFP and groundwater samples collected from the monitoring wells (Table 1, Figures 3 and 4). For example, boron, a typical gypsum indicator that is very mobile and non-reactive within a groundwater matrix, is elevated in GMF surface water and pore water samples (29 - 98 mg/L), whereas the monitoring wells G52L, G60L and P60 contain significantly lower concentrations (0.022 – 0.068 mg/L) that are more consistent with background results. Given the geochemical behavior of boron, it would be expected that elevated boron concentrations above background values would be observed in monitoring wells had a release occurred from the GMF pond. Similarly, fluoride and sulfate, other very mobile GMF constituents, would be expected to be observed in monitoring wells above the site GWPS in the event of a release from the GMF Pond. Figures 3 and 4 below and Table 1 show the

differences in concentrations between GMF surface water/pore water and monitoring wells for other key GMF constituents. Table 1 also contains site background and the Part 845 GWPSs. These data support that the GWPS standard exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP.

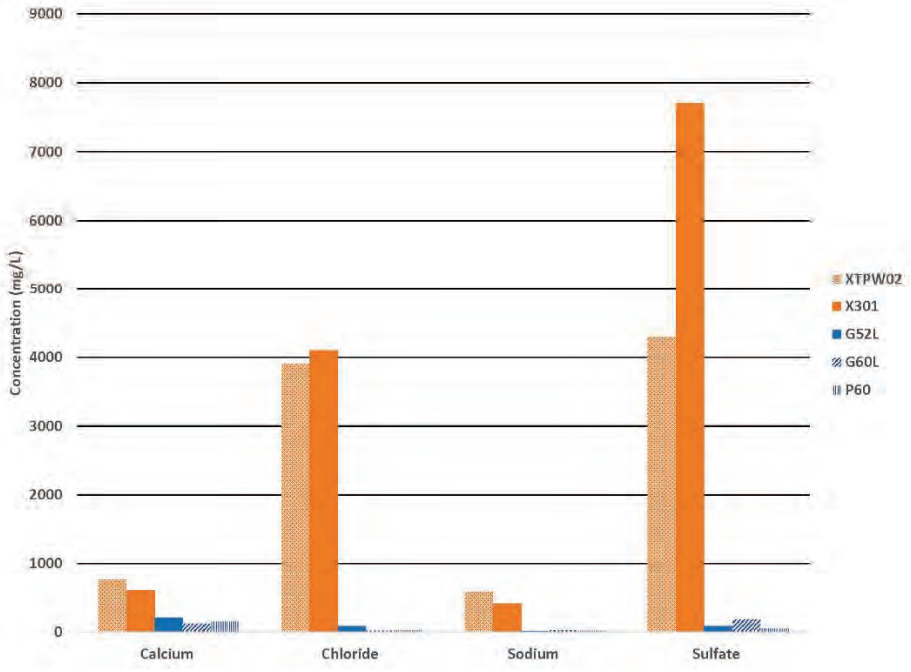


Figure 3: Bar chart showing GMFP constituent concentration comparisons between GMFP Surface and Pore Water and monitoring wells G52L, G60L and P60.

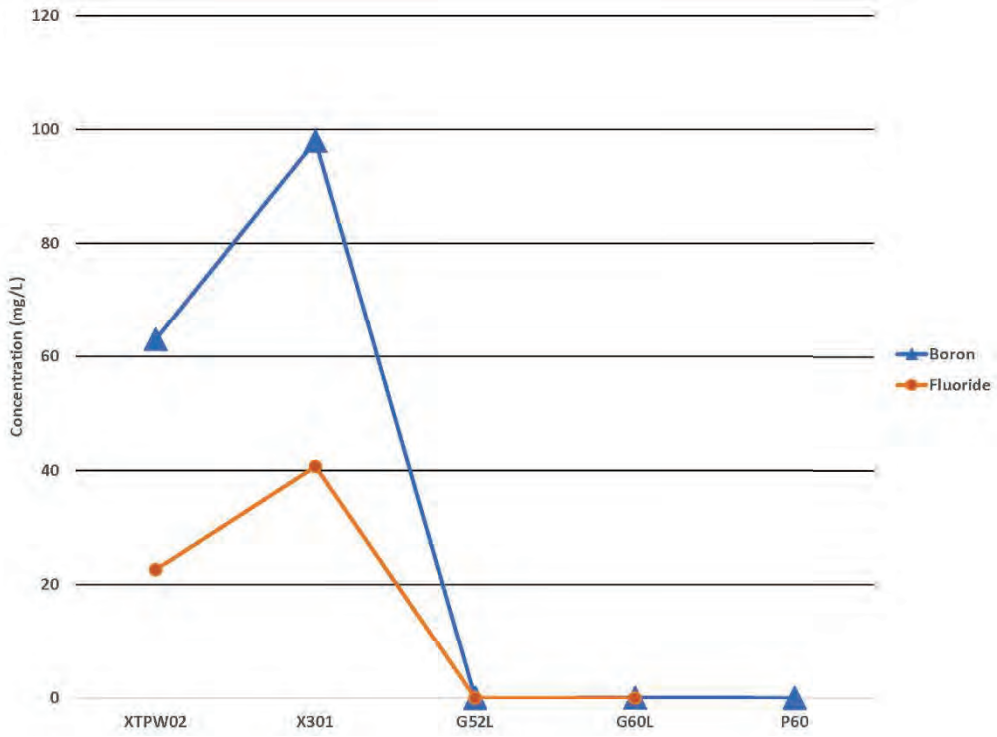


Figure 4: Line chart showing GMFP constituent concentration comparisons between GMFP Surface and Pore Water and monitoring wells G52L, G60L and P60.

- **High turbidity was recorded on the groundwater sampling record for the sample collected from P60.**

The arsenic and lead GWPS exceedances were based on a single sample collected from P60 in March 2021. The groundwater sampling record indicated an unusually high turbidity reading just before sample collection (1620 nephelometric turbidity units (NTU)). According to the sampling record, the sample did not appear to be field filtered, nor was it filtered in the lab. Thus, the arsenic and lead sample concentrations are likely elevated due to the presence of excessive soil and/or colloidal particles in the sample and are not representative of actual groundwater conditions in the vicinity of this well. These circumstances support the conclusion that GWPS standard exceedances of lead and arsenic in P60 are not related to the GMFP.

- **A peat layer ranging in thickness from 1 to 4 feet is present in the immediate vicinity of P60.**

Peat was recorded in the boring log of P60 within the saturated zone (approximately 19.5-20.5 and 24-24.2 feet below ground surface (ft bgs)), but above the screened interval of the well (approximately 29.5-34.5 feet bgs) (Appendix A). Approximately 4 feet of peat was recorded within the saturated zone in a nearby soil boring, B-55 (approximately 13.5-17.5 feet bgs). Given the interconnected nature of the unlithified water-bearing units, it is possible that the peat layer is interacting with the groundwater-bearing unit in the immediate vicinity. Peat is typically associated with low pH and is known to sequester certain metals, including arsenic and lead. In combination with a high turbidity and unfiltered sample, this may be the cause of the slightly elevated arsenic

and lead concentrations in P60. Thus, the GWPS standard exceedances of pH in G60L and the arsenic lead exceedance in P60 may be associated with the peat layer encountered in the immediate vicinity of those wells.

- **Arsenic and lead are not typical CCR indicators and are not present in GMFP pore and surface water above the GWPS.**

Arsenic and lead are not typical coal ash or gypsum indicators (EPRI, 2017). As shown on Table 1, arsenic and lead have been either not detected or detected below the applicable GWPS in GMFP pore and surface water samples. In addition, concentrations in GMFP pore and surface water are lower than concentrations measured in the groundwater sample collected from P60. These data support that GWPS exceedances of lead and arsenic in P60 are not related to the GMFP, as the unit is not a source of elevated arsenic or lead.

- **The GMFP liner was constructed with a dual composite liner system with a leak detection system, has undergone rigorous construction quality assurance and has indicated strong performance**

As discussed in Section 2.0, the GMFP liner was constructed with a primary and secondary liner system with a leak detection layer between the primary and secondary liners. The construction process underwent a detailed construction quality assurance program (Hanson, 2009). The leak detection system has to date shown excellent performance of the primary liner system. Pumps in the leak detection system designed to operate to remove water from the primary liner have only run for a few hours for the lifetime of the facility (beginning in 2009). This indicates that a release from the GMFP has likely not occurred and that the GWPS standard exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP.

4.0 SUMMARY

The evaluation presented in this document demonstrates that the GWPS exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP. The following lines of evidence demonstrate the GWPS exceedances are not related to the GMFP:

- The ionic composition of groundwater collected from G52L, G60L and P60 is similar to groundwater collected from background wells G02S, G50S and G52S and not the pore water/surface water in the GMFP.
- Concentrations of key gypsum constituents differ significantly between GMFP pore water samples and groundwater samples collected from monitoring wells G52L, G60L and P60.
- High turbidity was recorded on the groundwater sampling record for the sample collected from P60, which likely resulted in arsenic and lead concentrations that are not representative of actual groundwater conditions in the vicinity of this well.
- Arsenic and lead are not CCR indicators for this CCR unit and are not present in GMFP pore and surface water above their corresponding GWPS.
- The GMFP liner was constructed with a dual composite liner system with a leak detection system, has undergone rigorous construction quality assurance and has indicated strong performance.

- Naturally occurring peat is present within the saturated zone in the immediate vicinity of P60 and G60L and may be causing naturally occurring lower pH in G60L and slightly elevated arsenic and lead concentrations in P60, particularly in a high-turbidity, unfiltered groundwater sample.

5.0 REFERENCES

Electric Power Research Institute (EPRI). 2017, Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites, Report 3002010920, October 2017

Hanson (Hanson) Professional Services Inc. 2009 Acceptance Report, Gypsum Stack, Gypsum Management Facility, AERG Duck Creek Power Generating Station. December.

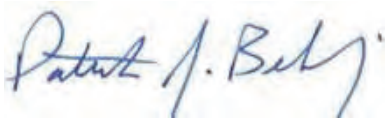
Natural Resource Technology, an OBG Company (NRT/OBG), October 17, 2017b. Hydrogeologic Monitoring Plan. Duck Creek GMF Pond – CCR Unit ID 203, Duck Creek Landfill – CCR Unit ID 204. Duck Creek Power Station, Canton, Illinois. Illinois Power Resources Generating, LLC.

6.0 CLOSING

Golder appreciates the opportunity to serve as your consultant on this project. If you have any questions concerning this Technical Memorandum or need additional information, please contact the undersigned.

Golder Associates Inc.





Roberta Russell
Senior Geologist
RR/JSI/PJB

Pat Behling
Principal, Practice Leader

Attachments: Table 1 – GMF Pond Surface Water, Pore Water, and Groundwater Monitoring Data
Figure 1 – Gypsum Management Facility Pond Well Locations and Typical Groundwater Flow Direction
Appendix A – Boring Logs

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Table

Table 1

GMF Pond Surface Water, Pore Water and Groundwater Monitoring Data

Duck Creek Power Plant

Canton, Illinois

Sampling Information		Potential Exceedance Constituents			Key Flue Gas Desulfurization Material (Gypsum) Constituents					
Well ID	Sampling Date	pH	Arsenic (Total)	Lead (Total)	Boron (Total)	Calcium (Total)	Chloride (Total)	Fluoride (Total)	Sodium (Total)	Sulfate (Total)
Units		SU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Part 845 Groundwater Protection Standards										
Site Background	NA	6.6 - 7.4	0.0092	0.015	0.21	NA	17	0.5	NA	55
Part 845 Standard	NA	6.5 - 9.0	0.01	0.0075	2	NA	200	4	NA	400
Part 845 GWPS	NA	6.5 - 9.0	0.01	0.015	2	NA	200	4	NA	400
GMF Pond Surface Water and Pore Water Samples										
XTPW02	6/23/2021	6.55	0.0026	ND < 0.001	63	750	3,900	22.6	570	4,300
X301	2/24/2021	5.50	NS	NS	29	180	1,200	14.4	110	2,300
X301	4/14/2021	6.70	0.0031	0.0013	97	580	3,700	35.4	390	7,300
X301	4/29/2021	6.60	0.0025	ND < 0.001	88	560	3,600	36.9	400	7,200
X301	5/12/2021	6.48	0.0024	ND < 0.001	84	560	4,100	40.7	410	7,700
X301	6/1/2021	6.64	0.0029	ND < 0.001	98	550	3,700	36.8	400	7,300
X301	7/26/2021	6.22	0.0018	ND < 0.001	85	600	3,600	38.1	370	6,900
Monitoring Wells										
G52L*	2/19/2021	6.39	ND < 0.001	ND < 0.001	0.037	210	30	ND < 0.25	13	87
G60L	4/14/2021	6.20	ND < 0.001	ND < 0.001	0.034	110	19	ND < 0.25	29	ND < 250
G60L	4/29/2021	6.10	ND < 0.001	ND < 0.001	0.029	120	19	ND < 0.25	31	160
G60L	5/13/2021	6.19	ND < 0.001	ND < 0.001	0.025	110	19	ND < 0.25	30	180
G60L	6/1/2021	6.26	ND < 0.001	ND < 0.001	0.029	110	20	ND < 0.25	30	170
G60L	6/15/2021	6.18	ND < 0.001	ND < 0.001	0.029	110	16	ND < 0.25	32	180
G60L	6/21/2021	6.16	ND < 0.001	ND < 0.001	0.068	110	18	ND < 0.25	29	180
G60L	7/12/2021	5.98	ND < 0.001	ND < 0.001	0.027	110	18	ND < 0.25	30	180
G60L	7/28/2021	6.22	ND < 0.001	ND < 0.001	0.022	110	15	ND < 0.25	29	160
P60	3/24/2021	6.60	0.02	0.036	0.056	150	32	NS	22	53

Notes:

1) GMF - Gypsum Management Facility, SU - standard unit, mg/L - milligrams per liter, ND - non-detect, NS - not sampled.
2) X301 samples are collected from a riser pipe from the ring drain beneath the pond.
3) XTPW02 results represent a porewater sample.
4) * - G52L data displays dissolved values.
5) Site background values based on Ramboll Determination of Potential Exceedances Table.
6) GWPS - Groundwater Protection Standard.
7) NA - Not Available.

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Checked by: GM
Reviewed by: PJB

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Figure

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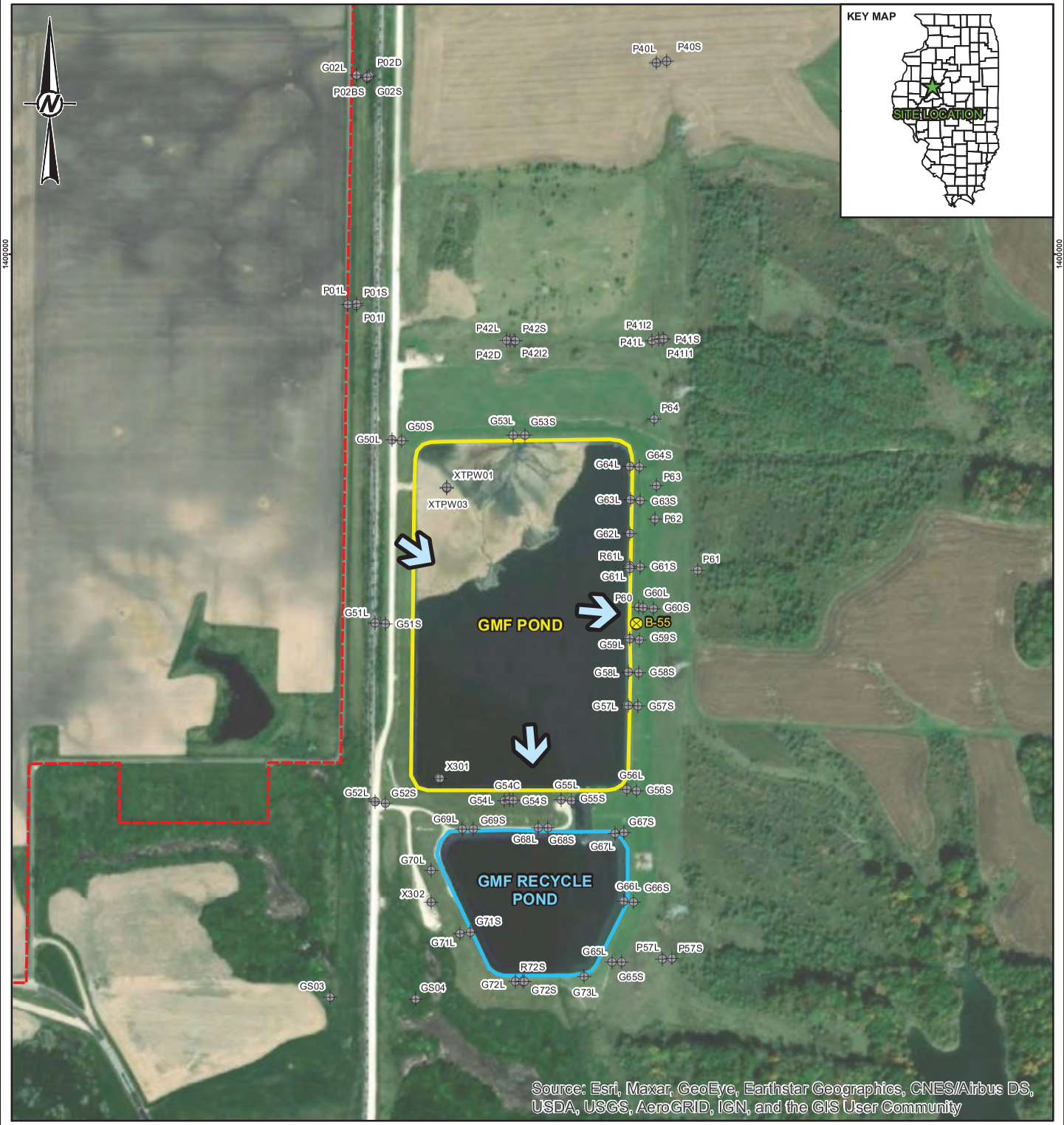

LEGEND

- WELL LOCATION
- SOIL BORING LOCATION
- APPROXIMATE PROPERTY BOUNDARY
- TYPICAL GROUNDWATER FLOW DIRECTION

0 250 500 1,000 Feet

NOTE(S)

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GMF - GYPSUM MANAGEMENT FACILITY.

REFERENCE(S)

1. RAMBOLL 2020. ILLINOIS ADMINISTRATIVE CODE PART 845 DATA GAP ANALYSIS AND WORK PLAN, DUCK CREEK GYPSUM MANAGEMENT FACILITY AND RECYCLE POND - CCR UNIT 203 AND 206.

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC.
DUCK CREEK POWER PLANT

PROJECT
MONITORED NATURAL ATTENUATION EVALUATION

TITLE
GYPSUM MANAGEMENT FACILITY POND WELL LOCATIONS AND TYPICAL GROUND WATER FLOW DIRECTION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-14
DESIGNED	JSI
PREPARED	ETF
REVIEWED	BTT
APPROVED	PJB

PROJECT NO.	PHASE	REV.	FIGURE
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Appendix A
Boring Logs

FIELD BORING LOG

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HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: **Start:** 4/1/407
Finish: 4/4/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler

FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-55
Well ID: hole abandoned
Surface Elev: 611.07 ft. MSL
Completion: 20.00 ft. BGS
Station: 15,438.7N
987.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark brown, clayey TOPSOIL (OL)			
1A	15/18 *83%*	ss	*2-3* *3* N=6	29		1.75 *B*	2	Brown-gray, silty CLAY, trace sand (CL)		610	
2A	16/18 *89%*	ss	*3-4* *5* N=9	22		0.78 *BSh*	4			608	
3A	16/18 *89%*	ss	*3-4* *4* N=8	26			6	Brown-gray, clayey SILT, trace sand (ML)		606	
4A	15/18 *83%*	ss	*3-4* *5* N=9	26		1.94 *BSh*	8			604	
5A	18/18 *100%*	ss	*2-3* *4* N=7	33		1.32 *B*	10	Gray-brown, clayey SILT, trace sand (ML)		602	
6A	18/18 *100%*	ss	*3-4* *5* N=9	20		1.16 *BSh*	12			600	
							▼			598	
							14	Black, PEAT (PT)		596	
							16			594	
							18	Gray, silty CLAY, trace sand and gravel (CL)		592	
							20	**End of Boring = 20.0 ft. BGS**			

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	14/24 58%	SS	2-3 3-4 N=6				0			620	
2A	18/24 75%	SS	3-6 8-11 N=14	17.5			2			618	
3A	15/24 63%	SS	3-4 6-7 N=10	19.6			4	FILL - Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		616	
4A	20/24 83%	SS	6-8 11-14 N=19	18.5			6			614	
5A	22/24 92%	SS	3-5 6-7 N=11	26.8			8			612	
6A	21/24 88%	SS	2-4 5-5 N=9	23.8			10	Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.		610	
7A	20/24 83%	SS	4-4 6-7 N=10	22.8			12	Yellowish brown (10YR5/8) with 30% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		608	
8A	21/24 88%	SS	5-6 7-7 N=13	22.1			14			606	
9A	21/24 88%	SS	5-5 6-6 N=11	21.0			16	Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, moist, medium, SILT with few clay and trace sand.		604	
10A	24/24 100%	SS	2-3 4-7 N=7	28.1			18	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, medium, SILT with few clay and trace sand.		602	
10B				61.7			20	Dark yellowish brown (10YR3/4), moist, medium, SILT with few clay and trace sand, trace organics. Dark brown (10YR3/3), moist, medium, PEAT.			

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark brown (10YR3/3), moist, medium, PEAT. *[Continued from previous page]*		600	
11A	20/24 *83%*	SS	*2-5* *6-7* N=11	31.4			22	Very dark gray (10YR3/1), moist, medium, SILT with some clay and trace sand, trace organics.		598	
12A	24/24 *100%*	SS	*9-8* *7-6* N=15	33.7			24	Very dark gray (10YR3/1), wet, medium, SILT with some clay and trace sand, trace organics.		596	
								Dark brown (10YR3/3), moist, medium, PEAT.			
13A	20/24 *83%*	SS	*4-3* *4-4* N=7	23.0			26	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand and gravel.		594	
14A	22/24 *92%*	SS	*4-5* *6-6* N=11	20.6			28			592	
15A	24/24 *100%*	SS	*3-3* *4-5* N=7	17.5			30	Greenish gray (5G6/1), moist, medium, CLAY with some silt and trace sand and gravel.		590	
16A	24/24 *100%*	SS	*1-3* *3-3* N=6	20.2			32			588	
17A	24/24 *100%*	SS	*5-6* *6-7* N=12	15.9			34	Greenish gray (5G6/1), wet, soft, SILT with few clay, little sand, and trace gravel.		586	
	0/7 *0%*	BD						**End of Boring = 34.62 ft bgs**			

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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APPENDIX F

Closure Priority Categorization

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Phil Morris
Illinois Power Resources Generating
Luminant
1500 Eastport Plaza Drive
Collinsville, IL 62234

May 19, 2021

Mr. Darin LeCrone, P.E.
Manager, Industrial Unit
Bureau of Water, Division of Water Pollution Control, Permits Section
Illinois Environmental Protection Agency
1021 North Grand Avenue, East
Springfield, IL 62794-9276

Re: CCR Surface Impoundment Category Designation and Justification for Illinois Power Resources Generating, LLC

Dear Mr. LeCrone:

Pursuant to 35 I.A.C. 845.700(c), Illinois Power Resources Generating, LLC submits the information necessary to categorize the CCR surface impoundments located at the Edwards Power Plant and the now retired Duck Creek Power Plant. The following parameters were used in assessing and justifying each assigned category.

- Category 1 – *Impacts to existing potable water supply well or impacts to groundwater quality within the setback of an existing potable water supply well.*
    - This review includes an assessment of potable water wells within 2,500 feet of CCR surface impoundments to determine whether any potential impacts are occurring within the setback zone of any community water supply well established under the Illinois Groundwater Protection Act.
    - This information was developed during the Part 845 rulemaking and is summarized in Attachment 1, Table 2: Impacts to Potable Water Supply.
- Category 2 – *Imminent threat to human health or the environment or have been designated by IEPA under (g)(5)*
    - The surface impoundments at Edwards and Duck Creek Power Plants do not pose an imminent threat to human health or the environment. There are no known conditions at or around the facility where someone or something may be exposed to contaminant concentrations reasonably expected to cause harm
- Category 3 – *Located in areas of environmental justice ("EJ") concern*
    - EJ areas were evaluated using the EJ mapping link from IEPA's webpage located at https://www2.illinois.gov/epa/topics/environmental-justice. Per the IEPA mapping tool, the EJ Status thresholds were determined as twice the state averages for Minority and Low Income consistent with 35 IAC 845.700(g)(6).
    - An EJ map denoting the facilities with impoundments is located in Attachment 2.

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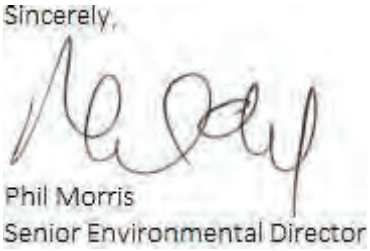
- Category 4-7
    - Category 4 - Inactive CCR surface impoundments that have an exceedance of the groundwater protection standards in Section 845.600
    - Category 5 - Existing CCR surface impoundments that have exceedances of the groundwater protection standards in Section 845.600
    - Category 6 - Inactive CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600.
    - Category 7 – Existing CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600

Based on the information above, category designations have been assigned. The category designations for each CCR impoundment are shown in Attachment 1, Table 1: Category Designations.

If you have any questions regarding this submittal, please contact Phil Morris at 618-343-7794 or phil.morris@vistracorp.com.

Sincerely,



Phil Morris
Senior Environmental Director

Attachments

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Attachment 1

Table 1: Category Designation

Facility	Pond Description	Classifications	Potable Water Supply Impacts (Category 1)	Human Health or Environment Threat (Category 2)	Located within Environmental Justice Areas[1] (Category 3)	Standards Exceedances[2] (Categories 4,5,6,7)	Impoundment Category 845.700(g)
Edwards	Ash Pond 1	Existing	No	No	No	Yes	5
Duck Creek	Bottom Ash Basin	Inactive	No	No	Yes	NA[3]	3
	GMF Pond	Inactive	No	No	Yes	NA[3]	3
	GMF Recycle Pond	Inactive	No	No	Yes	NA[3]	3

[1] See Attachment 2 Environmental Justice Area Map

[2] Ground water analyses for purposes of categories 4-7, assumptions have been made based on current groundwater data. However, since sampling and analysis is ongoing and subject to IEPA review and approval, IPGC reserves the right to update its category designations for Categories 4-7.

[3] NA for this determination since the CCR surface impoundment was assign a highest priority category

Table 2: Impacts to Potable Water Supply

Site Name	Private and Semi-Private Wells	Non-Community Water Supply (CWS) Wells	Non-CWS Surface Water Intakes	Community Water Supply Wells	CWS Surface Water Intakes
Edwards	**Present, but not at risk** Seven (7) water wells were identified and one (or possibly two) are located potentially downgradient of the site. Based on Ramboll's review of groundwater data, these wells are unlikely to be impacted by coal ash constituents.	**Present, but not at risk** One non-CWS well was identified; however, it is unlikely to be at risk because of its hydrogeologic location relative to the power plant.	Absent	Absent	Absent
Duck Creek	**Present, but not at risk** Three (3) water wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant and/or they are abandoned. None of the off-site wells are located in a downgradient direction.	Absent	Absent	Absent	Absent

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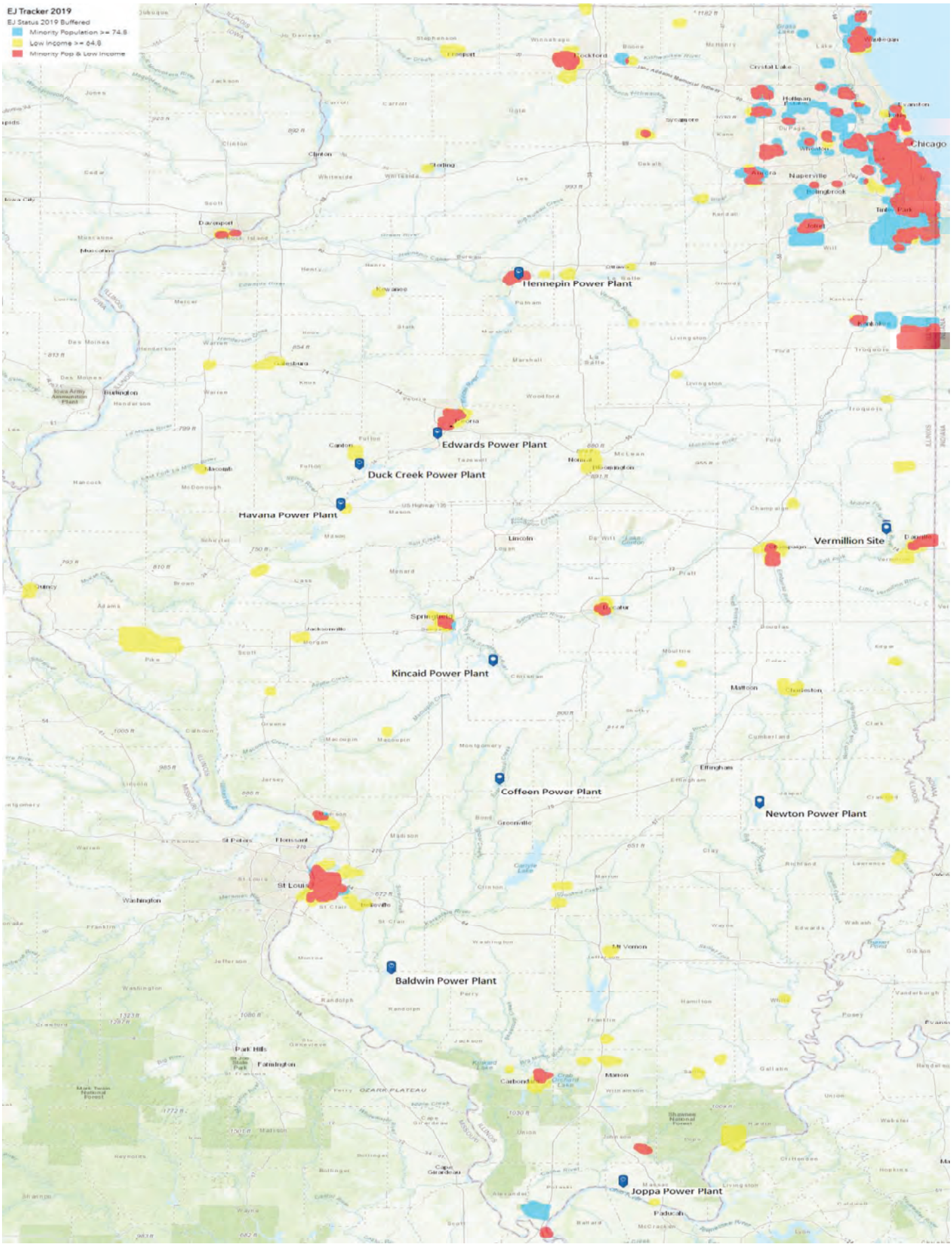
Attachment 2: EJ Mapping Denoting Facilities with Impoundments



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APPENDIX G

Groundwater Modeling

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Intended for
Illinois Power Resources Generating, LLC

Date
January 28, 2022

Project No.
1940101010 - 002

GROUNDWATER MODELING REPORT

GYPSUM MANAGEMENT FACILITY POND

DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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GROUNDWATER MODELING REPORT
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND

Project Name	**Duck Creek Power Plant Gypsum Management Facility Pond**
Project No.	**1940101010 - 002**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Groundwater Modeling Report**
Revision	**Final**
Date	**January 28, 2022**

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APPENDICES

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ACRONYMS AND ABBREVIATIONS

§	Section
±	plus or minus
35 I.A.C.	Title 35 of the Illinois Administrative Code
bgs	below ground surface
CBR	closure by removal
CCR	coal combustion residuals
CIP	closure in place
cm/s	centimeters per second
CSM	conceptual site model
DCPP	Duck Creek Power Plant
$ft^2/d/ft$	square feet per day per foot
ft^3/d	cubic feet per day
ft/d	feet per day
GMF	Gypsum Management Facility
GMP	Groundwater Monitoring Plan
GMR	Groundwater Modeling Report
GWL	groundwater elevation
GWPS	groundwater protection standard
Hanson	Hanson Professional Services, Inc.
HCR	Hydrogeologic Site Characterization Report
HDPE	high-density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
HUC	Hydrologic Unit Code
ID	identification
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
K	hydraulic conductivity
K_{eff}	effective hydraulic conductivity
mil	Millimeter
msl	above mean sea level
NA	not applicable
NID	National Inventory of Dams
No.	Number
NRT/OBG	Natural Resource Technology, an OBG Company
oz/yd^2	ounce per square yard
Part 845	Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: 35 I.A.C. § 845
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc
RMSE	root mean squared error
RQD	rock quality designation
SI	surface impoundment

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std	standard deviation
TVD	total-variation-diminishing
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

This Groundwater Modeling Report (GMR) has been prepared to show how proposed closure solutions for the Gypsum Management Facility (GMF) Pond will maintain compliance with the applicable groundwater standards at the Duck Creek Power Plant (DCPP), Fulton County, Illinois. This report integrates existing site data and information with the latest hydrogeology and groundwater quality data to generate a conceptual and numerical model of the GMF Pond. The conceptual site model (CSM) includes hydrogeologic and groundwater quality data specific to the GMF Pond, which has been collected between 2015 and 2021.

The GMF Pond (Vistra identification [ID] number [No.] 203, Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04, and National Inventory of Dams [NID] No. IL50573) is located at the DCPP southwest of Canton, Illinois (**Figure 1-1**). The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP. Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development.

The GMF Pond is a 1,500-foot by 900-foot earthen berm double-lined coal combustion residual (CCR) surface impoundment (SI) located north of the former power plant. The GMF Pond decant water discharges to the lined GMF Recycle Pond. In addition to the CCR within the lined GMF Pond, there are five layers of unlithified material present above the Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). These materials have been categorized into three hydrostratigraphic units presented below in descending order:

- **Uppermost Aquifer:** this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sands. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (Natural Resource Technology, an OBG Company [NRT/OBG], 2017a).
- **Lower Radnor Till/Lower Confining Unit:** Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick.
- **Bedrock Confining Unit:** The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet.

While the primary migration pathway is the shallow sand of the uppermost aquifer, the groundwater within the overlying Peoria/Roxanna Loess has the potential to be impacted and is considered a potential migration pathway (PMP).

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow in the sands is generally in a northwest to southeast direction. Seasonal variation of groundwater levels at the GMF Pond are present and may fluctuate approximately 1 to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond associated with the elevation changes. Groundwater flows toward the Duck Creek Cooling Pond located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Cooling Pond is estimated to range from 562.5 to 565 feet North American

Vertical Datum of 1988 (NAVD88), which is approximately 20 feet lower than water elevations at the GMF Pond.

The CSM for modeling the GMF Pond is as follows:

- All hydrostratigraphic layers are laterally continuous across the area. The flat to gently rolling uplands are dissected by deeply incised streams (into the materials of the uppermost aquifer and lower confining unit) that are tributaries to major river systems in areas that have not been disturbed by strip mining activity.
- The GMF Pond is constructed such that the double liner system is in direct contact with the lower confining unit or backfill of similar properties (i.e., removal of the uppermost aquifer sand below the footprint of the GMF Pond).
- Groundwater migrates vertically through the upper portions of the uppermost aquifer and horizontally within the sands above the lower confining unit to the southeast towards the Duck Creek Cooling Pond. The stage in Duck Creek Cooling Pond is managed with minimal (less than 3 feet) variability throughout the year.
- Vertical gradients measured between the bedrock and uppermost aquifer are generally downward near the GMF Pond, indicating that it is a recharge area.

Groundwater quality parameters were monitored in the shallow sands and the PMP monitoring wells at the GMF Pond as part of the groundwater quality investigations performed between 2015 and 2021. The History of Potential Exceedances attached to the Operating Permit Application summarizes all potential groundwater exceedances following the proposed statistical analysis plan. The following potential exceedances were identified:

- Arsenic and lead – determined from a single sample from well P60 screened in the loess (PMP).
- pH – values less than the lower limit were determined in wells G52L and G60L which are also screened in the loess (PMP).

Multiple lines of evidence that these limited potential groundwater protection standard (GWPS) exceedances are not related to the GMF Pond is provided in the technical memorandum attached to this report, *Evaluation of potential GWPS Exceedances* (Golder, 2021). Based on statistical analysis and evaluation of subsequent potential exceedances it has been determined there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF Pond.

All available hydrological information were used to construct a conceptual model and numerical model of the GMF Pond. A steady state, 5-layer numerical model was constructed to characterize the long-term groundwater flow conditions at the site. Calibration of the model focused on simulating mean groundwater elevations for 59 wells at the site by modifying hydraulic parameters for the different hydrostratigraphic units, alongside drain and general head boundary conductance. The calibrated model represents a reasonable match to the observed data given the simplicity of the model. Particle tracking was used both for the closure scenario and sensitivity analysis to provide a quantitative estimate of the distance a potential contaminant from the GMF Pond may travel in 100 years.

Particle tracking for the CIP scenario for a 100-year period indicates that contaminants will not migrate beyond the liner system, maintaining compliance with the applicable groundwater standards post closure.

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: 35 I.A.C. § 845 (Part 845) (IEPA, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this GMR on behalf of the DCPP (**Figure 1-1**), operated by Illinois Power Resources Generating, LLC (IPRG). This report will apply specifically to the CCR Unit referred to as the GMF Pond. However, information gathered to evaluate other CCR units in the vicinity regarding geology, hydrogeology, and groundwater quality is included, where appropriate.

1.2 Previous Groundwater Reports

Numerous hydrogeologic investigations have been performed at the DCPP. The information presented in this GMR includes data collected as part of a 2021 field investigation and previous investigations summarized and presented in the Hydrogeologic Site Characterization Report (HCR) (Ramboll, 2021a) which was provided as an attachment to the Initial Operating Permit application required by 35 I.A.C. § 845.230.

1.3 Site Location and Background

The DCPP is located in Fulton County, Illinois and approximately 6 miles southeast of the town of Canton. The GMF Pond is located north of the power plant in Section 18 of Township 6 North, Range 5 East (**Figure 1-1**). The GMF Recycle Pond is located just south of the GMF Pond (**Figure 1-2**). The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. The Landfill is located due north of the GMF Pond and the closed units, Ash Pond No. 1 and Ash Pond No. 2, are located south of the GMF Recycle Pond. Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP (**Figure 1-1**). Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems in areas that have not been disturbed by strip mining activity.

1.4 Site History and CCR Units

Surface preparation for the GMF Pond began in 2007 and construction took place from 2008 to 2009. The GMF Recycle Pond was constructed at the same time.

The GMF Pond, also referred to as the gypsum stack/management system, operates under an IEPA permit (#2017-E0-62640) issued in December 2017. It consists of a 1,500-foot by 900-foot earthen berm with 3.5:1 side slopes, a maximum elevation of 620 feet, a double geomembrane liner consisting of a 60-millimeter (mil) high-density polyethylene (HDPE) geomembrane liner, 12-inch clay cushion, 4 ounce per square yard (oz/yd^2) non-woven geotextile filter fabric, 12-inch highly permeable granular drainage (sand), 10 oz/yd^2 non-woven geotextile filter fabric, 60-mil HDPE geomembrane liner, reinforced bentonite mat, 36-inch compacted clay, all installed over in-situ foundation soil, and all pipes, pumps, and appurtenances necessary for the storage of approximately 3.6 million tons of gypsum at a maximum elevation of 715 feet with discharge to the GMF Recycle Pond.

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During construction, shallow sand was encountered and completely removed from underneath the northeast corner and southwest corner of the GMF Pond, putting the liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains. The GMF Pond decant water discharges to the GMF Recycle Pond, which has a capacity of 32.6 million gallons. The GMF Recycle Pond is lined with a 60-mil HDPE geomembrane liner, reinforced bentonite mat and 36 inches of compacted clay (Ramboll, 2021a).

2. SITE GEOLOGY AND HYDROGEOLOGY

2.1 Stratigraphy

The hydrogeology of the GMF Pond is described in detail in the Hydrological Characterization Report (Ramboll, 2021a). A short summary is provided below.

The unlithified stratigraphy within and immediately surrounding the GMF Pond consists of the following in descending order: fill material and CCR; silt and clayey silt loess (Peoria/Roxanna Loess); weathered till (upper Radnor Till); shallow, medium-grained sand to silt zone within the Radnor Till; and till (lower Radnor Till). The unlithified units overlay Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation).

CCR (gypsum) is present within the GMF Pond at a maximum thickness of approximately 22 feet, as estimated from topography and the elevation of the base of the liner from available construction details (AECOM, 2016). The range of gypsum thickness is estimated from less than 1 to 22 feet. The thickest areas of gypsum are to the north and west within the GMF Pond and thin toward the south end of the GMF Pond. The base of the liner rests on top of the lower Radnor Till.

The Wisconsinan Stage Peoria/Roxanna Loess extends from beneath the topsoil developed in the loess to depths ranging from 11 to 21 feet. The loess consists predominantly of silt and clayey silt with minor amounts of sand. The loess exhibits iron staining, concretions, and some fracturing. The Loess Unit is saturated below depths varying from approximately 3.5 to 11 feet.

The loess is generally underlain by a relatively thin till sequence consisting of the Berry Clay (where present) and the Illinoian Stage upper Radnor Till. The till sequence ranges in thickness from 9 to 21 feet in the area of the GMF Pond. This shallow till is generally weathered and exhibits signs of oxidation and fracturing. The till is primarily clayey silt with minor amounts of sand and gravel.

The shallow sand zone is laterally extensive within the Radnor Till across the site and varies in thickness from less than 1 to 18 feet near the GMF Pond; the top of the shallow sand zone is generally located at an elevation of 570 to 590 feet msl. The shallow sand zone exhibits lateral facies changes across the site and varies from a medium-grained sand to a silt and often contains intercalated till seams. The shallow sand zone is saturated.

Till sequences underlying the shallow sand zone consist of clay, silt, and sand of the Illinoian Stage lower Radnor Till. The till ranges in thickness from 42 to 58 feet. In some areas of the site, including the area near the GMF Pond, the till sequences typically extend from the base of the shallow sand to the bedrock surface. In other areas of the site, the till sequences extend to intermediate or deep sands. The till sequences are typically high in silt content with varying amounts of clay, sand, and gravel, and are often calcareous.

Pennsylvanian bedrock was encountered at greatly varying depths across the site. Bedrock depths ranged from a minimum of 52 feet to a maximum of 108 feet below ground surface (bgs). The bedrock shows little compositional variation across the site and consists primarily of shaley siltstone and silty shale. The shale bedrock unit is typically weathered near the surface, has low hydraulic conductivity, and underlies the glacial till sequences. These units often contain thin dolomite ledges and nodules and some fractures.

2.2 Hydrogeology

Three distinct water-bearing layers have been identified at the site based on stratigraphic relationships and common hydrogeologic characteristics, which are summarized below:

- **The Uppermost Aquifer**: This unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and the shallow sands described in detail in **Section 2.5.1**. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (NRT/OBG, 2017a). The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally located at an elevation of 570 to 590 feet above mean sea level (msl). The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the northeast corner and southwest corner of the pond), putting the base of liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.
- **Lower Radnor Till/Lower Confining Unit**: Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick. Previous hydrogeologic studies indicate discontinuous sand lenses observed within the till are not hydraulically connected to the shallow sand unit (NRT/OBG, 2017a).
- **Bedrock Confining Unit**: The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation are estimated to have a thickness of approximately 300 to 400 feet.

2.2.1 Groundwater Flow

Groundwater flow around the GMF Pond is generally in a southeast direction. The Peoria/Roxanna Loess (PMP) and shallow sands of the uppermost aquifer are hydraulically connected. The groundwater flow in the Peoria/Roxanna Loess is expected to be primarily vertical, with the majority of the horizontal migration expected to occur within the shallow sand unit. Groundwater flow across the GMF Pond within the uppermost aquifer (well locations adjacent to the pond are shown in **Figure 2-1**) is consistently in a southeast direction toward the Duck Creek Cooling Pond (as shown by groundwater elevation contours from April 14, 2021, **Figure 2-2**). Groundwater elevations of the uppermost aquifer vary seasonally although flow directions are generally consistently downward (Ramboll, 2021a). Surface water elevations within the GMF Pond are higher than the groundwater. The elevation difference between the phreatic surface and groundwater elevations, in addition to no observations of radial flow, provide evidence that the GMF Pond does not impact groundwater flow directions via recharge to groundwater. Given the low permeability of the liner system, it is more likely that the GMF Pond is a barrier to groundwater flow within the uppermost aquifer, deflecting flow from upgradient areas around the perimeter of the pond toward the downgradient areas.

2.2.2 Hydraulic Properties

Field estimates of the hydraulic properties of the uppermost aquifer (including both the loess and the shallow sand zones) indicated hydraulic conductivities from 3.0×10^{-5} to 3.9×10^{-3} centimeters per second (cm/s) (equivalent to 0.085 to 11.1 feet per day [ft/d]) with a geometric mean of 3.6×10^{-4} cm/s (1.02 ft/d), based on field tests conducted on 12 wells (5 wells were screened in the loess and 7 wells were screened in the sand) (Ramboll, 2021a).

Hydraulic properties for the Loess ranged from 3.0 x 10^{-5} to 2.3 x 10^{-3} cm/s (0.085 to 6.5 ft/d) with a geometric mean of 2.2 x 10^{-4} cm/s (0.62 ft/d). Shallow sand wells ranged from 6.5 x 10^{-5} to 3.9 x 10^{-3} cm/s (0.18 to 11.0 ft/d) with a geometric mean of 4.9 x 10^{-4} cm/s (1.4 ft/d).

Additional laboratory analysis of seven samples from the loess, upper Radnor Till and shallow sand provided vertical hydraulic conductivities ranging from 7.1 x 10^{-8} to 2.3 x 10^{-6} cm/s (0.0002 to 0.0065 ft/d).

Laboratory estimates for the Lower Radnor Till based on two samples indicated a vertical hydraulic conductivity ranging from 4.1 x 10^{-8} to 5.4 x 10^{-6} cm/s (0.00012 to 0.015 ft/d).

Results of field hydraulic conductivity tests conducted in 2021 in the bedrock confining unit by Hanson Professional Services, Inc. (Hanson) at monitoring well G54C ranged from 1.4 x 10^{-4} to 1.6 x10^{-4} cm/s, with a geometric mean of 1.5 x 10^{-4} cm/s. This is high in comparison to the horizontal hydraulic conductivity range of 1.3 x 10^{-6} cm/s to 1.3 x 10^{-9} cm/s, established by Hanson in 2015, which used pressure testing on borehole OM32. The higher values observed at G54C are attributed to the highly weathered nature of the bedrock in the screen interval, which is supported by the low rock quality designation (RQD) N values ranging from 14 to 22 (lower numbers indicating lower percentage of intact rock core recovered).

2.2.3 Groundwater Elevation Data

There are 59 wells located around the GMF Pond, with most wells located around the perimeter of the GMF Pond and the GMF RP. In most of these wells, water level measurement are available from 2004 to 2021 (**Table 2-1**). The data are summarized in **Table 2-2**. The observed range in groundwater elevation (GWL) within the data set is 41.6 feet. For wells with more than 1 reading, the mean variation in GWL within each well is 13.9 feet (mean GWL variation), with an observed minimum and maximum variation of 4.8 and 28.4 feet, respectively.

2.2.4 Mining Activity

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) coal seam. Mining operations in the area have ceased (NRT/OBG, 2017a). Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) coal unit at some portions of the site. Previous investigations completed outside of the GMF Pond at the site also indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 feet to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts, and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to several former large surface mining areas (**Figure 2-3**).

3. GROUNDWATER QUALITY

3.1 Groundwater Classification

Per 35 I.A.C. § 620.210, groundwater within the uppermost aquifer at the GMF Pond meets the definition of a Class I – Potable Resource Groundwater based on the following criteria:

- Groundwater in the uppermost aquifer extends 10 feet or more below the land surface.
- Hydraulic conductivity exceeds the 1 x 10^{-4} cm/s criterion.

Field hydraulic conductivity tests performed on the unlithified geologic materials that include loess and shallow sand at the GMF Pond had geometric mean hydraulic conductivities exceeding 1 x 10^{-4} cm/s. Based on this information groundwater is classified as Class I – Potable Resource Groundwater.

However, background (upgradient) groundwater originates from areas north and west of the GMF Pond that have been surface mined and present a significant alternative source for groundwater impacts.

3.2 Potential Groundwater Exceedances

There are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF Pond as described below.

Groundwater concentrations from 2015 to 2021 presented in the HCR Table 4-1 (Ramboll, 2021a), and evaluated and summarized in the History of Potential Exceedance tables (Ramboll, 2021b), are considered potential exceedances because the methodology used to determine them is proposed in the Statistical Analysis Plan (Appendix A to Groundwater Monitoring Plan [GMP]; Ramboll, 2021c), which has not been reviewed or approved by IEPA at the time of submittal of 35 I.A.C. § 845 Operating Permit application.

The History of Potential Exceedances attached to the Operating Permit Application summarizes all potential groundwater exceedances following the proposed Statistical Analysis Plan. The following potential exceedances were identified:

- Arsenic and lead – determined from a single sample from well P60 screened in the loess (PMP)
- pH – values less than the lower limit were determined in wells G52L and G60L, which are also screened in the loess (PMP)

Multiple lines of evidence that these limited potential GWPS exceedances are not related to the GMF Pond is provided in the *Evaluation of potential GWPS Exceedances* (**Appendix A**, Golder, 2021) and summarized below:

- The ionic composition of groundwater collected from G52L, G60L, and P60 is similar to groundwater collected from background wells G02S, G50S, and G52S.
- Concentrations of key GMF Pond constituents differ significantly in GMF Pond pore water samples when compared to groundwater samples from monitoring wells G52L, G60L, and P60.
- High turbidity was recorded on the groundwater sampling record for the one sample collected from P60 that had elevated arsenic and lead concentrations.

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- A peat layer ranging in thickness from 1 to 14 feet is present in the immediate vicinity of P60, resulting in lower pH.
- Arsenic and lead are not typical CCR indicators and are not present in GMF Pond porewater and surface water at concentrations above the GWPS.
- The GMF Pond liner was constructed with a dual composite liner system with a leak detection system, has undergone rigorous construction quality assurance, and has indicated strong performance.

4. GROUNDWATER MODEL

4.1 Overview

Data collected at the Site from 2004 to the recent 2021 field investigation were used to construct a groundwater model of the GMF Pond. The model was then used to evaluate how the proposed closure plan would maintain compliance with the applicable groundwater standards following the closure construction. The modeling results are summarized and evaluated in this GMR. A disk containing the associated model files is included as **Appendix B**.

4.2 Conceptual Model

The HCR (Ramboll, 2021a) forms the foundation of the GMF Pond hydrogeological setting. The GMF Pond overlies the recharge area for the underlying transmissive geologic media, which are composed of unlithified deposits.

4.2.1 Hydrogeology

As discussed in **Section 2.2**, groundwater flow around the GMF Pond is generally in a southeast direction. The Peoria/Roxanna Loess and Shallow Sands are hydraulically connected. The groundwater flow in the Peoria/Roxanna Loess is expected to be primarily vertical, with the majority of the horizontal migration expected to occur within the Shallow Sands unit. The geological conceptual model for the site consisted of the following layers:

- Loess – silt and clayey silt of the Wisconsinan Stage Peoria/Roxanna Loess which extends beneath the topsoil.
- Upper Radnor Till – a thin layer of low permeability till consisting of the Berry Clay and the Illinoian Stage upper Radnor Till.
- Shallow Sands – glacial outwash and re-worked glacial deposits at the base of the Upper Radnor Till formation is the lowermost, laterally extensive coarse grained unlithified deposit identified beneath the site.
- Lower Radnor Till – composed of clay, silt, and sand of the Illinoian Stage lower Radnor Till.
- Bedrock Confining Unit – lowermost unit identified at the site and underlies all unlithified deposits. This unit, composed of low permeability shaley siltstone, silty shale, and coal beds, occurs within the Carbondale Formation of the Kewanee Group.

Surfaces for each of the four major geological units (Loess, Upper Radnor Till, shallow sand, and lower Radnor Till) was made by interpolating contacts between the units interpreted from boring logs. Since all boring log information is centered around the ponds, the surfaces were extended to the full model domain by extrapolation. During construction of the pond, it was noted that sand was removed so that the liner was in contact with the Lower Radnor Till or backfill of similar properties.

4.2.2 Extent and Boundaries

The United States Geological Survey (USGS) National Map places the DCPP within the lower Illinois-Lake Chautauqua watershed subbasin (Hydrologic Unit Code [HUC] 07130003). The GMF Pond CSM extent is bounded by a hydrological catchment (watershed) divide to the east based on watershed data from USGS. Along the north, south, and east, the model boundary has been

placed along known waterbodies as much as possible. As such, it is assumed groundwater inflow from adjacent watersheds is negligible through both the uppermost aquifer and lower confining unit.

The Duck Creek Cooling Pond water levels are managed such that they remain at an elevation between 562.5 and 565 feet NAVD88. The Duck Creek Cooling Pond is the receiving body of water for the area encompassed by the CSM.

Infiltration of precipitation to the groundwater table is applied as recharge at the site. Groundwater in the loess and upper Radnor Till migrates downward into the shallow sands (the primary horizontal migration pathway) (discussed in **Section 2.2.1**). Groundwater flow through the loess and upper Radnor Till above the sand zone adjacent to the GMF Pond is considered a PMP.

4.2.3 GMF Pond

The GMF Pond is a 1,500-foot by 900-foot earthen berm and has a double liner system which acts as a low permeability interface (**Table A**) between the gypsum contained within the GMF Pond and the ambient groundwater system. The double liner system was installed along the inner faces of the pond (sides and base of the excavated area).

Table A. Double Liner System Properties from Top to Bottom

Liner Component	Thickness (feet)	Hydraulic Conductivity (ft/d)
HDPE geomembrane	0.005	5.7×10^{-10}
Cushion of soil	1	16.4
4 oz/yd^2 non-woven geotextile filter fabric	NA	high
Drainage layer (sand)	1	28.4
10 oz/yd^2 non-woven geotextile filter fabric	NA	high
HDPE geomembrane	0.005	5.7×10^{-10}
Geosynthetic clay liner (bentonite)	0.005	1×10^{-10} *
Compacted Clay	3	2×10^{-3}
Vertical Harmonic Mean of double-liner system	**5.015**	**2.8×10^{-7}**

* Estimated based on available information
NA = not applicable

Estimates of the hydraulic properties of each of the components within the double-liner system were derived using values from the Hydrologic Evaluation of Landfill Performance (HELP) model Tolaymat and Krause, 2020); see **Section 5-1** for more information about HELP. For flow perpendicular to the layer orientation, as is the case in the liner where the hydraulic gradient is vertical for the base and horizontal for the sides of the pond, the harmonic mean was used to obtain the effective hydraulic conductivity (K_{eff}) (Fetter, 1988). The harmonic mean was determined by:

$$K_{eff} = \frac{\sum b}{\sum \frac{b}{K}}$$

where b is the layer thickness and K is the horizontal hydraulic conductivity.

Findings from the HCR (Ramboll, 2021a) indicate that the GMF Pond does not appear to impact groundwater flow directions via recharge to groundwater. Given the low permeability of the liner system and the removal of sand below the unit, it is more likely that the GMF Pond is a barrier to groundwater flow within the Loess and Shallow Sands aquifers, directing flow from upgradient areas around the perimeter of the pond toward the downgradient areas south and east of the pond toward the Duck Creek Cooling Pond.

If a release to groundwater were to occur, this would be detected by increased boron concentrations (or other parameters included in 35 I.A.C. § 845.600(a)(1)) in the uppermost aquifer or PMP wells. Boron is commonly used as an indicator parameter for contaminant transport modeling for CCR because: (i) it is commonly present in coal ash leachate; (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater; and (iii) it is less likely than other constituents to be present in background groundwater from natural or other anthropogenic sources. Groundwater quality data shows no boron levels above background levels, therefore there is no meaningful data to use in model calibration. Contaminant transport is therefore modeled with particle tracking, which allows for evaluation of transport times and directions.

4.3 Model Approach

A three-dimensional groundwater flow model was calibrated to represent the conceptual flow system described above. A steady state model was used to simulate the mean groundwater flow conditions at the site. The model was calibrated to match mean groundwater elevations observed between 2004 to 2021 (**Table 2-2**). Prediction simulations were then performed to evaluate the potential impacts to groundwater from closure in place as presented in the *Final Closure Plan for the Gypsum Management Facility Pond, Duck Creek Power Plant* (Golder, 2022) which is an appendix to the Construction Permit Application to which this report is also attached.

Three model codes were used to simulate groundwater flow and contaminant transport:

- Groundwater flow was modeled in three dimensions using MODFLOW 2005.
- Contaminant transport was modeled in three dimensions using MODPATH.
- Percolation (recharge) was modeled using the results of the HELP model.

5. MODEL SETUP AND CALIBRATION

5.1 Model Descriptions

For the construction and calibration of the numerical groundwater flow model for the site, Ramboll selected the model code MODFLOW, a publicly-available groundwater flow simulation program developed by the United States Geological Survey (USGS) (McDonald and Harbaugh, 1988). MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory and litigation proceedings. MODFLOW uses a finite difference approximation to solve a three-dimensional head distribution in a transient, multi-layer, heterogeneous, anisotropic, variable-gradient, variable-thickness, confined or unconfined flow system—given user-supplied inputs of hydraulic conductivity, aquifer/layer thickness, recharge, wells, and boundary conditions. The program also calculates water balance at wells, rivers, and drains.

MODFLOW was developed by the USGS (McDonald and Harbaugh, 1988) and has been updated several times since. Major assumptions of the code are: (1) groundwater flow is governed by Darcy's law; (2) the formation behaves as a continuous porous medium; (3) flow is not affected by chemical, temperature, or density gradients; and (4) hydraulic properties are constant within a grid cell. Other assumptions concerning the finite difference equation can be found in McDonald and Harbaugh (1988). MODFLOW 2005 was used for these simulations with Groundwater Vistas 7 software for model pre- and post- processing tasks (Environmental Simulations, Inc, 2017).

The program uses the standard finite difference method, the particle-tracking-based Eulerian-Lagrangian methods and the higher-order finite-volume total-variation-diminishing (TVD) method for the solution schemes. The finite difference solution has numerical dispersion for low-dispersivity transport scenarios but conserves good mass balance. The particle-tracking method avoids numerical dispersion but was not accurate in conserving mass. Groundwater quality data indicates negligible transport of contaminants from the GMF Pond; therefore, the particle-tracking method was used to provide estimates of groundwater transport in the event of leakage through the pond liner.

The HELP model was developed by USEPA. HELP is a one-dimensional hydrologic model of water movement across, into, through and out of a landfill or soil column based on precipitation, evapotranspiration, runoff, and the geometry and hydrogeologic properties of a layered soil and waste profile. For this modeling, results of the HELP model, HELP Version 4.0 (Tolaymat and Krause, 2020) completed for the groundwater model were used to estimate the hydraulic flux from beneath the GMF Pond.

5.2 Flow and Transport Model Setup

Under current conditions, the groundwater protection standards are being met for the GMF Pond. While no potential exceedances of GWPS have been identified in the monitoring well network for this unit (**Section 3.2**); and, source control will mitigate future groundwater impacts, groundwater modeling of closure in place was completed to demonstrate that closure will maintain compliance with applicable groundwater quality standards following construction. The modeled area was approximately 7,900 feet by 9,950 feet with the GMF Pond located in the southeast quadrant. The model grid and boundary conditions for the five model layers are displayed in **Figures 5-1 through 5-5**.

Evaluation of monitoring well data for the GMF Pond has not identified statistically significant seasonal trends in groundwater flow or quality which could affect model applicability for prediction of transport. The MODFLOW model was calibrated to mean groundwater elevations from 2004 to 2021. Multiple iterations of MODFLOW calibration were performed to achieve an acceptable match to observed flow data. For the GMF Pond, the calibrated flow model was used in predictive modeling to evaluate closure in place (CIP). Because no groundwater impacts attributable to the CCR unit have been observed, there is no need to simulate a closure by removal (CBR) option because no future exceedances would be expected. Details of the proposed CIP are described below:

- The CCR within the GMF Pond will be consolidated in the north end of the pond, graded, and covered with a geomembrane and soil layers with an estimated timeline of completion of 12 months.

5.2.1 Grid and Boundary Conditions

A five-layer, 340 x 220 node grid was established with 25-foot grid spacing (**Figure 5-1 through 5-5**), with a total number of 200,732 active cells. The northern and western edges of the model are no-flow boundaries in all layers of the model. For both the southern and eastern boundaries, where the model boundary is the Duck Creek Cooling Pond, a constant head boundary was placed equal to the surface elevation of the Duck Creek Cooling Pond. In areas where the model boundary deviates inland from the Duck Creek Cooling Pond, a general head boundary with a conductance estimate based on the distance to the Duck Creek Cooling Pond was placed. The southern and eastern boundaries are only present in layer 5 due to the change in elevation.

The bottom of the model was also a no-flow boundary. The top of the model was a time-dependent specified flux boundary, with specified flux rates equal to the mean recharge rate.

Natural (streams) and man-made (associated with the railroad) drainage features are present in the modeled area; these are represented as drains in the model.

5.2.1.1 Layer Top/Bottom

A digital elevation model of the area was used to assign the top of layer one. The elevations for the base of each hydrostratigraphic layer were interpolated from boring log data primarily from logs provided in the HCR (Ramboll, 2021a) and imported as grid data into MODFLOW. The silts and clays of the Upper Radnor Till unit was divided into two layers to accommodate the explicit inclusion of the GMF Pond liner system (see **Section 5.2.1.4**). The Loess, Shallow sands, and Lower Radnor Till were all represented as single layers within the model.

Flow model layer description and parameters are summarized in **Table B** below.

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Table B. Flow Model Layer Descriptions

Layer	Hydrostratigraphic unit name	Hydrostratigraphic unit used to determine layer thickness	Top Elevation (feet)	Bottom Elevation (feet)	Thickness (feet)
			Mean (Minimum – Maximum)		
1	uppermost aquifer (PMP)	Loess	616.2 (594.7-663.0)	597.7 (585.0-604.5)	18.6 (0.5-65.6)
2 & 3	uppermost aquifer	Silts and clays of the Upper Radnor Till	597.7 (585.0-604.5)	587.0 (577.0-597.5)	10.2 (1.0-19.8)
4	uppermost aquifer	Shallow sands	587.0 (577.0-597.5)	582.8 (566.8-595.4)	4.2 (0.5-14.3)
5	lower confining unit	Lower Radnor till	582.8 (566.8-595.4)	527.7 (517.3-547.7)	54.9 (34.0-67.1)

PMP = potential migration pathway

5.2.1.2 Hydraulic Conductivity

The spatial distribution of the hydraulic conductivities within each layer was considered homogenous. With the exception that in the strip-mining area to the south of the GMF Pond described in **Section 2.2.4** (**Figure 2-3**), where all hydrostratigraphic units were excavated and the area back-filled, resulting in what is assumed to be a more homogenous fill in the strip-mining area. Therefore, the hydraulic conductivity values for each layer in the mine spoil area are uniform. **Figures 5-6 through 5-11** show the spatial distribution of the hydrostratigraphic units, as well as the mining spoils associated with the strip mining activity, GMF Pond and GMF Recycle Pond, and the GMF Pond liner for each of the model layers.

Where available, hydraulic conductivity values were derived from field measured values reported in the HCR (Ramboll, 2021a) (**Section 2.2.2**). During calibration it became clear that tested values in general were low and therefore hydraulic conductivities for the hydrostratigraphic layers were further refined through model calibration and tend to be greater than the tested values. No horizontal anisotropy was assumed. Vertical anisotropy with ratios between 1/10 and 1/3 were applied to the Loess, Upper Radnor Till, Shallow sands, Lower Radnor Till, and the mine spoils to simulate preferential flow in the horizontal direction in these materials.

5.2.1.3 Recharge

Recharge rates were determined through calibration of the model to observed groundwater elevations. For the calibration model, recharge was applied uniformly across the model. Model inputs are summarized in **Table C** in **Section 5.4**.

5.2.1.4 GMF Pond Parameters

Implementation of the GMF Pond into the model used hydraulic flow barriers to represent the double liner system on the sides of the pond. The bottom of the liner is implemented by assigning the liner system hydraulic conductance to model layer 2 within the footprint of the pond. The base elevation of layer 2 within the footprint of the GMF Pond simulates the base elevation of the liner. The thickness of model layer 2 within the footprint of the pond was set to five feet. Removal of the Shallow Sands below the GMF Pond (as described Section 4.2.3) means that the liner is in direct contact with the Upper Radnor Till or backfill of similar characteristics.

A drain was placed in model layer 1, where the elevation of the base of the drain was equal to the water level monitored in the pond. The drain was included to represent flow to the GMF Recycle Pond. The GMF Recycle Pond was implemented in the same way. The actual recharge to the ponds is unknown, but for simplicity the same values as were used for the surrounding area were applied. The drain conductance was adjusted to allow for enough "runoff" from the ponds to fit expected water levels in both ponds.

The vertical hydraulic conductivity of the double liner system was calculated as 2.8×10^{-7} ft/d (horizontal hydraulic conductivity of 2.8×10^{-6} ft/d) based on the harmonic mean of the hydraulic conductivities for the different components within the liner (**Table A** in **Section 4.2.3**). These values were assigned to model layer 2 within the footprint of the GMF Pond representing the liner system.

5.2.2 Transport Model Input Values

Particle tracking was used both for the sensitivity analysis (discussed in **Section 6.2.1**) and the closure scenario to provide a quantitative estimate of the distance a potential contaminant from the GMF Pond may travel in 100 years.

5.2.2.1 Effective Porosity

MODPATH uses estimates of the effective porosity of the hydrostratigraphic unit to calculate Darcy velocities, which strongly impact the movement of particles. Estimates of porosity for the hydrostratigraphic units provided in the HCR (Ramboll, 2021a) and summarized below:

- Loess - Average total porosity of 37 percent (range of 32.4 to 41.8 percent).
- Upper Radnor Till - Average total porosity of 36.8 percent (range of 30.7 to 41.4 percent).
- Shallow sands - Average total porosity of 29.5 percent (range of 27.4 to 31.4 percent).
- Lower Radnor Till - Average total porosity of 22.3 percent (range of 20.6 to 23.5 percent)

The values from the HCR are based on laboratory testing and are not expected to represent effective porosities, but rather be at the upper level of possible values. The values used in the modeling were chosen based on expected values for the hydrostratigraphic units; the chosen values are shown in **Table C** in **Section 5.4**.

5.2.2.2 Particles

Particles represent a given mass of contaminant and are initially placed within the GMF Pond at the top of model layer 2 (representing the top of the liner). At each cell within the GMF Pond, one particle was started at the top of model layer 2 and allowed to travel for 100 years.

Simplifying assumptions were made while developing this model:

- Except for changes induced by cap construction and ash fill consolidation/removal, the groundwater flow system is at steady state.
- Natural recharge is constant over the long term.
- Fluctuations in Duck Creek Cooling Pond stage do not affect groundwater flow and transport over the long term.
- Hydraulic conductivity is consistent within hydrostratigraphic units.

- The conductance term used to simulate the GMF Pond double liner system adequately represents a composite estimate of the permeability of the liner system.
- Particles represent a mass of Boron which leaves the GMF Pond and enters the groundwater system.
- Boron is not adsorbed and does not decay, and mixing and dispersion are the only attenuation mechanisms.

5.3 Calibration Flow Model

The groundwater model was manually calibrated to best approximate the mean groundwater elevations in 59 wells at the site. The mean elevations used for calibration and locations of wells within the flow model are summarized in **Table 2-2**. Well locations are shown in **Figure 2-1**. This involved modifying the hydraulic conductivities of the different hydrostratigraphic units, recharge rate, and conductance of the drains and general head boundaries within the model to minimize the difference between the mean observed groundwater elevation and simulated groundwater elevation. Where possible, the range of the parameter values used during calibration were based on observed values (*i.e.,* for the range in hydraulic conductivity estimates from the HCR). Where this was not possible, such as for the drain and general head boundary conductance, the range of parameter values were based on other site information or inferred from knowledge from similar sites. Where data were limited, the parameter values were less constrained during calibration (*e.g.,* parameter values had wider ranges). The root mean squared error (RMSE) was used as a metric to identify the optimal values for the different parameters.

The groundwater model is steady state and is therefore only able to simulate the long term mean groundwater flow conditions. It is unable to capture seasonal variability in groundwater elevations. There may be a bias in the groundwater elevation data used to quantify the mean groundwater elevation for the wells, based on the temporal distribution of the data and the frequency of the data collection. The potential for deviation away from mean conditions can be integrated into the calibration process by using the standard deviation of the groundwater levels as an additional metric (**Table 2-2**). This assumes that all groundwater data have a gaussian distribution (normal distribution) such that 95 percent of the observed groundwater elevation would fall within plus or minus (±) 2 standard deviations (std) from the average groundwater elevation. If a simulated groundwater level was within ±2 std of the mean observed groundwater level, the simulation may be considered reasonable.

5.4 Calibration Flow Model Results

Results of the MODFLOW modeling are presented below. A disk containing the model files is attached to this report (**Attachment A**). **Table C** shows the calibrated hydraulic conductivity for the different units shown in **Figures 5-6** to **5-11**.

Groundwater model calibration results are presented in **Figure 5-12** and **Figure 5-13**, which shows the observed GWL and simulated groundwater elevations. The RMSE of the GWL across all wells was 6.22 feet. The mass balance error for the flow model was 0.001 percent and the ratio of the residual std to the range of heads was 20.9 percent, which is above the desired target value of 10 percent. The simulated groundwater elevations within the Loess (**Figure 5-12A**) are generally in good agreement with the observed groundwater elevations. Most of the simulated groundwater elevations fall within ±1 std of the observed groundwater elevation. The simulated groundwater elevations in the shallow sands have a greater tendency to be overestimated

relative to the observed groundwater levels. **Figure 5-13** shows the observed versus simulated concentrations within the model. Overestimation of groundwater elevation in the model is more pronounced in the shallow sands at lower groundwater elevations.

Table C. Calibrated Flow Model Layer Hydraulic Parameters

Parameter	Type	Units	Calibrated Value	Ratio Kh to Kv	Porosity
Recharge	Rate	ft/d	0.001	NA	NA
Layer 1: Uppermost Aquifer (PMP)	Hydraulic conductivity	ft/d	5	7	0.37
Layer 2 & 3: Uppermost Aquifer	Hydraulic conductivity	ft/d	1	5	0.37
Layer 4: Uppermost Aquifer (Sand)	Hydraulic conductivity	ft/d	30	3	0.17
Layer 5: Lower Confining Unit	Hydraulic conductivity	ft/d	0.7	10	0.22
Strip mining area	Hydraulic conductivity	ft/d	5	5	0.20
GMF Pond Base Liner	Hydraulic conductivity	ft/d	2.8×10^{-6}	10	0.20
GMF Pond Horizontal Flow Barrier	Hydraulic conductivity	ft/d	5.68×10^{-7}	NA	NA
General Head	Conductance	$ft^2/d/ft$	1.5	NA	NA
Drains: railway	Conductance	$ft^2/d/ft$	1.8×10^{-2}	NA	NA
Drains: stream	Conductance	$ft^2/d/ft$	8.0×10^{-2}	NA	NA
Drains: GMF Pond	Conductance	$ft^2/d/ft^2$	5.0×10^{-3}	NA	NA

$ft^2/d/ft$ = square feet per day per foot
NA = not applicable
Kh = horizontal Hydraulic Conductivity
Kv = Vertical Hydraulic Conductivity

Figure 5-14 and **Figure 5-15** show the simulated groundwater elevations for layers 1 (Loess) and 4 (Shallow Sands), respectively. In both the Loess and Shallow Sands, the model is able to simulate the groundwater levels around the GMF Pond within 1 standard deviation. This indicates that the model is adequate to simulate the hydraulic head between the GMF Pond and the surrounding groundwater in the uppermost aquifer, which is an important driver of groundwater flow from the pond into the aquifer. The largest errors tend occur in wells to the north and south of the GMF Pond. In general, the flow patterns are comparable to those shown in **Figure 2-2** interpreted from the site well data for May 2021. The GMF Pond forms a barrier to groundwater flow, directing groundwater to flow around the unit in layer 1 of the model. Some impact of the GMF Pond on groundwater flow can be seen in **Figure 5-14**, where the groundwater contours are deflected along the GMF Pond's footprint. **Table D** provides an overview of the GMF Pond water balance. The estimated particle travel distances after 100 years are also provided as a no action scenario for comparison to the proposed closure scenario.

Table D. Water Balance Results from Calibrated GMF Pond and Particle Travel Distances after 100 years for Current Conditions (no action scenario)

Water Balance Components	Calibrated Model
Inflow: Recharge (ft^3/d)	942.5
Outflow: Drain Flow (ft^3/d)	941.0
Outflow: Leakage (ft^3/d)	0.62
Mean distance travelled by particles (feet) ± (std)	0.123±0.039
Mean distance travelled by particles in z direction (feet) ± (std)	0.121±0.035

ft^3/d = cubic feet per day
K = hydraulic conductivity

Review of the model calibration indicates good agreement with observed conditions in the local area around the GMF Pond. The elevated ratio of the residual std to the range of heads suggests that sitewide subsurface heterogeneity (the uppermost aquifer is located in glacial deposits that grade laterally from sand to silt) is not optimally represented by the homogenous layers used in the model. Further, because the shallow sand layer is less than 5-feet thick in most locations, wells monitoring the shallow sand are screened across the shallow sand and into the overlying and/or underlying finer grained deposits of the Radnor Till, which are represented in the model as separate layers. Based on the objective of the model to estimate potential impacts from the GMF Pond, a homogenous representation in hydraulic properties within layers was maintained.

6. CLOSURE SCENARIO MODEL

As discussed in **Section 5.2**, because no groundwater impacts attributable to the CCR unit have been observed, there is no need to simulate a CBR option because no future exceedances would be expected. Modeling for the CIP closure scenario was conducted using particle tracking for a period of 100 years, based on a steady state model of the site under closure conditions. HELP (Version 4.0; (Tolaymat and Krause, 2020) was used to estimate percolation through GMF Pond capping solution (described below). HELP modeling input and output values can be found in **Appendix C**.

The following simplifying assumptions were made for the simulation:

- Cap construction has an instantaneous and constant effect on recharge and percolation through surface materials.
- In the CIP scenario, average annual percolation rates through the cap system were estimated from a 100-year HELP model run. There was no significant change in percolation rates over the 100-year timeframe of HELP-simulated values. This 100-year HELP-calculated percolation rate remained constant over the duration of the closure scenario prediction model runs.
- The design for CIP for the GMF Pond involves pumping out ponded water from the GMF Pond, construction of a berm mid-way (east-west orientation) across the pond (also lined with 60-mil HDPE geomembrane), and collection of all gypsum south of the berm to be deposited north of the berm. The existing double-liner system south of the berm will be disposed.
- Cap construction in the scenario was assumed to be completed with a cover system consisting of the following (listed from ground surface down): a vegetative cover (6 inches thick), protective layer of compacted soil (18 inches thick), geo-composite drainage layer, and 40-mil Linear Low-Density Polyethylene (LLDPE) geomembrane.
- Final grade of the capping system was assumed at or above current top of berms. Proper storm water control systems were assumed to remove excess water from the surface of the capped areas based on design drawings (Golder, 2022).
- Predicted recharge rates for the GMF Pond cover system can be estimated based on the HELP cap system percolation rates.
- All saturated gypsum is consolidated into the designed footprint of the CIP closure scenario. This assumes all gypsum is placed within the final footprint of the caps for the closure-in-place scenario. Local fill materials were assumed to replace the compacted clay liner.
- Local fill materials applied to the CIP models have similar hydraulic properties as the Upper Radnor Till used in the calibrated model.

6.1 Closure in Place Model Setup

Both the HELP and a modified version of the calibrated groundwater flow models were used to evaluate the impact of the CIP scenario. The scenario was simulated as steady state flow model and particle tracking was used to estimate contaminant travel distances from the capped unit. In the modified version of the steady state flow model the horizontal flow boundary and liner properties of layer 1 and 2 are only applied within the CIP footprint.

HELP input data and results are provided in **Appendix C**. The CIP scenario was modeled for a period of 100 years. Climatic inputs were synthetically generated using default equations developed for Indianapolis, Indiana (the closest weather station included in the HELP database), 100-year average precipitation and temperature values recorded at the Peoria, Illinois weather station, and the latitude of the GMF Pond. Soil layering was developed for the CIP scenario using data provided in the closure scenario designs documented in the Golder (2022) report described above.

HELP model results indicated that an average of 0.00025 inches/year (2.1×10^{-5} foot/year) of leakage occurs through the CIP cap system (**Appendix C**). The CIP scenario footprint is shown in **Figure 6-1**, the HELP calculated cap system percolation rate was applied to the CIP footprint as recharge, the recharge rate for the area outside this footprint was set the same as in the calibrated model (**Table C**). The CIP plan also includes surface drainage in the southern area of the GMF Pond footprint, therefore the drainage in this area was simulated with drain cells set equal to the planned surface elevation. The Recycle Pond was removed as part of the CIP model scenario. The CIP scenario model was run as steady state. A particle was placed in each cell in the CIP footprint (**Figure 6-2**) to simulate advective transport.

The groundwater flow from the CIP GMP Pond footprint is correlated to the conductivity of the liner system; therefore, a sensitivity analysis was performed for the CIP scenario to determine the impact of the liner system's hydraulic properties on the leakage from the CIP GMP Pond footprint. The conductance values of the horizontal hydraulic barriers and liner of the pond were increased by an order of magnitude. This simulation approach represents the upper bounds of potential flow rates through the liner and results are presented in **Section 6.2.1**. All other hydraulic parameters were unchanged from the calibrated model in the CIP scenario model.

Two additional CIP sequences were simulated using HELP to support the *Proposed Alternative Final Protective Layer Equivalency Demonstration* (Geosyntec, 2022) which is an appendix to the Construction Permit Application to which this report is also attached. Results of these HELP simulations were not incorporated into the MODFLOW model simulations for CIP:

- One CIP sequence was simulated by increasing the thickness of the proposed Final Protective Layer from 24 to 36 inches. This cap construction scenario consisted of the following (listed from ground surface down): a vegetative cover (6 inches thick), protective layer of compacted soil (30 inches thick), geo-composite drainage layer, and 40-mil LLDPE geomembrane underlain by gypsum.
- The other CIP sequence representing the default cover system provided in 35 I.A.C. § 845.750(c) consisted of the following (listed from ground surface down): a vegetative cover (6 inches thick), protective layer of compacted soil (30 inches thick), and 36 inches of compacted clay with a hydraulic conductivity of 1×10^{-7} cm/sec underlain by gypsum.

HELP simulation inputs and output results are presented in **Appendix C**.

6.2 Closure in Place Model Results

The simulation of the CIP scenario resulted in dry cells within the CIP footprint in both layer 1 (the gypsum) and layer 2 (the basal liner) indicating water is not expected to accumulate in the closed unit following placement of the cap. Low levels of saturation within the capped CIP scenario are anticipated due the unwatering and dewatering of the GMF pond prior to capping and the low infiltration rate through the cap. However, in order to use MODPATH to determine

the travel distance of particles through the basal liner, cells are required to be saturated (active). To get saturated cells in the CIP footprint, the horizontal and vertical hydraulic conductivities of the gypsum unit (see **Table C**) were reduced to 0.1 ft/d and 0.01 ft/d respectively, thus allowing for MODPATH simulations. All water balance and particle tracking results provided below pertain to the groundwater model with the reduced gypsum hydraulic conductivity.

The results of simulated CIP for the GMP Pond at DCPP are shown in **Table E** below. All particles remain within the CIP footprint (liner and gypsum), indicating the proposed closure method is not expected to result in exceedances of the GWPS. The mean travel distance of all particles within the liner system and gypsum was 0.29 feet horizontally and 0.03 feet vertically after 100 years. Reduced head within the closed pond creates variable hydraulic gradients with the surrounding groundwater. This results in simulated groundwater inflow into the CIP footprint and outflow from the CIP footprint. Approximately 57 percent of the particles (in the north-western corner of the unit) move upward from the liner system into the over lying gypsum. The remaining 43 percent move downward while remaining within the liner system.

Estimated vertical flow rates are reduced compared to the calibration model. In the calibrated model, vertical flow is 0.62 ft^3/d (**Table D**); whereas, in the CIP scenario this is reduced to 0.07 ft^3/d (**Table E**).

Of primary interest is the simulation of particles moving downwards within the liner which could potentially enter the groundwater system. Comparison of the downwards advective travel distance of the particles for the calibration model (no action) and CIP scenario show a reduction in travel distance after 100 years. In the calibrated model, the mean distance traveled by the particles was 0.12 feet (**Table D**) into the liner system; whereas, in the CIP scenario this is reduced to 0.04 feet (**Table E**) into the liner system.

Table E. Water Balance Results from Closure-in-Place Scenario and Particle Travel Distances after 100 Years

Water Balance components	CIP Scenario	CIP Increase liner K by 10^1
Inflow: Recharge (ft^3/d)	0.027	0.027
Inflow: Groundwater inflows (ft^3/d)	0.042	0.75
Outflow: Leakage (ft^3/d)	0.068	0.78
Mean distance travelled by all particles (feet)	0.285±0.46	17.21±18.12
Mean distance travelled by all particles in z direction (feet)	0.025±0.019	0.326±0.2
Percentage of particles which moved downward	43	42
Mean distance travelled by downward moving particles in z direction (feet)	0.035±0.02	0.226±0.127
Percentage of particles which moved upward	57	58
Mean distance travelled by upward moving particles in z direction (feet)	0.017±0.0	0.4±0.21

ft^3/d = cubic feet per day
K = hydraulic conductivity

6.2.1 GMF Pond Sensitivity

The impact of changes to the liner conductivity, on the simulated CIP GMP Pond groundwater outflows and particle tracking are shown in **Table E** above. Increasing the hydraulic conductivity of the liner system by an order of magnitude results in a similar increase in outflow from 0.07 to 0.78 ft^3/day. There is a significant lateral component to the particle movement in this sensitivity test leading to an increase in mean distance traveled by particles from 0.29 to 17.21 feet. However, the downward movement of particles only increases from 0.04 feet to 0.23 feet. In both simulations the particles remain within the CIP unit and pond liner system, which is 5 feet thick.

7. CONCLUSIONS

There are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF Pond. This GMR has been prepared to show how proposed CIP for the GMF Pond will maintain compliance with the applicable groundwater standards at the DCPP. This report integrates existing site data and information with the latest hydrogeology and groundwater quality data to generate a conceptual and numerical model of the GMF Pond.

The calibrated numerical model of the GMF Pond successfully simulated the groundwater flows and elevations around the GMF Pond. The water balance for the GMF Pond and particle tracking simulations indicated that the outflow from the GMF Pond will decrease as compared to current conditions and that all particles representing potential contaminant mass will remain within the CIP unit and liner system after 100 years.

In the CIP scenario, estimated vertical flow rates through the GMF Pond liner system were reduced from 0.62 ft^3/day in the calibration model to 0.07 ft^3/day. Particle tracking showed that the hydraulic gradient between the CIP unit and the groundwater in the aquifer moved particles a mean distance of 0.29 feet horizontally and 0.04 feet downward after 100 years and remained within the model layers representing the liner system and gypsum unit. Increasing the conductivity of the liner system for sensitivity testing influenced both the water balance and the travel distances of the particles. With the liner conductivity in the CIP model increased by one order of magnitude for testing, the flow out of the pond increased from 0.07 ft^3/day to 0.8 ft^3/day; likewise, the downwards distance travelled by the particles increased from 0.04 feet to 0.22 feet. This indicates that in both the CIP scenario and sensitivity test simulations, the particles do not migrate beyond the liner system which is 5 feet thick.

Particle tracking for the CIP scenario for a 100-year period indicates that contaminants will not migrate beyond the liner system, maintaining compliance with the applicable groundwater standards post closure.

8. REFERENCES

AECOM, 2016. History of Construction, USEPA Final CCR Rule, 40 C.F.R. § 257.73(c), Duck Creek Power Station. October.

Environmental Simulations, Inc., 2017. Groundwater Vistas 7 Software.

Fetter, C. W., 1988. Applied Hydrogeology, Merrill Publishing Company, Columbus Ohio.

Geosyntec, 2022. Proposed Alternative Final Protective Layer Equivalency Demonstration, Hennepin East Ash Pond and Duck Creek GMF Pond CCR Surface Impoundments, Technical Memorandum, January 28, 2022.

Golder, 2021. Evaluation of Potential GWPS Exceedances, Gypsum Management Facility Pond, Duck Creek Power Station, Technical Memorandum, October 15, 2021.

Golder, 2022. Final Closure Plan for the Gypsum Management Facility Pond, Duck Creek Power Plant, which is an appendix to the Construction Permit Application to which this report is also attached, January 2022.

Hanson Professional Services, Inc. (Hanson), 2015. *Aquifer Evaluation in the Surface Strip Mining Area (Ash Ponds 1 and 2).* December 22, 2015.

Hanson Professional Services, Inc. (Hanson), 2021. *First Quarter 2021 Groundwater Report, Duck Creek Power Station, Gypsum Stack and Recycle Pond*, WPC Permit No. 2017-EO-62640, Fulton County. March 25, 2021.

Illinois Environmental Protection Agency (IEPA), 2021. *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New Title 35 Illinois Administration Code 845, Addendum*. April 15, 2021.

McDonald, M.G., and A.W. Harbaugh, 1988. *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: Techniques of Water-Resources Investigations*, Techniques of Water-Resources of the United States Geological Survey, Book 6, Chapter A1.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017a. *Hydrogeologic Monitoring Plan, Duck Creek GMF Pond – CCR Unit ID 203 and Duck Creek Landfill – CCR Unit ID 204.* October 17, 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021a. *Hydrogeological Site Characterization Report, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois,* October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021b. *History of Potential Exceedances, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois,* October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021c. *Groundwater Monitoring Plan, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois,* October 25, 2021.

Tolaymat, T., and Krause, M, 2020. *Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual*. United States Environmental Protection Agency, Washington, DC, EPA/600/B 20/219.

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TABLES

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TABLE 2-1. GROUNDWATER ELEVATION TIMESERIES DATA
GROUNDWATER MODELING REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

	Uppermost Aquifer / PMP (Peoria and Roxana Loess)																												
Date	**G50L**	**G51L**	**G52L**	**G53L**	**G54L**	**G55L**	**G56L**	**G57L**	**G58L**	**G59L**	**G60L**	**G61L**	**G62L**	**G63L**	**G64L**	**G65L**	**G66L**	**G67L**	**G68L**	**G69L**	**G70L**	**G71L**	**G72L**	**G73L**	**P57L**	**R61L**	**P01L**	**G02L**	**P40L**	**P41L**	**P42L**
1/9/2004																												613.73	610.22		
3/12/2004																												614.26	610.29		
7/21/2004																												612.27	609.69	602.99	
10/18/2004																												607.24	602.12		
1/28/2005																												616.13	615.3	606.31	612.39
4/11/2006																												614.51	616.49	606.33	613.74
3/29/2007	615.07																								584.97						
5/17/2007	614.03																								588.35						
6/19/2007	613.02																								587.68						
9/18/2007	606.69																								585.66						
11/27/2007	604.67																								584.47						
1/30/2008	609.25	606.31	587.79								591.38					587.77									584.7						
3/26/2008	611.2	609.08	589.31								590.33														585.14						
5/15/2008	611.53	609.21	591.14								589.46					587.79									586.03						
6/24/2008	611.28	607.9	591.85								589.23														586.41						
9/15/2008	612.67	610.68	590.46																						593.64						
11/5/2008	611.28	606.17	591.29																						586.27						
2/16/2009																											616.89	613.96	608.6	605.99	608.48
3/4/2009	611.8	608.4	592.59	603.4		589.29															588.94				586.76						
4/21/2009	613.44	611.62	596.41	607.24	583.7	589.84							590.87			587.87	597.5	597.46	588.78	589.77	590.29				590.51		618.48	615.33	616.27	603.98	610.42
6/8/2009	612.92	610.29	597.01	606.53	583.47	590.1							590.83			587.88	603.4	600.25		590.54	591.24			582.13	588.94		617.76	614.21	614.42	604.61	610.05
4/30/2013	613.62	610.99	595.09	604.59	583.27	590.16	596.96	595.36	589.57	587.74	588.73	600.79	597.74	599.1	593	587.84	596.84	599.3	588.76	589.52	588.19	584.79	589.88	581.53	609.39	600.79					
7/23/2013																												611.86			
10/16/2013																												606.16			
1/20/2014																												613.26			
1/30/2014																															
4/21/2014																												614.5			
4/22/2014																															
7/14/2014																											616.73	614.21			607.95
7/16/2014																															
10/14/2014																											617.01	614.31	616.23	605.22	609.72
2/24/2015																											616.35	614.04	613.15	605.43	611.27
2/25/2015																															
4/15/2015																											611.2	613.81	611.85	605.41	611
4/16/2015																															
7/21/2015																											617.84	614.69	617.3	606.03	610.08
7/22/2015																															
10/12/2015																											614.59	611.59	612.77		603.95
10/15/2015																															
12/10/2015																															

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TABLE 2-1. GROUNDWATER ELEVATION TIMESERIES DATA
GROUNDWATER MODELING REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

	Uppermost Aquifer / PMP (Peoria and Roxana Loess)																													
Date	**G50L**	**G51L**	**G52L**	**G53L**	**G54L**	**G55L**	**G56L**	**G57L**	**G58L**	**G59L**	**G60L**	**G61L**	**G62L**	**G63L**	**G64L**	**G65L**	**G66L**	**G67L**	**G68L**	**G69L**	**G70L**	**G71L**	**G72L**	**G73L**	**P57L**	**R61L**	**P01L**	**G02L**	**P40L**	**P41L**	**P42L**
25/01/2016	614	609.8	599.63	614.2		597.26	603.05	602.98	596.01	600.46			599.53	600.06	599.02	595.86	606.19	606.3		606.12	598.93	589.84	595.23	591.05			618.11	615.51	617.38	606.05	610.18
18/04/2016	611.88	606.81	594.89	611.68		596.57	602.96	600.93	594.87	591.16	589.99		594.03	597.89	600.14	592.18	600.88	603.2	593.13	600.16	596.55	586.6	590.53	589.45			615.25	612.01	612.84		604.44
09/08/2016	612.77	610.26	599.7	614.48	584.55	597.28	603.29	602.42	595.53	599.56	589.85		599.38	599.15	598.93	590.1	606	606.46	589.38	606.69	599.1	586.1	589.87	589.41			615.39	612.48	612.82		606.1
08/09/2016																															
14/10/2016	610.07	605.4	597.28	613.29	586.47	598.88	599.36	602.9	597.28	601.7	590.03		600	599.35	597.12	593.96	604.69	604.92	588.41	606.22	598.73	589.13	589.83	589.57			615.67	614.22	613.08		604.09
09/01/2017	609.05	605.49	594.91	610.14	589.18	596.58	600.82	598.92	592.48	588.03	589.77		595.56	596.3	598.17		602.01	602.2	591.34	604.95	597.67	586.39		586.28			614.89	614.76	612.33		603.14
04/02/2017																															
10/02/2017																															
02/04/2017	613.47	609.21	598.63	614.03	587.35	599.27	599.88	601.57	598.08	601.5	589.44		597.5	599.65	599.64	593.71	605.46	606.07	593.5	606.01	604.32	588.84	593.74	590.13			617.44	615.36	617.11	605.63	609.82
26/07/2017	614.09	610.26	600.87	614.55	588.67	598.08	599.42	599.87	598.84	602.7	590.41		598.58	600.25	600.09	594.18	605.86	606.11	595.34	606.45	605.18	588.64	589.73	592.08		601.52	617.45	615.51	617.18	605.64	610.24
01/09/2017																															
02/10/2017			590.67	604.5	586.85	595.78	598.26	595.47	590.83		588.23		593.83	594.51	596.77	588.86			594.36	595.64	593.87	586.29		586.95		591.29	612.71		607.25		600.97
02/01/2018		603.81	588.46	606.1	584.19	592.28					589.5		593.56	594.19	596.84		TOP		590.37	598	591.2			587.08			614.9		612.23		603.14
01/02/2018																															
07/02/2018																															
10/02/2018																															
06/03/2018																											615.77	606.41	612.45		603.19
10/04/2018	614.39	610.65	596.62	614.12	583.65	594.68	600.32	603.39	598.12	598.86	589.94		597.62	599.97	599.92	589.49	604.52	604.89	593.96	606.02	595.77			585.37			617.32	615.51	616.87	605.28	609.65
03/06/2018																															
02/07/2018	606.86	604.9	588.58	606.43	585.71	594.04	597.47	593.79	590.13	587.32	589.34		593.87	594.15	596.62	587.55	599.04	591.39	590.55	598.12	592.06	584.69	589.79	588.03		591.38	616.84	612.31	616.41	604.26	610.19
02/10/2018	610.77	608.61	592.48	604.41	586.34	594.18		593.52			589.73		595.18	594.14	595.31	587.69	598.74	600.22	590.32	598.18	592.83	584.64		585.13		591.29	616.05	607.93	616.35	605.53	610.134
04/10/2018																															
11/01/2019	607.18	604.98	589.9	607.35	585.76	593.78	597.48	593.95	590.29	587.45	589.48		594.5	594.59	597.16	587.88	598.08	599.37	591.45	598.24	592.55	584.92		588.05		591.32	616.56	612.79	617.38	604.33	610.17
04/04/2019	603.94	600.18	594.28	604.14	587.55	598.17	600.29	597.86	592.44	596.5	592.42		596.29	601.06	596.26	590.74	601.95	605.01	592.46	599.57	597.21	586.2	589.78	587.33		593.79	616.89	616.48	618.56	604.8	610.14
01/07/2019	613.15	607.19	593.65	603.06	588.06	598.16	604.92	603.92	598.49	595.27	592.53		597.95	599.05	600.9	589.84	603.09	604.55	597.81	599.52	599.87	588.55	591.79	583.01		593.14	617.24	609.77	616.73	605.98	610.14
11/11/2019	612.09	608.44	594.53	611.17	589.22	597.64	602.09	600.08	595.74	595.37	599.53		599.4	596.92	598.56	592.48	602.26	603.58	596.24	601.63	598.2	589.34	590.51	589.91		597.07	617.06	612.43	611.91	608.39	610.3
03/01/2020	613.17	610.1	591.63	614.03	591.56	598.31	603.26	601.75	596.44	596	602.53		601.19	598.37	599.97	592.08	604.26	604.88	597.2	602.71	598.9	589.23	589.91	590.51		599.16	617.52	615.78	614.73	607.73	613.71
13/04/2020	612.97	609.82	596.88	613.8	591.01	600.31	605.64	604.11	600.59	602.76	605.49		605.03	611.32	603.52	596.36	604.14	605.58	598.91	604.34	601.69	591.48	591.71	593.52		604.89	616.68	614.51	614.65	608.44	613.87
06/08/2020	609.55	603.54	593.79	610.48	592.39	600.19	602.74	600.58	596.31	597.2	599.81		601.8	599.58	599.98	593.83	599.93	602.69	598.92	600.26	597.43	589.34	590.51	591.48		602.25	611.94	608.31	610.34		610.43
16/11/2020	606.36	602.25	591.67	605.38	592.56	597.8	598.92	596.16	592.08	590.7	593.44		597.64	596.31	596.91	590.2				596.14	594.57	587.72	589.88	588.05		596.68	608.45		601.99		606.24
18/02/2021	611.29	606.99	593.46	607.98	591.56	595.81	597.55	595.8	591.42	589.15	593.7		595.71	595.35	596.57	588.6	597.77	599.69		595.36	593.5	587.08	589.89	586.66		594.89	615.33	613.55	606.5		607.74

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TABLE 2-1. GROUNDWATER ELEVATION TIMESERIES DATA
GROUNDWATER MODELING REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

	Uppermost Aquifer (Shallow Sand)																										
Date	**G02S**	**P01S**	**P40S**	**P41S**	**P42S**	**G50S**	**G51S**	**G52S**	**G53S**	**G54S**	**G55S**	**G56S**	**G57S**	**G58S**	**G59S**	**G60S**	**G61S**	**G63S**	**G64S**	**G65S**	**G66S**	**G67S**	**G68S**	**G69S**	**G71S**	**G72S**	**R72S**	**P57S**
1/9/2004																											
3/12/2004																											
7/21/2004																											
10/18/2004																											
1/28/2005																											
4/11/2006																											
3/29/2007						614.94																					585.925
5/17/2007						613.91																					588.775
6/19/2007						612.95																					588.215
9/18/2007						606.56																					586.355
11/27/2007						603.67																					584.955
1/30/2008						607.7	606.43	583.95								582.43				584.6							585.265
3/26/2008						609.64	609.28	584.79								582.24				584.39							585.635
5/15/2008						609.9	609.35	585.11								581.93				585							586.775
6/24/2008						609.54	608.03	585.16								581.47				585.18							586.945
9/15/2008						611.59	610.87	587.55								584.29				584.79							586.575
11/5/2008						610.2	606.37	585.78								582.7				585.08							586.805
2/16/2009																											
3/4/2009						610.74	608.5	586.45	602.49	583.75	589.7	592.19	591.24	585.59	581.91	581.75	590.22	589.63	590.65	584.08	593.54	594.01	586.17	587.34	580.38		585.415
4/21/2009						612.31	611.51	588.79	604.2	583.47	589.71	592.54	591.87	586.99	582.25	583.02	590.06	590.29	591.44	584.82	598.13	597.24	586.15	588.75	581.29		586.905
6/8/2009						611.82	610.27	588.13	604.77	583.32	590.12	593.19	593.49	587.75	582.81	583.67	589.87	591.14	592.53	586.31	601.71	599.62	586.23	588.93	581.9		588.135
4/30/2013						612.43	611.34	590.21	604.88	582.97	589.69	592.49	592.1	591.71	587.27	588.42	588.37	592.4	593.82	584.2	596.06	595.72	586.51	586.07	584.73	583.6	609.705
7/23/2013																											
10/16/2013																											
1/20/2014																											
1/30/2014						607.77	603.88	587.9	600.4	582.88	589.87	592.24	591.42	586.95	584.3	584.69	586.87	591.5	592.64	584.83	591.94	593.18	586.86	585.48	582.4	584.05		
4/21/2014																											
4/22/2014						607.77	603.88	587.9	600.4	582.88	589.87	592.24	591.42	586.95	584.3	584.69	586.87	591.5	592.64	584.83	591.94	593.18	586.86	585.48	582.4	584.05		
7/14/2014																											
7/16/2014						611.03	609.08	589.59	604.58	583.05	590.39	593.57	592.88	586.03	585.83	586.63	587.37	592.88	594.28	585.45	598.79	598.29	586.94	586.85	584.08	585.88		
10/14/2014						611.6	610.59	590.62	606.97	583.42	591.55	595.61	595.58	591.01	586.83	587.93	588.04	593.93	595.52	588.72	601.8	600.14	587.88	588.58	585.66	589.91		
2/24/2015																											
2/25/2015						611.3	609.66	589.84	606.09	583.2	591.33	595.42	594.52	589.46	585.84	586.63	587.28	593.59	594.94	587.8	598.18	597.79	587.6	588.3	584.02			
4/15/2015																											
4/16/2015						610.54	607.06	589.62	606.85	583.33	591.62	596.29	595.95	590.15	585.86	586.69	587.74	594.13	595.45	587.9	598.38	598.32	587.44	588.46	584.32			
7/21/2015																											
7/22/2015						612.65	610.07	591.37	610.9	584.35	596.51	600.97	601.61	596.81	588.79	590.82	590.02	596.97	598.42	594.45	605.34	605.57	592.96	599.23	588.77	593.79		
10/12/2015																											
10/15/2015						608.15	604.08	589	606.7	584.87	596.13	600.04	597.19	590.61	585.28	586.07	589.2	595.21	596.06	592.02	600.09	601.71	592.36	595	586.34	588.41		
12/10/2015	611.53	614.27	612.3	600.64	603.95																							

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TABLE 2-1. GROUNDWATER ELEVATION TIMESERIES DATA
GROUNDWATER MODELING REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

	Uppermost Aquifer (Shallow Sand)																										
Date	**G02S**	**P01S**	**P40S**	**P41S**	**P42S**	**G50S**	**G51S**	**G52S**	**G53S**	**G54S**	**G55S**	**G56S**	**G57S**	**G58S**	**G59S**	**G60S**	**G61S**	**G63S**	**G64S**	**G65S**	**G66S**	**G67S**	**G68S**	**G69S**	**G71S**	**G72S**	**R72S**	**P57S**
25/01/2016						612.71	610.01	591.84	611.37	586.14	596.89	603.05	601.64	596.89	588.65	590.78	589.27	597.73	597.97	596.05	605.92	605.84	591.96	598.87	590.6	595.24		
18/04/2016						610.93	606.85	589.93	609.24	585.58	596.45	602.68	600.86	594.28	586.91	588.42	590.05	597.27	597.74	592.16	600.59	602.81	592.15	595.65	586.83	586.9		
09/08/2016						612.91	610.67	591.69	611.32	584.43	596.99	603.14	602.02	596.07	585.31	586.57	589.66	595.95	597.97	594.07	605.37	605.69	593.01	599.58	588.81			
08/09/2016	612.18	614.87	612.63	601.35	605.61																							
14/10/2016						608.63	605.6	589.92	608.65	586.46	598.82	599.84	602.32	598.08	589.8	591.86	590.49	597.21	598.77	593.96	604.16	604.75	592.8	598.51	589.35		589.57	
09/01/2017						606.55	605.53	589.6	608.37	588.84	596.77	600.84	598.79	593.01	586.65	587.37	591.35	596	596.62	590.63	599.56	601.67	594.64	596.5	586.97		585.71	
04/02/2017	614.9	617.15	616.67	605.75	608.2																							
10/02/2017	603.72	612.77	606.85	594.76	598.97																							
02/04/2017						612.06	609.47	606.84	610.72	584.57	596.26	600.7	600.83	594.8	589.16	591.78	591.16	597.97	598.96	593.61	605.27	605.36	592.46	599.11	589.76		594.05	
26/07/2017						609.36	609.98	608.1	610.46	585.5	596.13	600.72	601.68	597.95	591.75	593.09	592.33	597.8	597.78	594.07	605.46	605.72	592.93	600.18	589.96		594.97	
01/09/2017	612.45	616.13	611.64	600.82	602.2																							
02/10/2017						603.07	599.59	587.48	602.36	586.82	595.47	597.49	594.79	590.14	584.81	588.88	597.8	593.29	595.74	588.78	594.15	597	587.97	593.19	585.9		585.79	
02/01/2018						607.7	601.94	584.78	605.99	583.17	591.82	597.49	599.66	594.99	582.01	590.17	587.88	593.1	598.79	586.97	596.36	598.14	583.05	589.86	583.08		583.96	
01/02/2018	610.56	615.52	611.12	599	603.29																							
07/02/2018	612.97	616.52	615.83	604.57	608.09																							
10/02/2018	610.03	616.42	613.89	604.49	607.97																							
06/03/2018																												
10/04/2018						613.55	611.14	591.82	611.17	586.47	594.59	601.37	601.83	597.86	587.16	591.97	590.9	598.11	599.21	589.24	603.9	604.11	592.81	599.28	587.8		585.61	
03/06/2018	614.38	615.67	611.14	598.47	603.62																							
02/07/2018						607.87	605.67	586.41	606.41	585.61	591.71	597.1	598.82		581.8	590.47	587.85	593.06	598.77		597.11	598.29	581.95	580.08	583.09		583.99	
02/10/2018						610.4	608.94	588.8	603.14	586.21	593.99	596.87	595.02	589.68	584.73	585.43	590.9	593.22	593.97	587.01	598.11	599.5	580.82	588.58	586.2		585.17	
04/10/2018	614.88	616.93	616.49	605.91	608.14																							
11/01/2019						608.2	605.98	589.92	607.34	584.05	591.85	597.14	599.33	595.32	581.81	590.62	589	593.12	598.86	587.3	598.09	599.1	582.11	590.13	583.2		584.15	
04/04/2019								598.42	598.54	587.55	598.66	599.81	597.89	595.46	588.81	590.07	590.02	588.1	593.38	588.17	601.77	605.19	586.9	593.19	589.1		589.77	
01/07/2019						611.99	607.79	591.08	602.97	597.14	587.87	599.05	603.74	604.46	597.2	589.95	592.55	597.12	599.77	588.07	602.66	604.33	596.78	590.09	590.05		588.6	
11/11/2019						611.23	608.69	590.57	608.88	588.58	597.55	602.01	599.92	595.58	587.19	588.4	596.35	596.47	597.24	592.3	601.78	603.06	595.31	597.64	589.28		588.68	
03/01/2020						612.35	610.4	591.65	611.15	589.33	598.19	603.44	601.29	596.73	587.95	589.35	598.96	597.7	598.51	592.68	603.82	604.44	596.35	598.4	589.35		588.35	
13/04/2020						611.99	610.08	591.27	611.31	590.13	600.31	605.46	604.51	600.08	588.73	590.98	604.67	601.11	600.84	596.17	603.73	605.34	597.83	600.47	591.12		591.56	
06/08/2020						608.42	603.77	599.58	608.14	591.46	599.97	602.36	600.61	596.06	587.77	589.02	601.19	598.3	598.63	593.73	599.35	602.26	598.06	597.26	589.25		589.11	
16/11/2020						605.68	602.23	588.69	603.77	591.54	597.54	598.52	596.24	591.88	587.02	587.8	595.95	595.38	596.18	590.11	595.58	598.31	596.29	593.88	587.72		586.38	
18/02/2021						610.4	607.17	589.63	606.58	590.59	595.68	598.09	596.17	591.62	586.45	587.49	594.21	595.22	596.04	588.65	597.52	599.43	594.94	593.14	587.12		585.42	

[O:BP June 2021; C: NLN 10/25/21; C: BGH 10/29/21]

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TABLE 2-2. GROUNDWATER ELEVATION DATA
GROUNDWATER MODELING REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well ID	Easting (feet)	Northing (feet)	X model (feet)	Y model (feet)	Top of Screen (feet)	Bottom of Screen (feet)	Center of Screen (feet)	Standard Deviation (feet)	Number of Readings	Minimum GWL (feet)	Maximum GWL (feet)	Mean GWL (feet)	GWL Variation (feet)
G02L	2345393.92	1400757.03	2543.92	6707.03	609.5	604.5	607.00	2.67	38	606.16	616.48	613.04	10.32
G02S	2345396.37	1400748.81	2546.37	6698.81	596.18	591.18	593.68	2.70	18	603.72	615.5	612.70	11.78
G50L	2345538.178	1399222.503	2688.178	5172.503	609.24	604.53	606.89	2.85	34	603.94	615.07	611.16	11.13
G50S	2345538.017	1399216.604	2688.017	5166.604	591.66	586.85	589.26	4.36	44	586.56	614.94	609.57	28.38
G51L	2345467.956	1398451.651	2617.956	4401.651	604.8	600.01	602.41	2.81	30	600.18	611.62	607.64	11.44
G51S	2345468.02	1398447.042	2618.02	4397.042	592.82	588.04	590.43	4.29	39	587.69	611.51	607.17	23.82
G52L	2345467.443	1397701.96	2617.443	3651.96	587.49	582.9	585.20	3.46	31	587.79	600.87	593.72	13.08
G52S	2345467.996	1397697.133	2617.996	3647.133	577.41	572.63	575.02	5.07	39	583.95	608.1	590.25	24.15
G53L	2346049.245	1399242.023	3199.245	5192.023	603.37	594.02	598.70	4.07	25	603.06	614.55	609.08	11.49
G53S	2346053.266	1399241.972	3203.266	5191.972	589.72	585.23	587.48	3.52	33	598.54	611.37	606.58	12.83
G54L	2346007.979	1397706.511	3157.979	3656.511	592.86	583.43	588.15	2.97	22	583.27	592.56	587.41	9.29
G54S	2346004.479	1397706.819	3154.479	3656.819	576.75	572.28	574.52	3.26	33	582.88	597.14	586.11	14.26
G55L	2346248.805	1397709.746	3398.805	3659.746	584.33	583.85	584.09	3.24	25	589.29	600.31	595.78	11.02
G55S	2346248.641	1397706.061	3398.641	3656.061	579.07	574.62	576.85	3.51	33	587.87	600.31	594.24	12.44
G56L	2346522.917	1397750.899	3672.917	3700.899	606.19	597.85	602.02	2.55	20	596.96	605.64	600.73	8.68
G56S	2346522.742	1397747.224	3672.742	3697.224	586.67	582.18	584.43	3.77	33	592.19	605.46	598.30	13.27
G57L	2346531.002	1398106.794	3681.002	4056.794	604.05	594.6	599.33	3.52	21	593.52	604.11	599.30	10.59
G57S	2346531.145	1398102.358	3681.145	4052.358	590.55	586.02	588.29	3.92	33	591.24	604.51	597.79	13.27
G58L	2346532.815	1398246.776	3682.815	4196.776	599.48	590.07	594.78	3.27	20	589.57	600.59	594.78	11.02
G58S	2346533.675	1398242.523	3683.675	4192.523	588.74	584.26	586.50	4.80	33	582	604.46	592.82	22.46
G59L	2346536.298	1398385.852	3686.298	4335.852	597.2	587.78	592.49	5.45	19	587.32	602.76	595.23	15.44
G59S	2346536.3	1398381.765	3686.3	4331.765	582.73	578.23	580.48	3.13	33	581.8	597.2	586.45	15.4
G60L	2346593.584	1398516.878	3743.584	4466.878	592.57	587.78	590.18	4.53	25	588.23	605.49	592.17	17.26
G60S	2346593.887	1398511.868	3743.887	4461.868	581.21	576.42	578.82	3.27	39	581.47	593.09	587.35	11.62
G61L	2346537.794	1398682.764	3687.794	4632.764	610.56	601.2	600.30	1.00	1	600.79	600.79	600.79	NA
G61S	2346538.331	1398687.195	3688.331	4637.195	589.92	585.48	587.70	4.23	33	586.87	604.67	591.35	17.8
G62L	2346538.232	1398827.136	3688.232	4777.136	600.06	590.71	595.39	3.33	24	590.83	605.03	596.98	14.2
G63L	2346541.313	1398970.834	3691.313	4920.834	601.8	592.38	597.09	3.64	22	594.14	611.32	598.24	17.18
G63S	2346541.905	1398966.566	3691.905	4916.566	585.46	580.97	583.22	2.91	33	588.1	601.11	594.74	13.01
G64L	2346539.146	1399111.488	3689.146	5061.488	602.12	592.76	597.44	2.21	22	593	603.52	598.25	10.52
G64S	2346538.063	1399106.875	3688.063	5056.875	585.75	581.26	583.51	2.60	33	590.65	600.84	596.37	10.19
G65L	2346463.961	1397028.352	3613.961	2978.352	593.01	588.21	590.61	2.78	24	587.55	596.36	590.61	8.81
G65S	2346458.347	1397027.185	3608.347	2977.185	583.17	578.39	580.78	4.16	39	576.99	596.17	588.59	19.18
G66L	2346509.483	1397282.853	3659.483	3232.853	605.14	595.71	600.43	3.02	21	596.84	606.19	602.03	9.35
G66S	2346509.006	1397278.215	3659.006	3228.215	579.94	575.45	577.70	3.96	33	591.94	605.92	599.88	13.98
G67L	2346472.782	1397569.814	3622.782	3519.814	607.41	598.05	602.73	3.66	21	591.39	606.46	602.58	15.07
G67S	2346469.268	1397572.438	3619.268	3522.438	583.72	579.23	581.48	3.84	33	593.18	605.84	600.76	12.66
G68L	2346152.97	1397593.263	3302.97	3543.263	598.8	589.43	594.12	3.36	20	588.41	598.92	593.06	10.51
G68S	2346148.944	1397592.398	3298.944	3542.398	579.49	575.02	577.26	4.81	33	580.82	598.06	590.15	17.24
G69L	2345830.273	1397585.849	2980.273	3535.849	599.25	589.88	594.57	5.25	24	589.52	606.69	600.01	17.17
G69S	2345834.433	1397585.858	2984.433	3535.858	578.6	574.1	576.35	5.40	33	580.08	600.47	592.79	20.39
G70L	2345701.108	1397413.265	2851.108	3363.265	594.89	585.54	590.22	4.41	25	588.19	605.18	595.95	16.99
G71L	2345823.223	1397148.551	2973.223	3098.551	595.33	585.84	590.59	1.94	20	584.64	591.48	587.49	6.84
G71S	2345821.255	1397152.559	2971.255	3102.559	581.28	577.28	579.28	3.02	33	580.38	591.12	586.39	10.74
G72L	2346054.09	1396946.871	3204.09	2896.871	600.21	590.85	595.53	1.55	16	589.73	595.23	590.79	5.5
G72S	2346049.117	1396947.026	3199.117	2897.026	584.87	580.39	582.63	4.49	10	580.12	595.24	587.20	15.12
G73L	2346343.387	1396966.704	3493.387	2916.704	590.15	580.8	585.48	3.04	23	581.53	593.52	587.94	11.99
P01L	2345348.87	1399791.97	2498.87	5741.97	611.71	602.36	607.04	2.17	31	608.45	618.48	615.88	10.03
P01S	2345348.93	1399796.61	2498.93	5746.61	599.35	594.87	597.11	1.21	18	612.77	617.59	616.01	4.82
P40L	2346652.35	1400805.34	3802.35	6755.34	611.81	601.81	606.81	4.05	36	601.99	618.56	613.11	16.57
P40S	2346652.52	1400812.95	3802.52	6762.95	590.68	585.68	588.18	2.71	18	606.85	617.13	613.66	10.28
P41L	2346634.94	1399638.11	3784.94	5588.11	606.47	601.47	603.97	3.00	34	595.48	608.44	603.67	12.96
P41S	2346638.49	1399645.38	3788.49	5595.38	592.83	582.83	587.83	3.20	18	594.76	606.35	602.72	11.59

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TABLE 2-2. GROUNDWATER ELEVATION DATA
GROUNDWATER MODELING REPORT
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well ID	Easting (feet)	Northing (feet)	X model (feet)	Y model (feet)	Top of Screen (feet)	Bottom of Screen (feet)	Center of Screen (feet)	Standard Deviation (feet)	Number of Readings	Minimum GWL (feet)	Maximum GWL (feet)	Mean GWL (feet)	GWL Variation (feet)
P42L	2346018.89	1399640.95	3168.89	5590.95	609.03	599.03	604.03	3.31	33	600.97	613.87	608.70	12.9
P42S	2346012.93	1399640.29	3162.93	5590.29	591.21	586.21	588.71	3.10	18	598.97	610.88	606.31	11.91
P57L	2346672.501	1397040.105	3822.501	2990.105	589.44	584.74	587.09	6.05	15	584.469	609.389	588.59	24.92
P57S	2346669.285	1397043.518	3819.285	2993.518	579.92	575.21	577.57	5.86	15	584.955	609.705	588.16	24.75
R61L	2346537.97	1398692.52	3687.97	4642.52	601.12	591.49	596.31	4.50	14	591.29	604.89	596.39	13.6
R72S	2346044.05	1396948.06	3194.05	2898.06	584.98	580.32	582.65	3.21	18	583.96	594.97	587.82	11.01

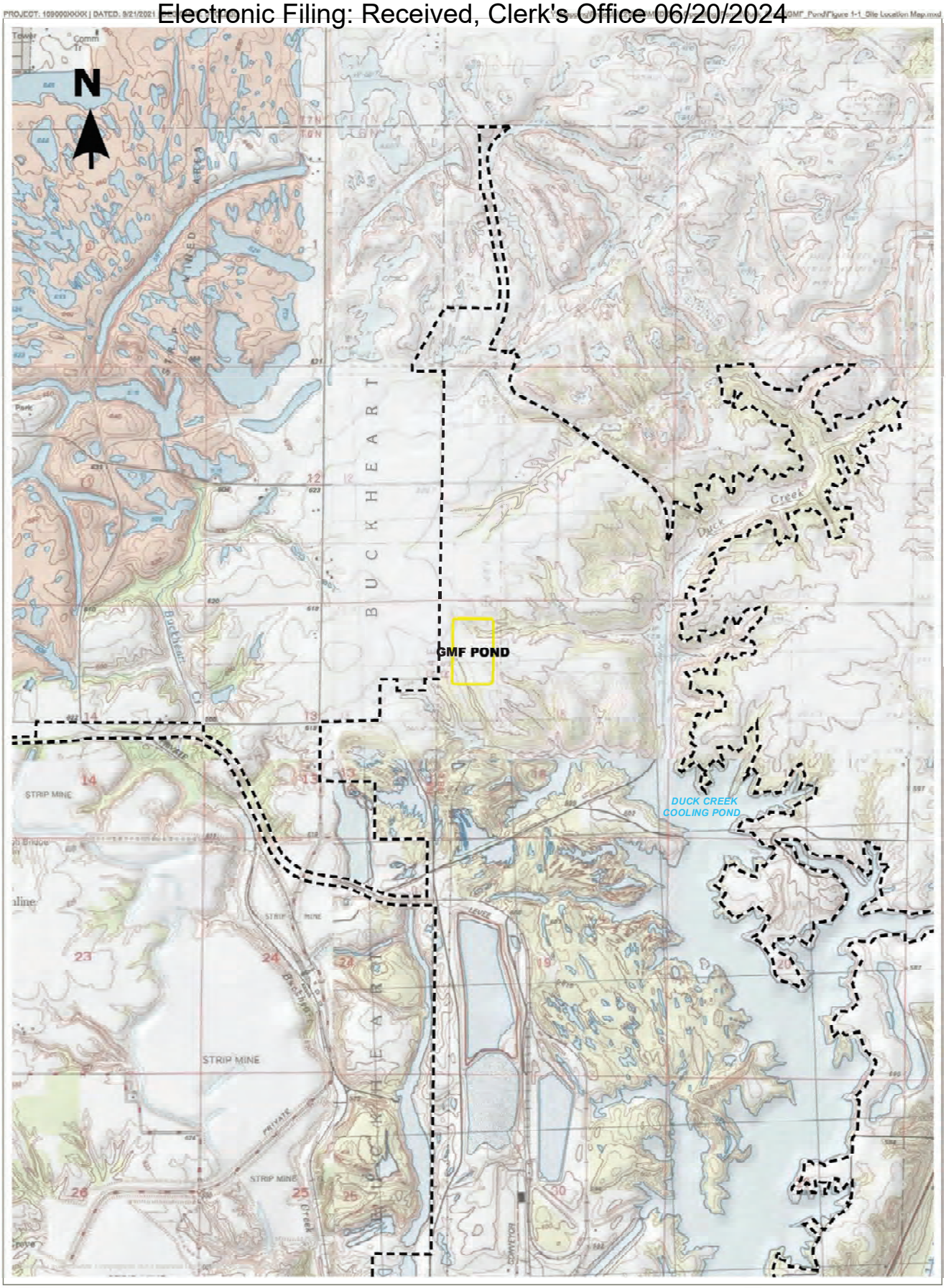
[O:BP June 2021; C: NLN 10/25/21; C: BGH 10/29/21]

Notes:
GMF - Gypsum Management Facility
GWL = groundwater elevation
NA = Not Applicable
NAVD88 = North American Vertical Datum of 1988

Electronic Filing: Received, Clerk's Office 06/20/2024

FIGURES

Electronic Filing: Received, Clerk's Office 06/20/2024



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-1

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: CLERK | Y:\Projects\2021\2021\GIS\Geoprocessing\Ramboll_Duck_Creek\GMF_Pond\Figure 1-2_Site Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SITE MAP

FIGURE 1-2

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

R002708

Electronic Filing: Received, Clerk's Office 06/20/2024

PROJECT: 169000XXXX | DATED: 10/22/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\MISC\Figure 2-1_DC_GMF_GWR_MW Loc Map.mxd



MONITORING WELL

PART 845 REGULATED UNIT (SUBJECT UNIT)

SITE FEATURE

PROPERTY BOUNDARY

0 150 300 Feet

MONITORING WELL LOCATION MAP

FIGURE 2-1

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

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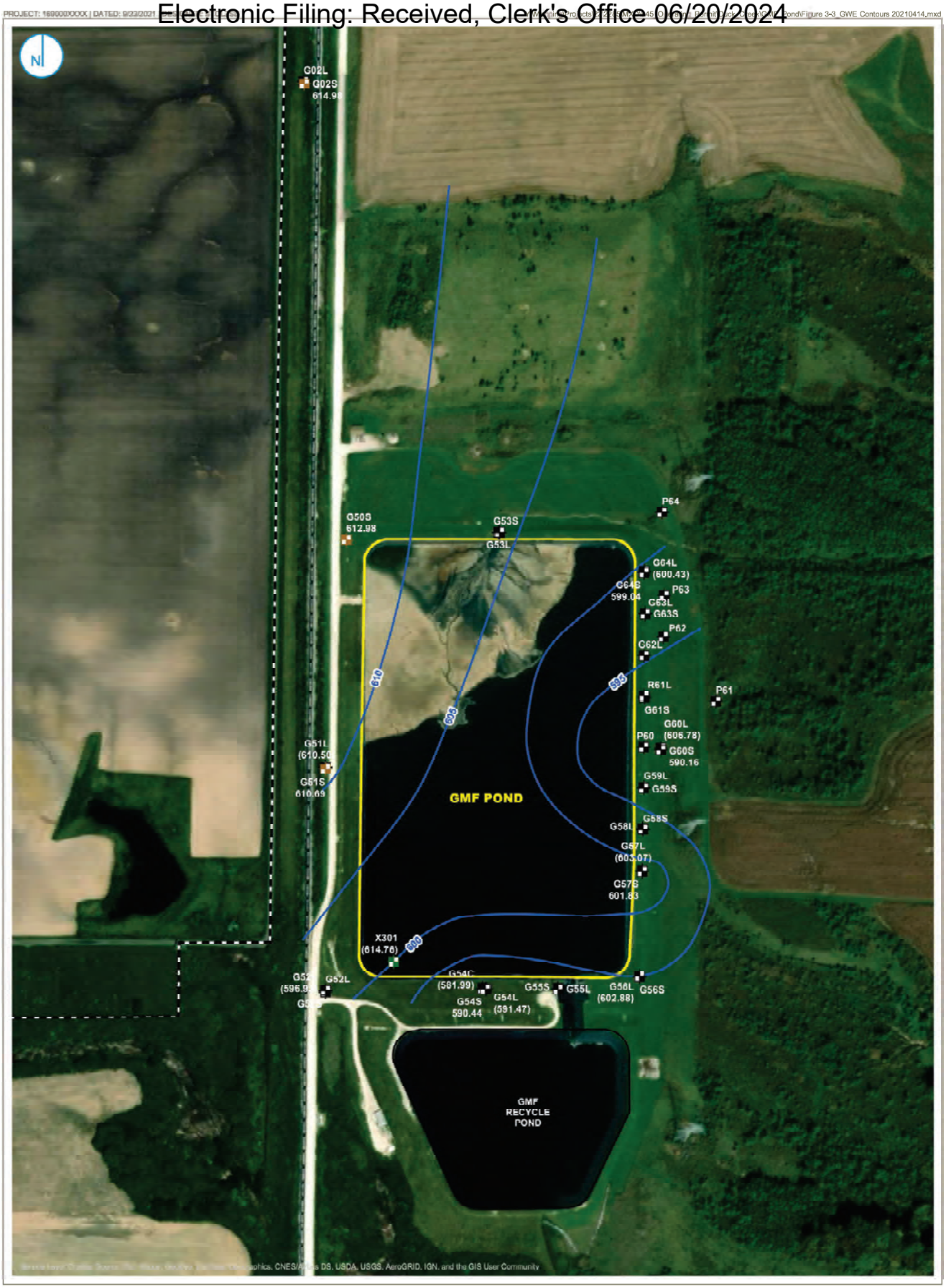

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS APRIL 14, 2021

FIGURE 2-2

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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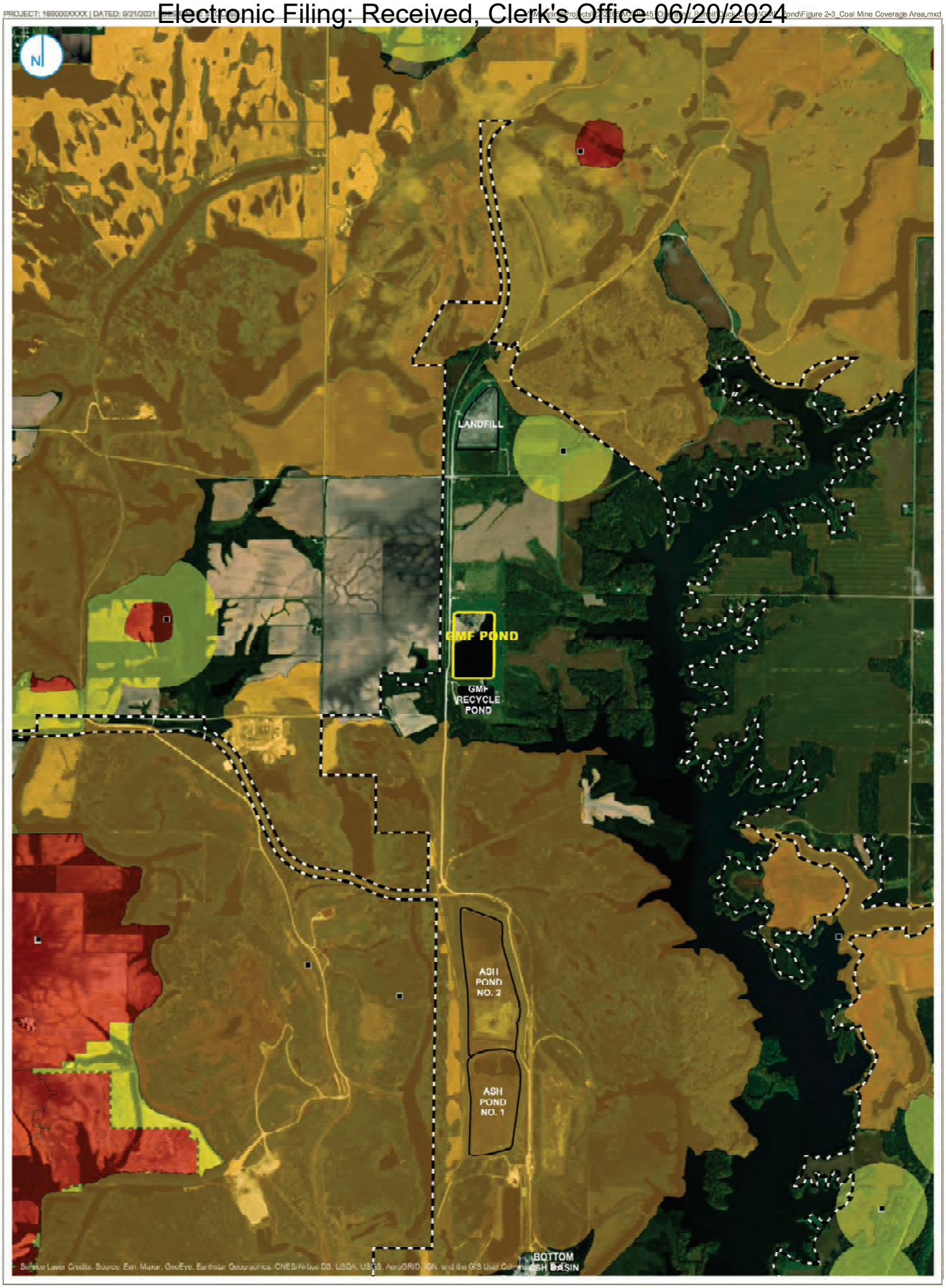

COAL MINE COVERAGE AREA

FIGURE 2-3

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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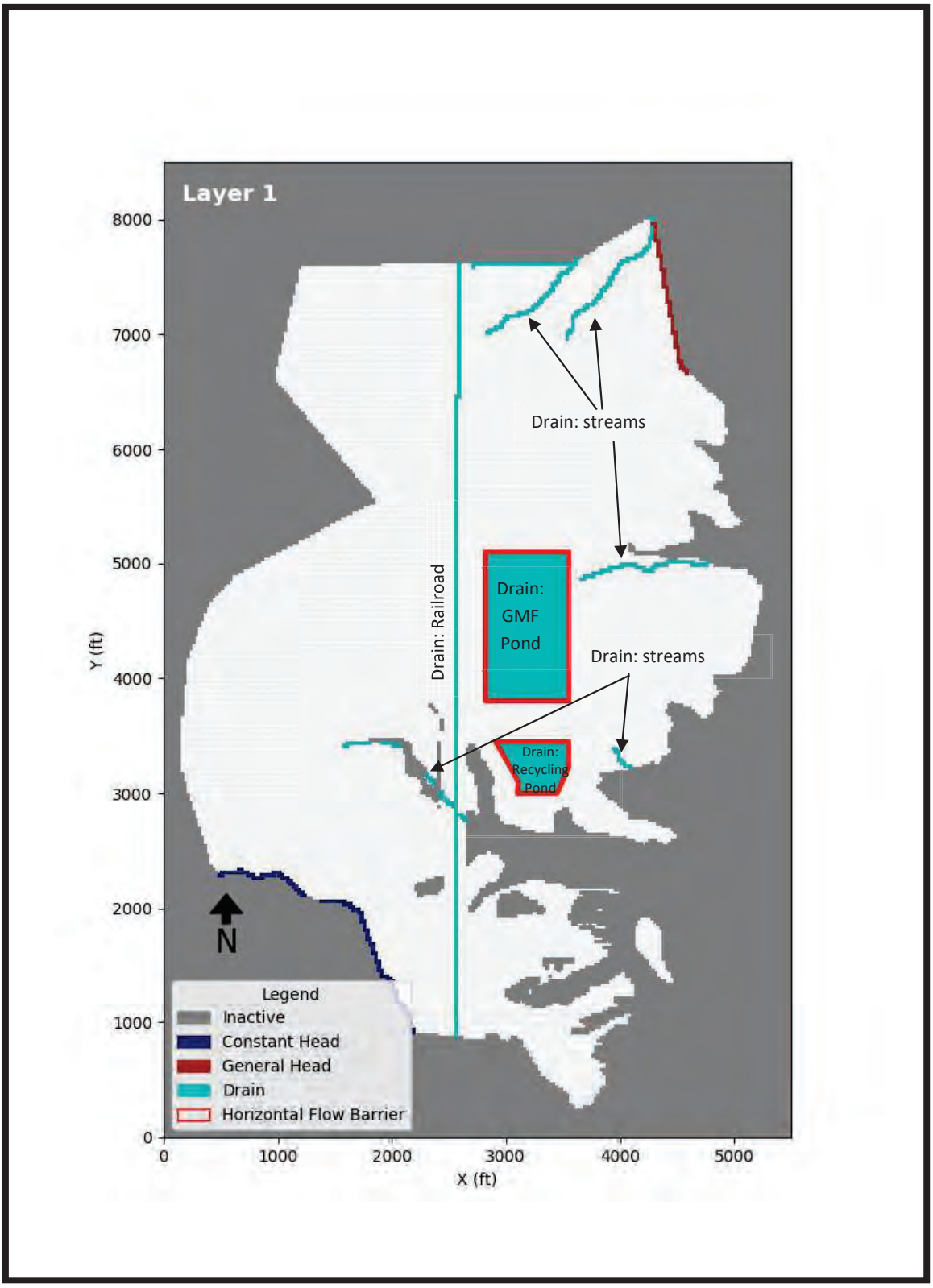

FIGURE 5-1 BOUNDARY CONDITIONS FOR LAYER 1 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK SITE
CANTON, ILLINOIS

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

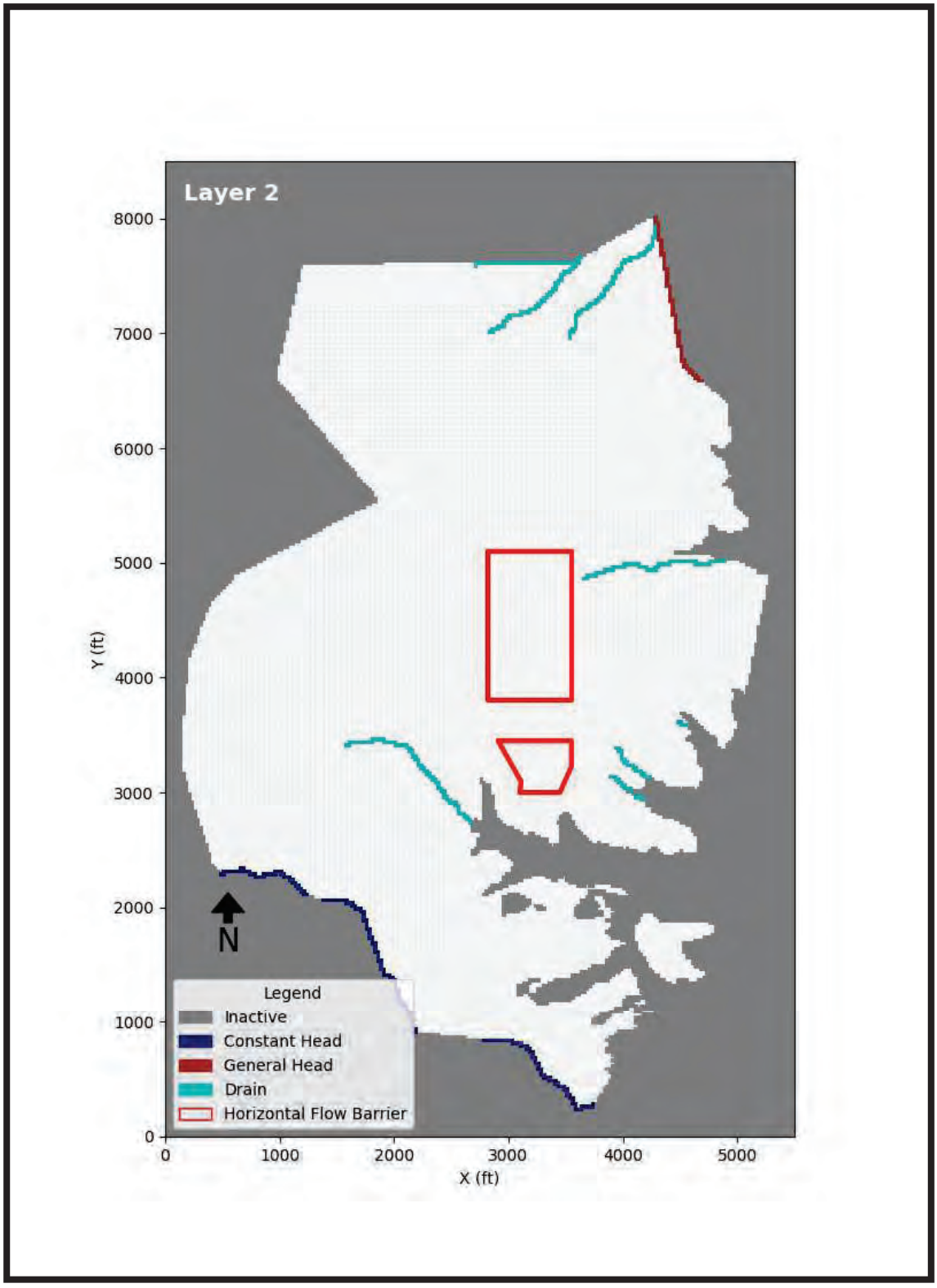

FIGURE 5-2 BOUNDARY CONDITIONS FOR LAYER 2 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK SITE
CANTON, ILLINOIS

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

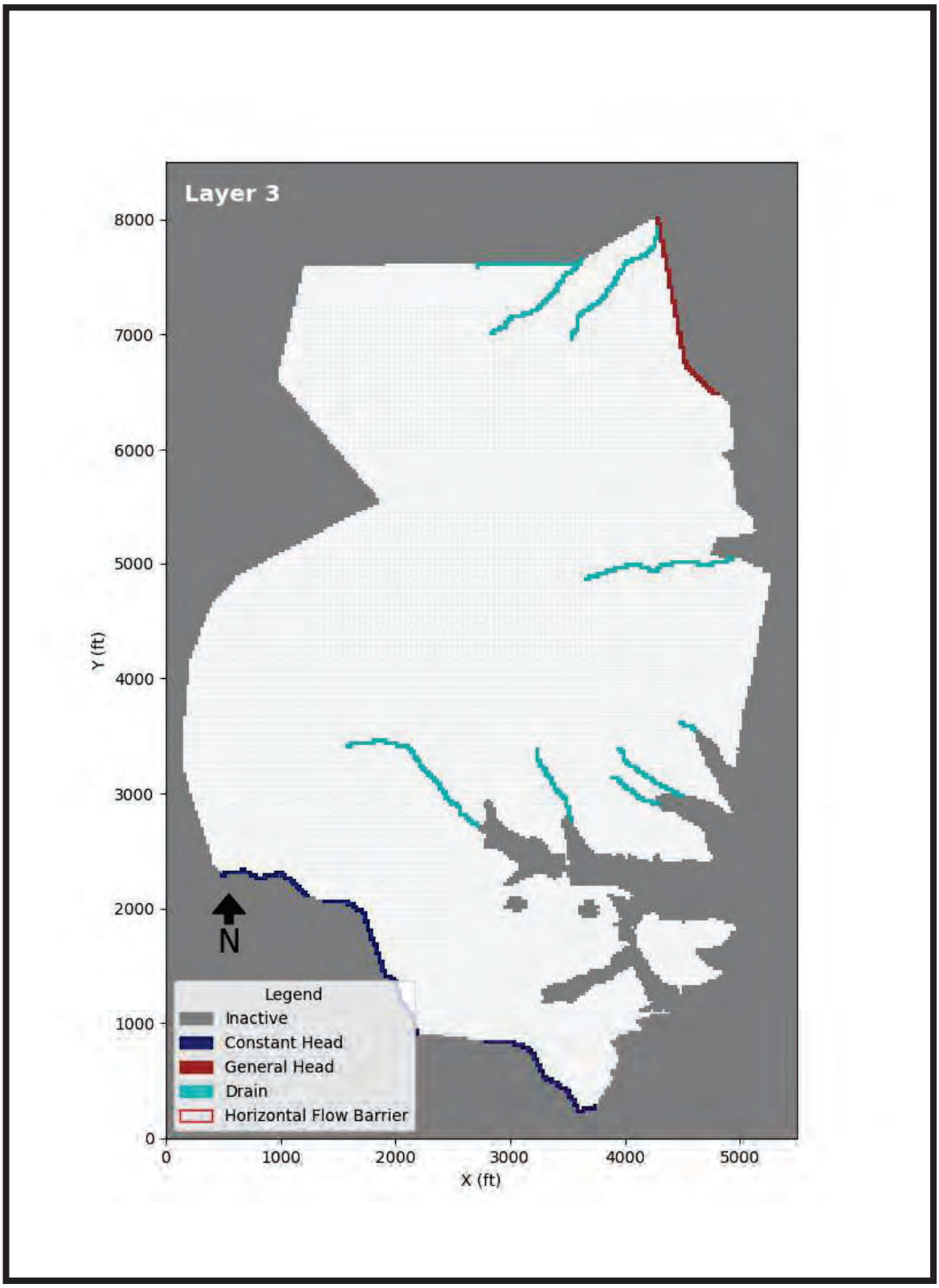

FIGURE 5-3 BOUNDARY CONDITIONS FOR LAYER 3 OF THE CALIBRATED NUMERICAL MODEL

Electronic Filing: Received, Clerk's Office 06/20/2024

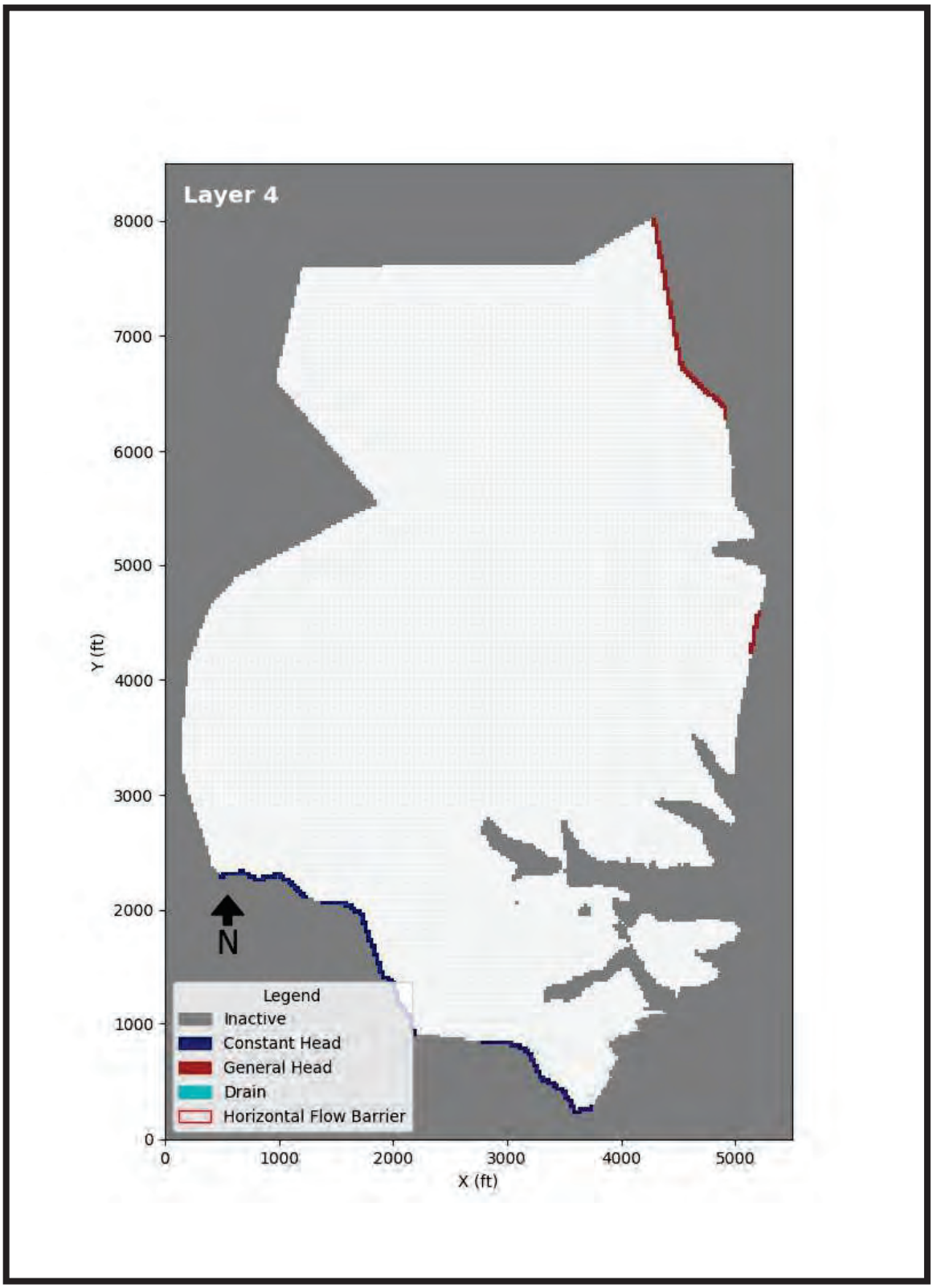

FIGURE 5-4 BOUNDARY CONDITIONS FOR LAYER 4 OF THE CALIBRATED NUMERICAL MODEL

Electronic Filing: Received, Clerk's Office 06/20/2024

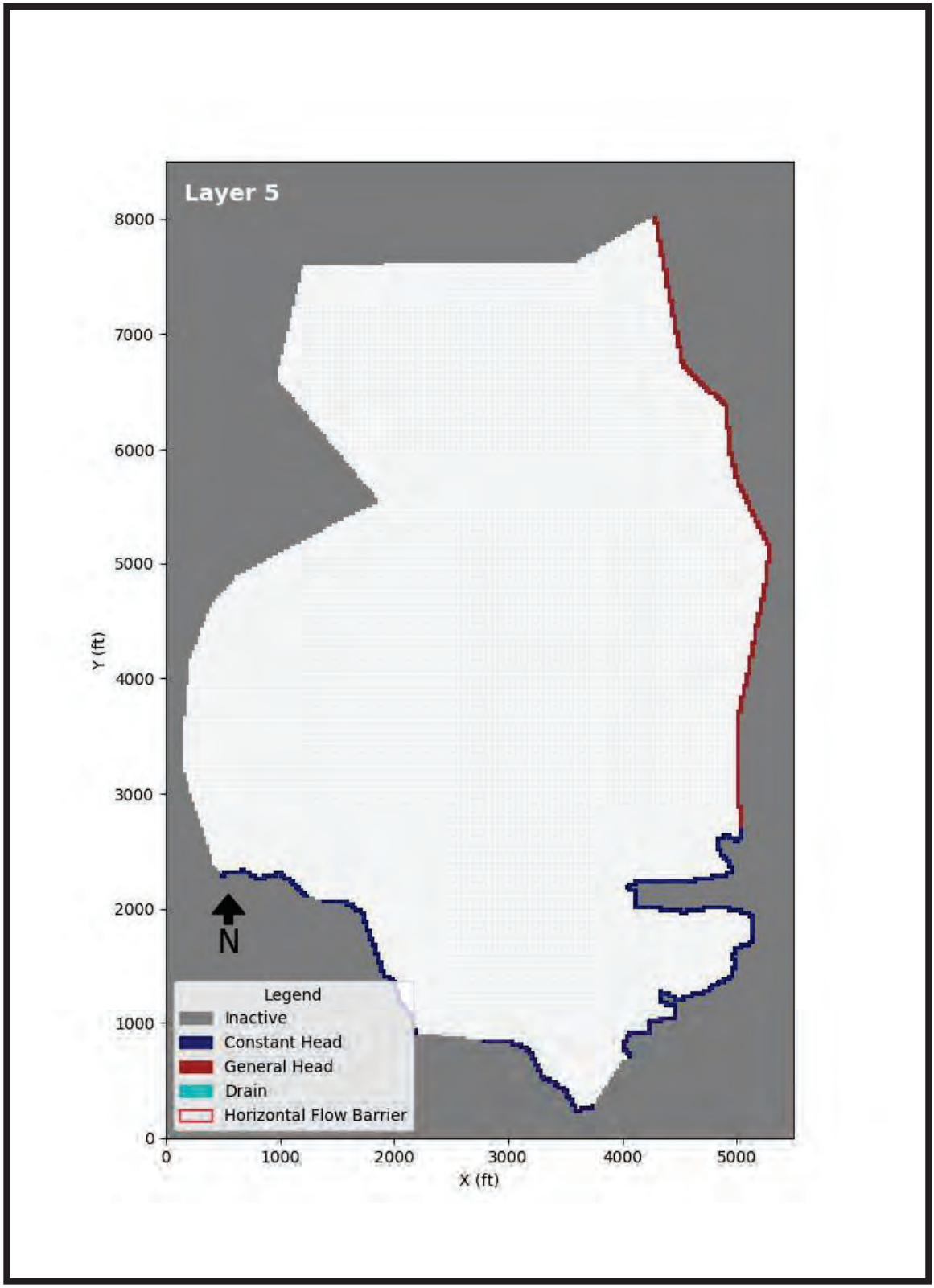

FIGURE 5-5 BOUNDARY CONDITIONS FOR LAYER 5 OF THE CALIBRATED NUMERICAL MODEL

Electronic Filing: Received, Clerk's Office 06/20/2024

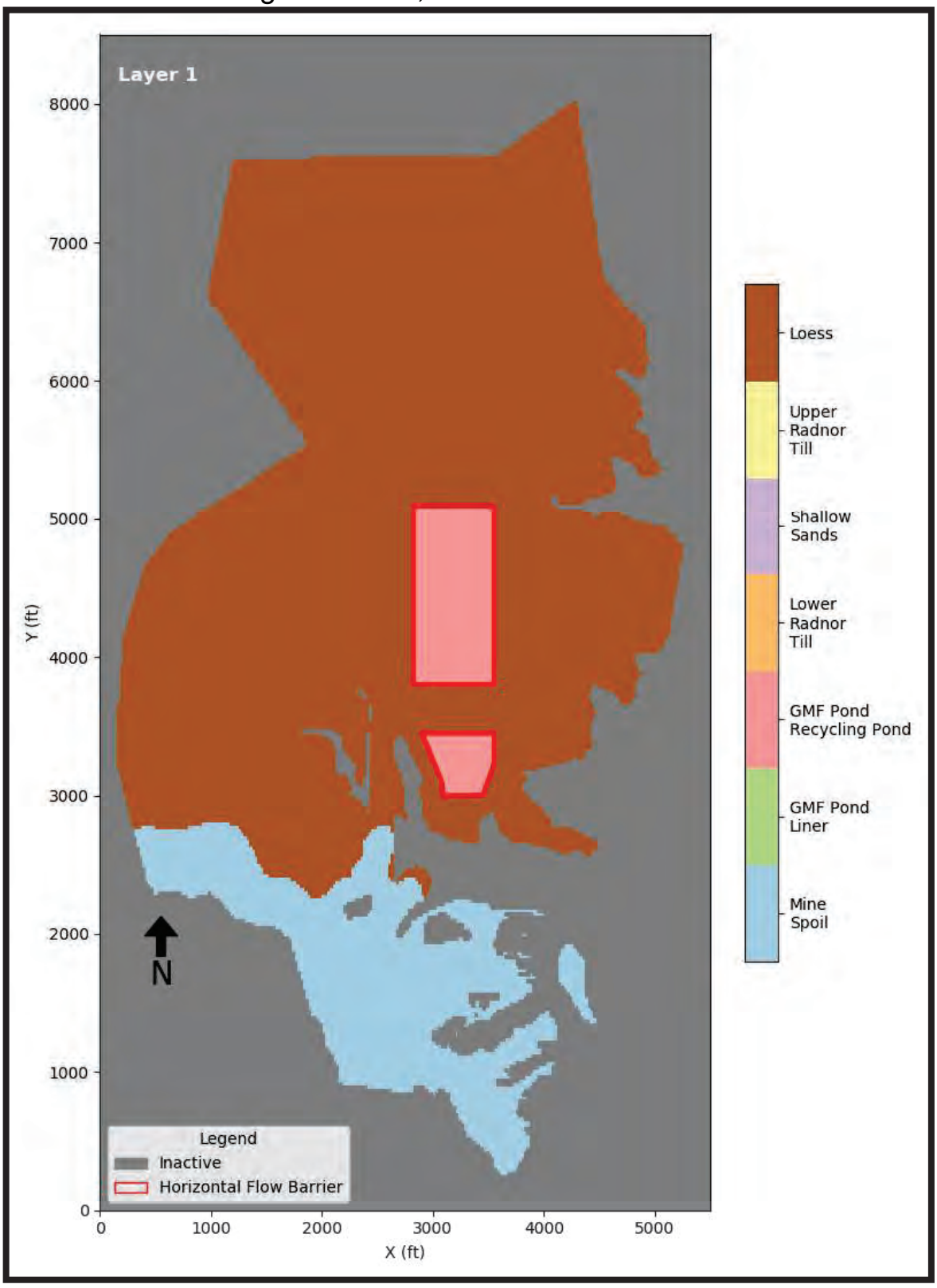

FIGURE 5-6 SPATIAL DISTRIBUTION OF HYDROSTRATIGRAHPIC LAYERS FOR LAYER 1 IN THE NUMERICAL MODEL

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK SITE
CANTON, ILLINOIS

RAMBOLL

Electronic Filing: Received, Clerk's Office 06/20/2024

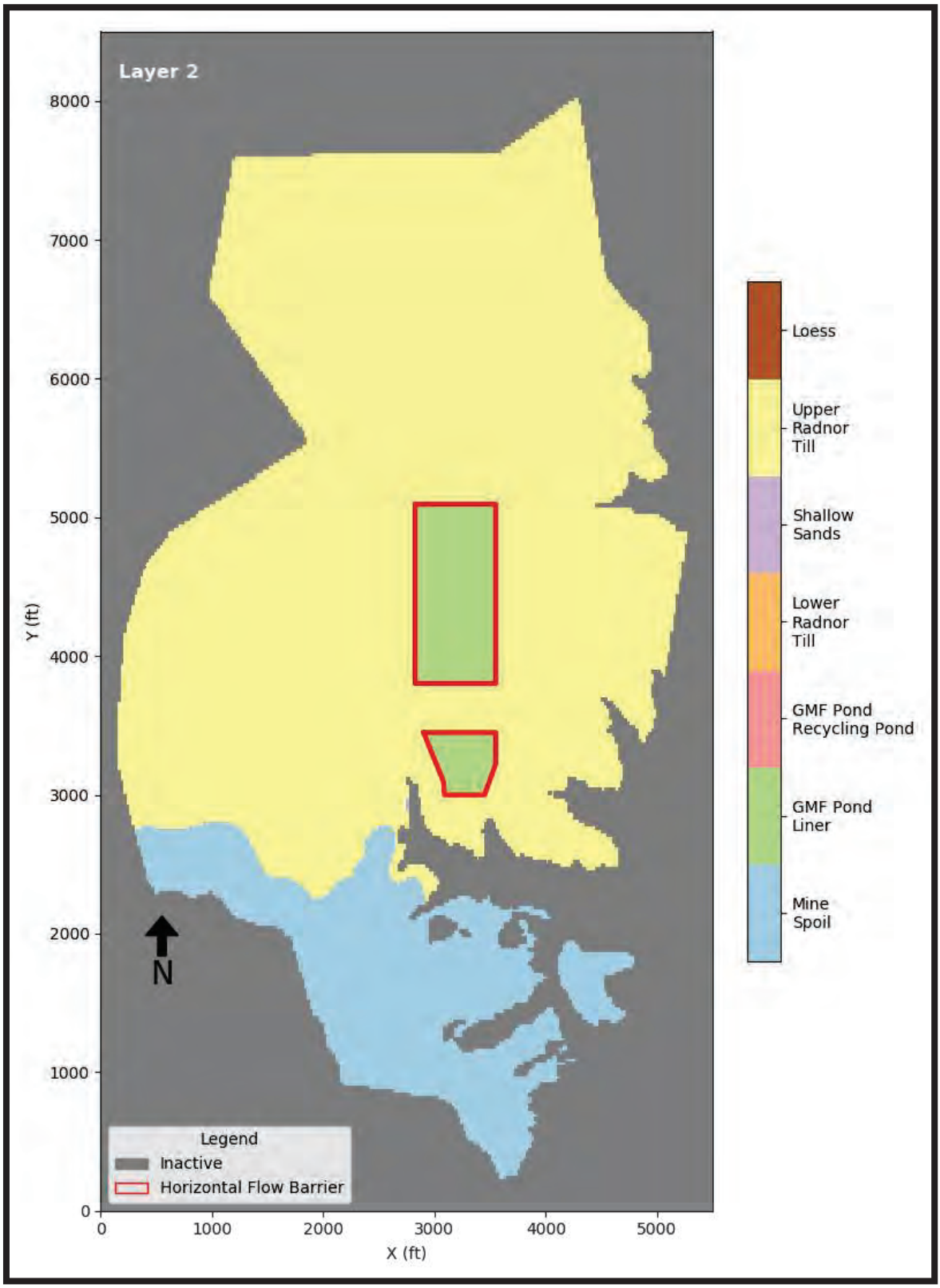

FIGURE 5-7 SPATIAL DISTRIBUTION OF HYDROSTRATIGRAHPIC LAYERS FOR LAYER 2 IN THE NUMERICAL MODEL

Electronic Filing: Received, Clerk's Office 06/20/2024

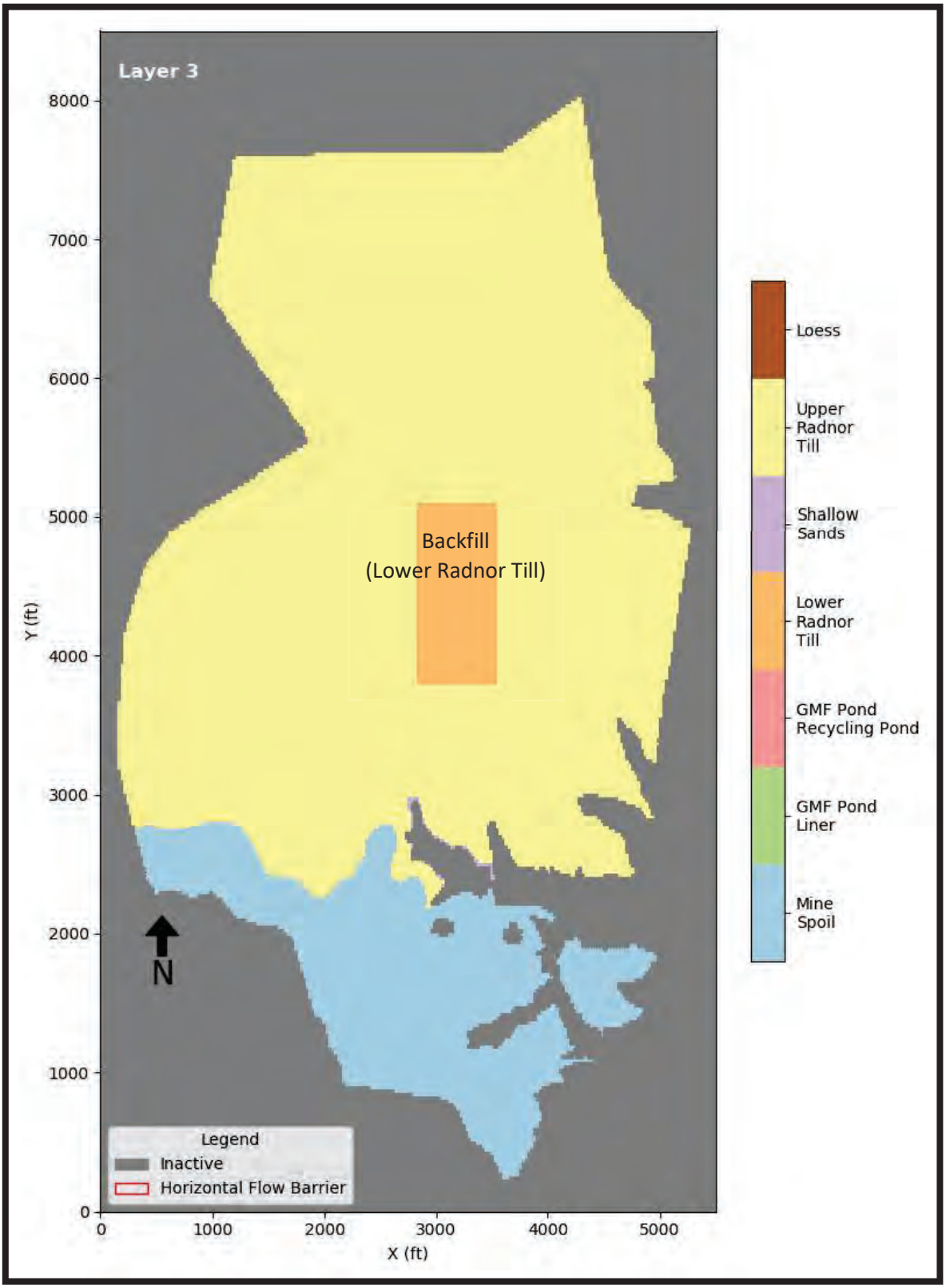

FIGURE 5-8 SPATIAL DISTRIBUTION OF HYDROSTRATIGRAHPIC LAYERS FOR LAYER 3 IN THE NUMERICAL MODEL

Electronic Filing: Received, Clerk's Office 06/20/2024

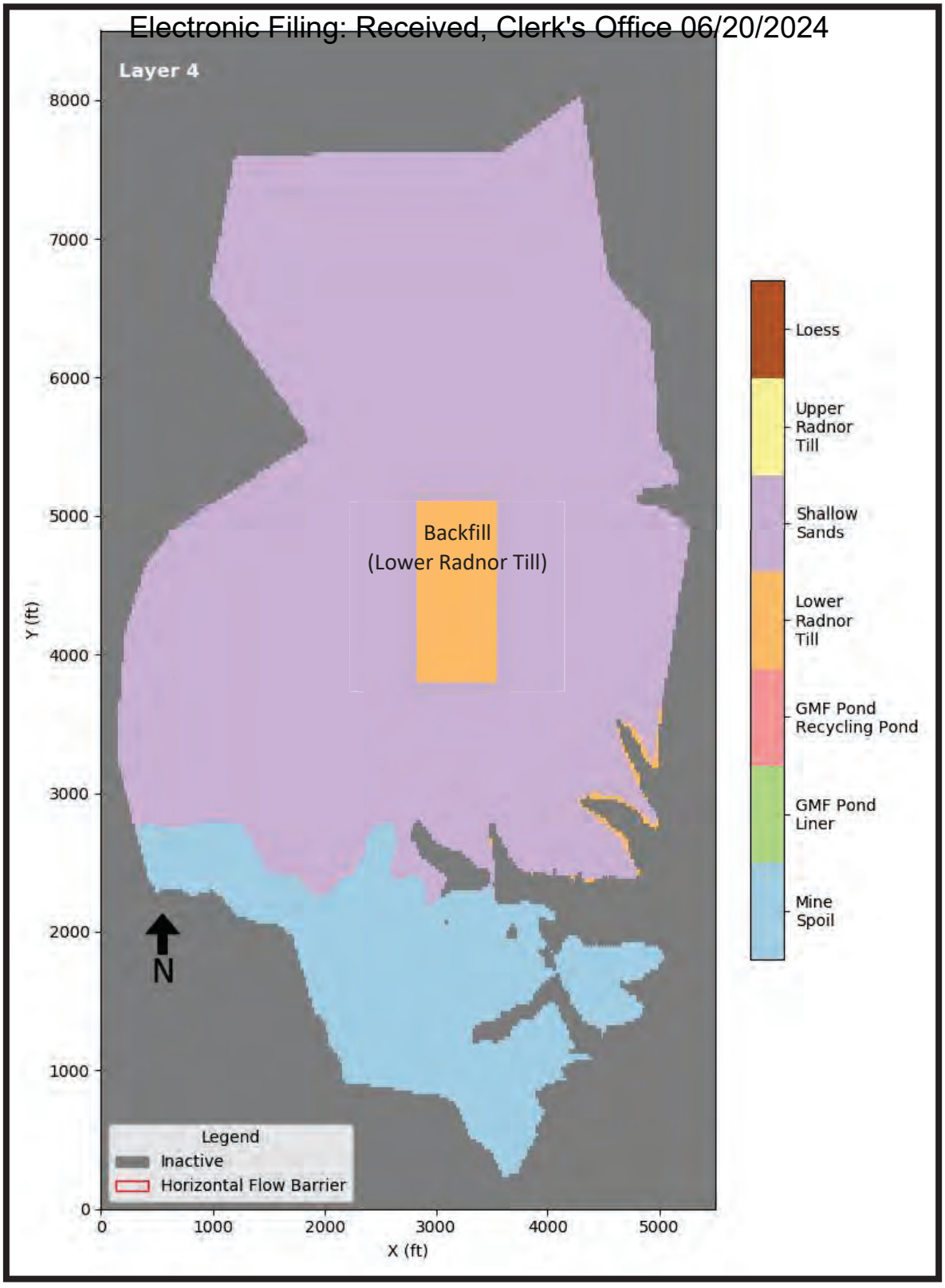

FIGURE 5-9 SPATIAL DISTRIBUTION OF HYDROSTRATIGRAHPIC LAYERS FOR LAYER 4 IN THE NUMERICAL MODEL

Electronic Filing: Received, Clerk's Office 06/20/2024

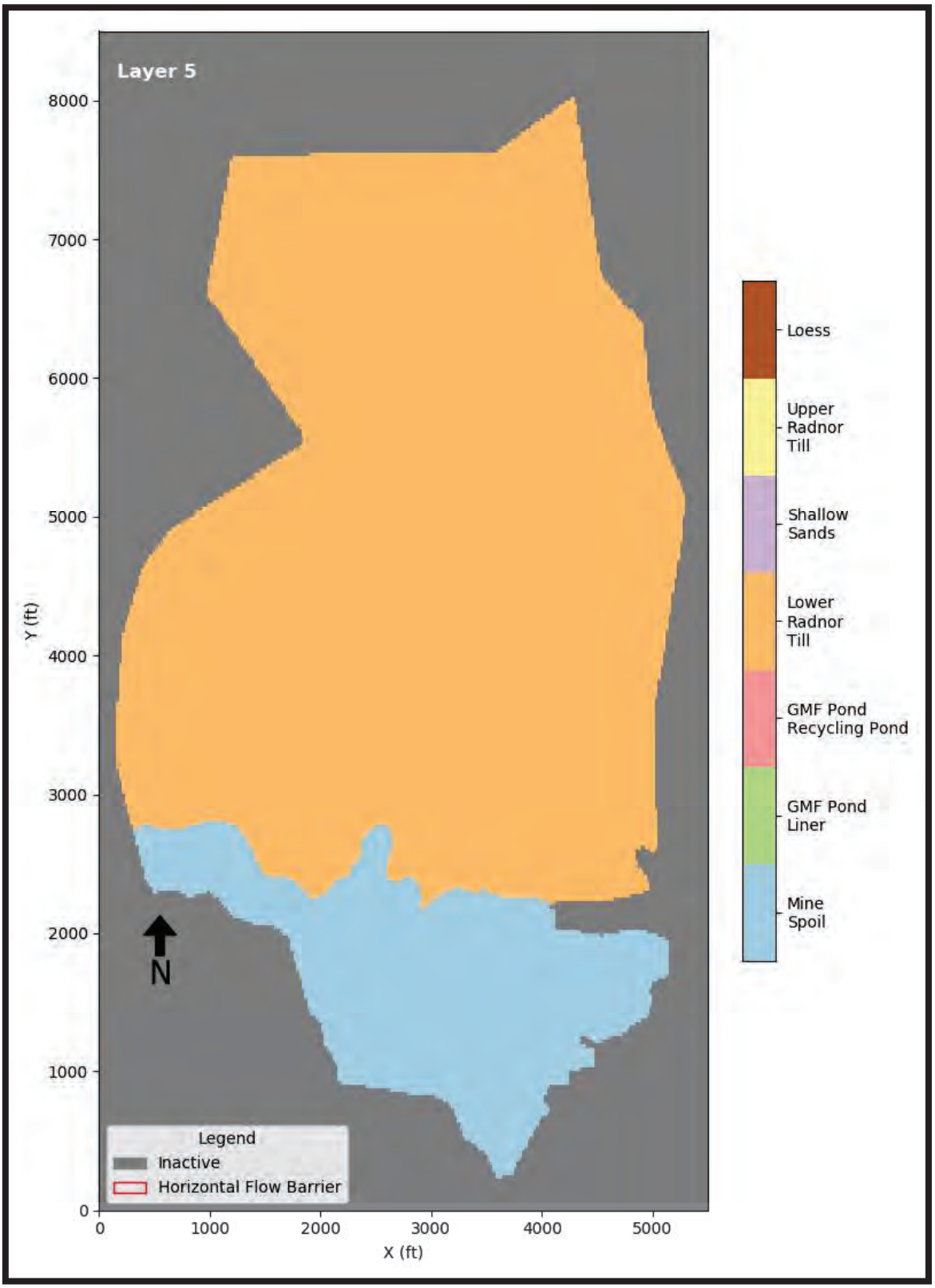

FIGURE 5-10 SPATIAL DISTRIBUTION OF HYDROSTRATIGRAHPIC LAYERS FOR LAYER 5 IN THE NUMERICAL MODEL

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Electronic Filing: Received, Clerk's Office 06/20/2024

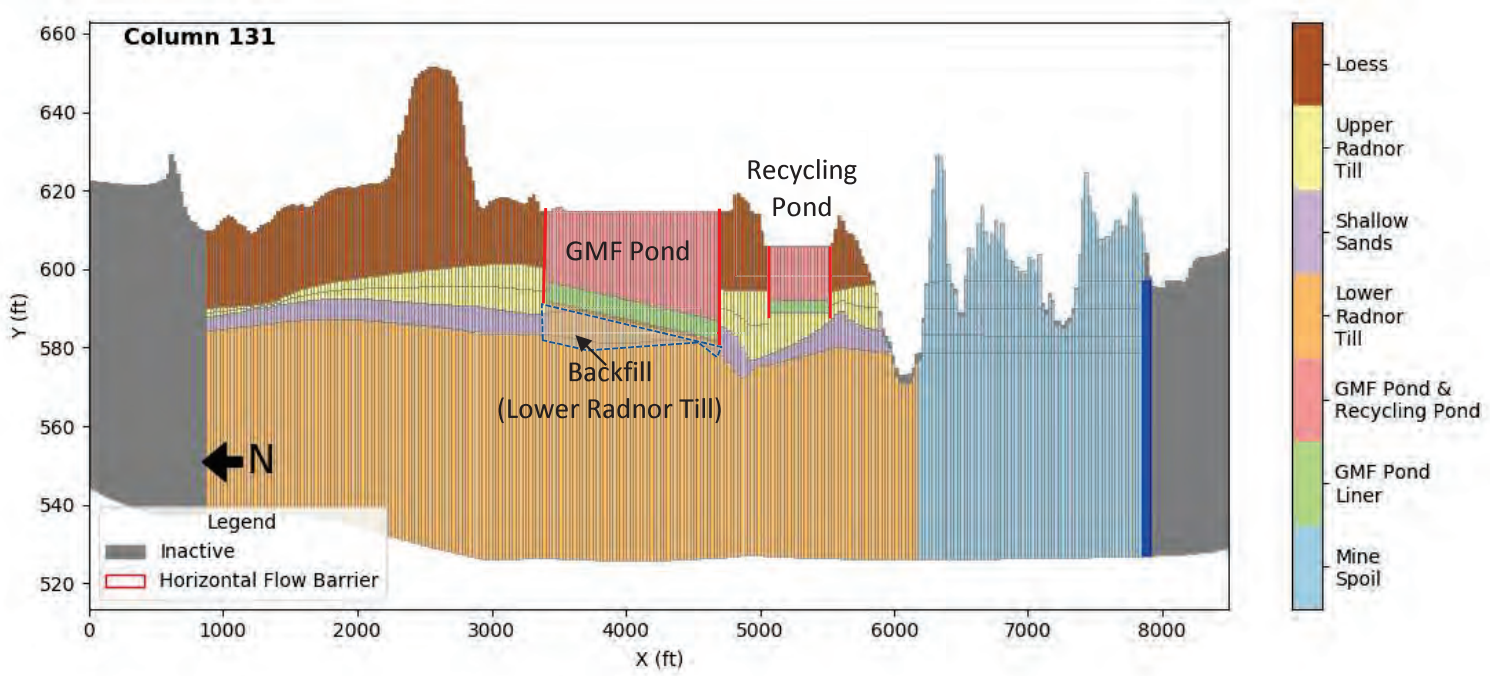

FIGURE 5-11 CROSS SECTION OF THE OF HYDROSTRATIGRAHPIC LAYERS FOR COLUMN 131 IN THE NUMERICAL MODEL

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK SITE
CANTON, ILLINOIS

RAMBOLL

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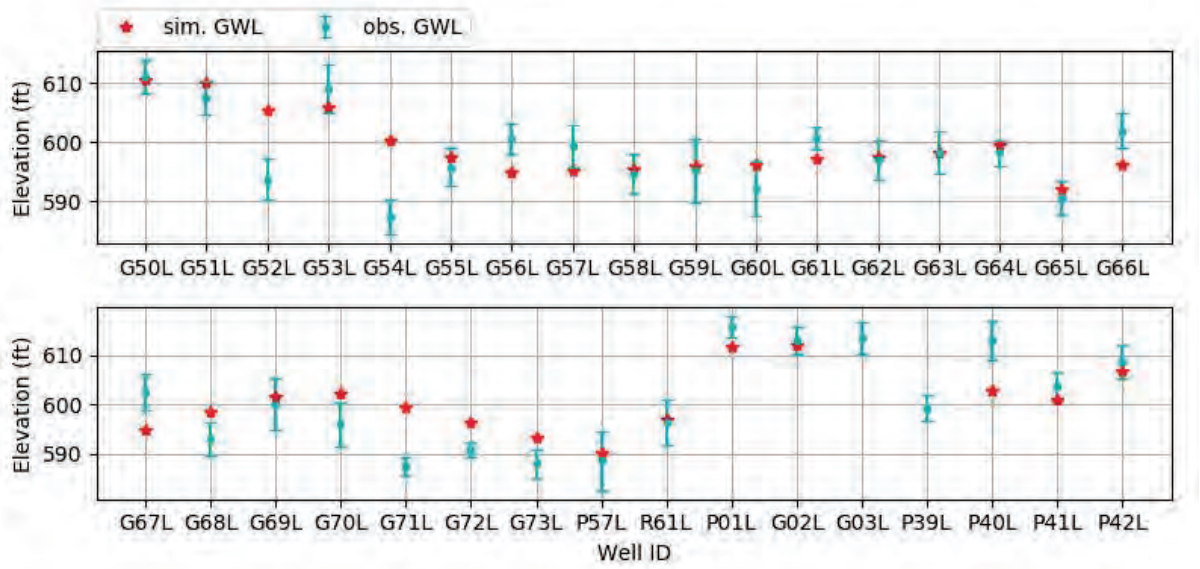
A. Loess



B. Shallow Sands

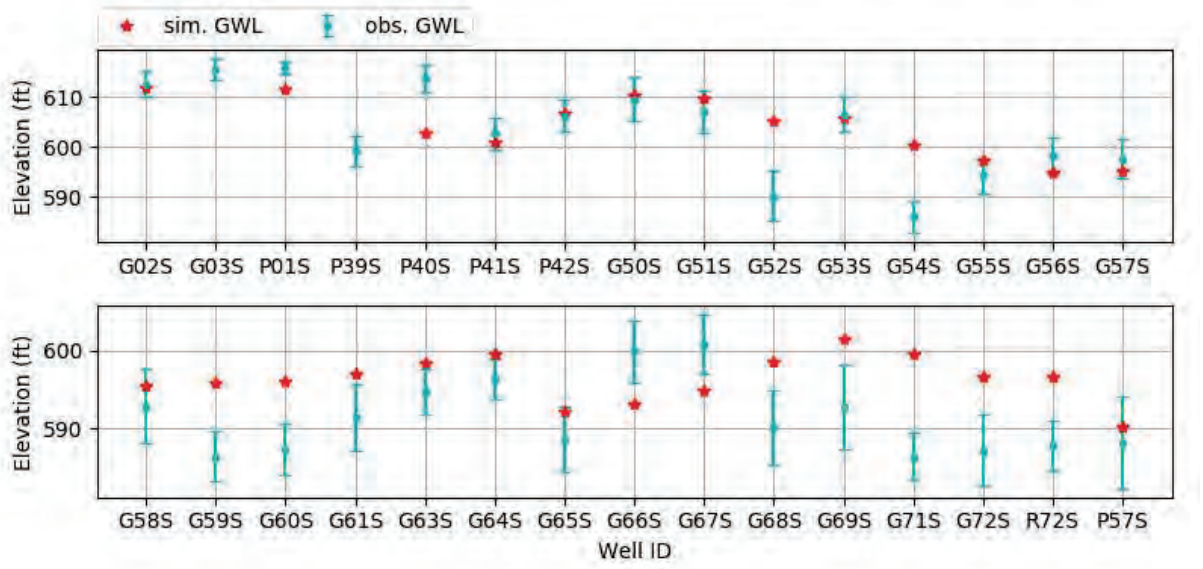


FIGURE 5-12 OBSERVED AND SIMULATED GROUNDWATER LEVELS FROM THE CALIBRATED MODEL FOR WELLS SCREENED IN **A** THE LOESS AND **B** THE SHALLOW SANDS.

(ERROR BARS REPRESENT 1 STANDARD DEVIATION)

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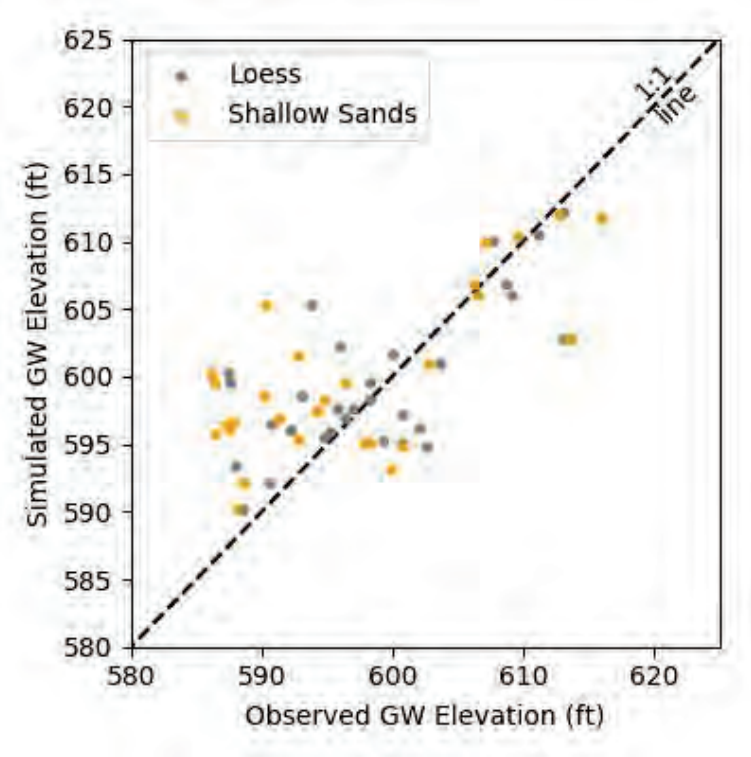

FIGURE 5-13 OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS FROM THE CALIBRATED MODEL

WELLS SCREENED IN THE LOESS ARE GRAY AND THE SHALLOW SANDS ARE ORANGE

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK SITE
CANTON, ILLINOIS

Electronic Filing: Received, Clerk's Office 06/20/2024

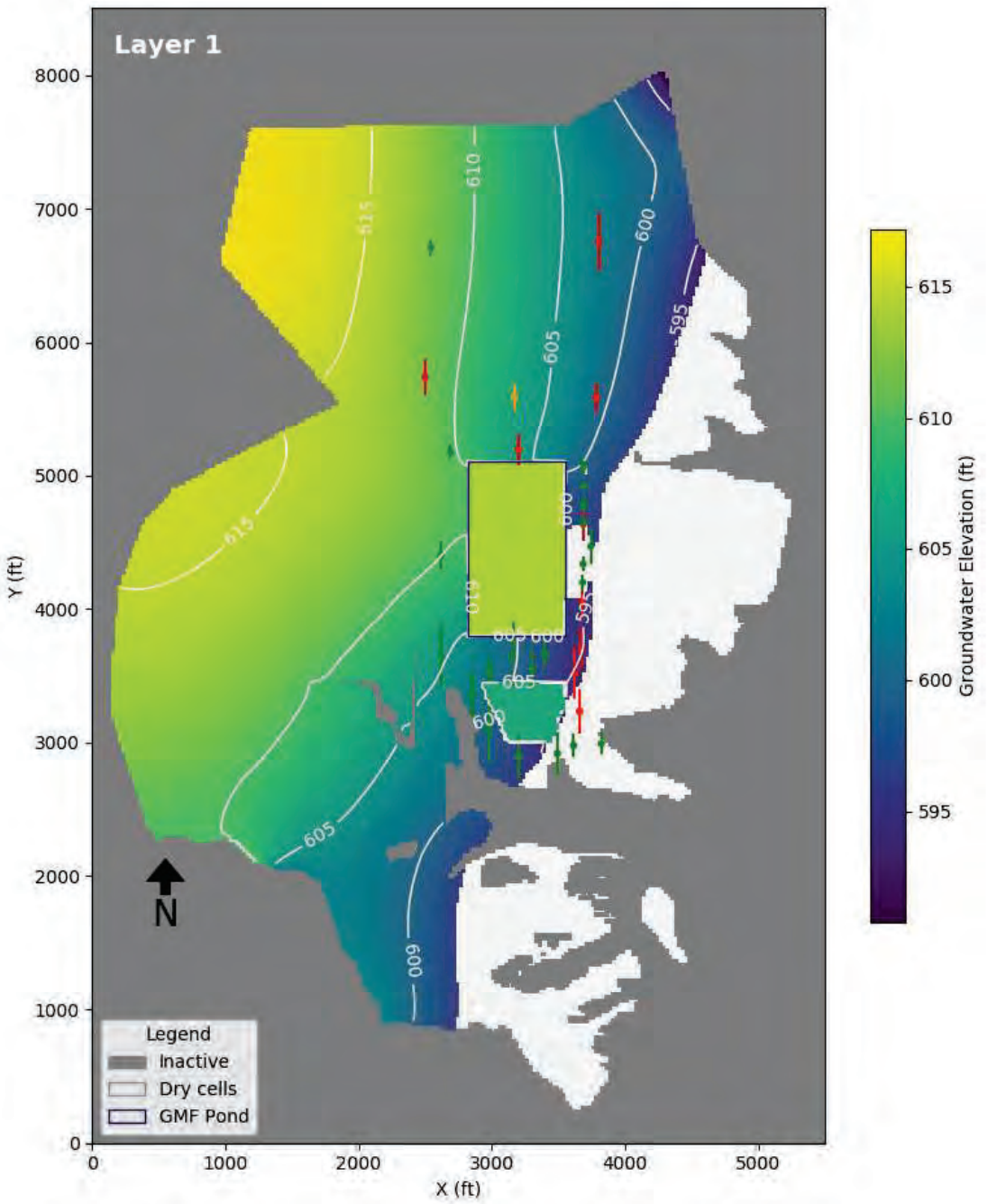

FIGURE 5-14 GROUNDWATER ELEVATION CONTOURS FOR LAYER 1 OF THE CALIBRATED NUMERICAL MODEL. WELL ERROR BARS INDICATE THE SIZE OF THE RESIDUAL BETWEEN SIMULATED AND OBSERVED GROUNDWATER LEVEL (GWL), AND THE COLOR INDICATES IF THE SIMULATED GWL IS ±1 (GREEN), ±2 (ORANGE) OR GREATER THAN ±3 (RED) STANDARD DEVIATIONS FROM THE OBSERVED GWL DATA

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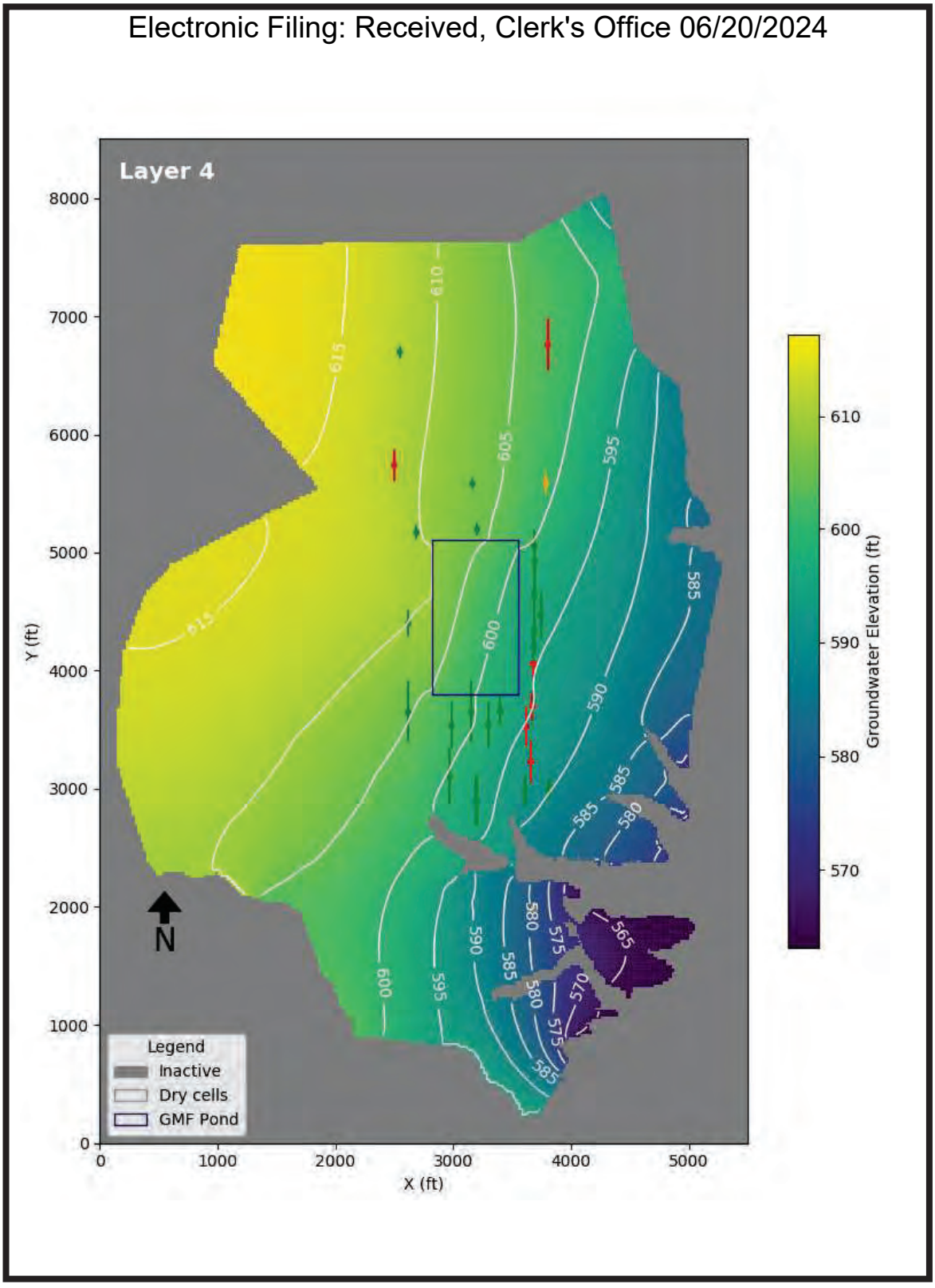
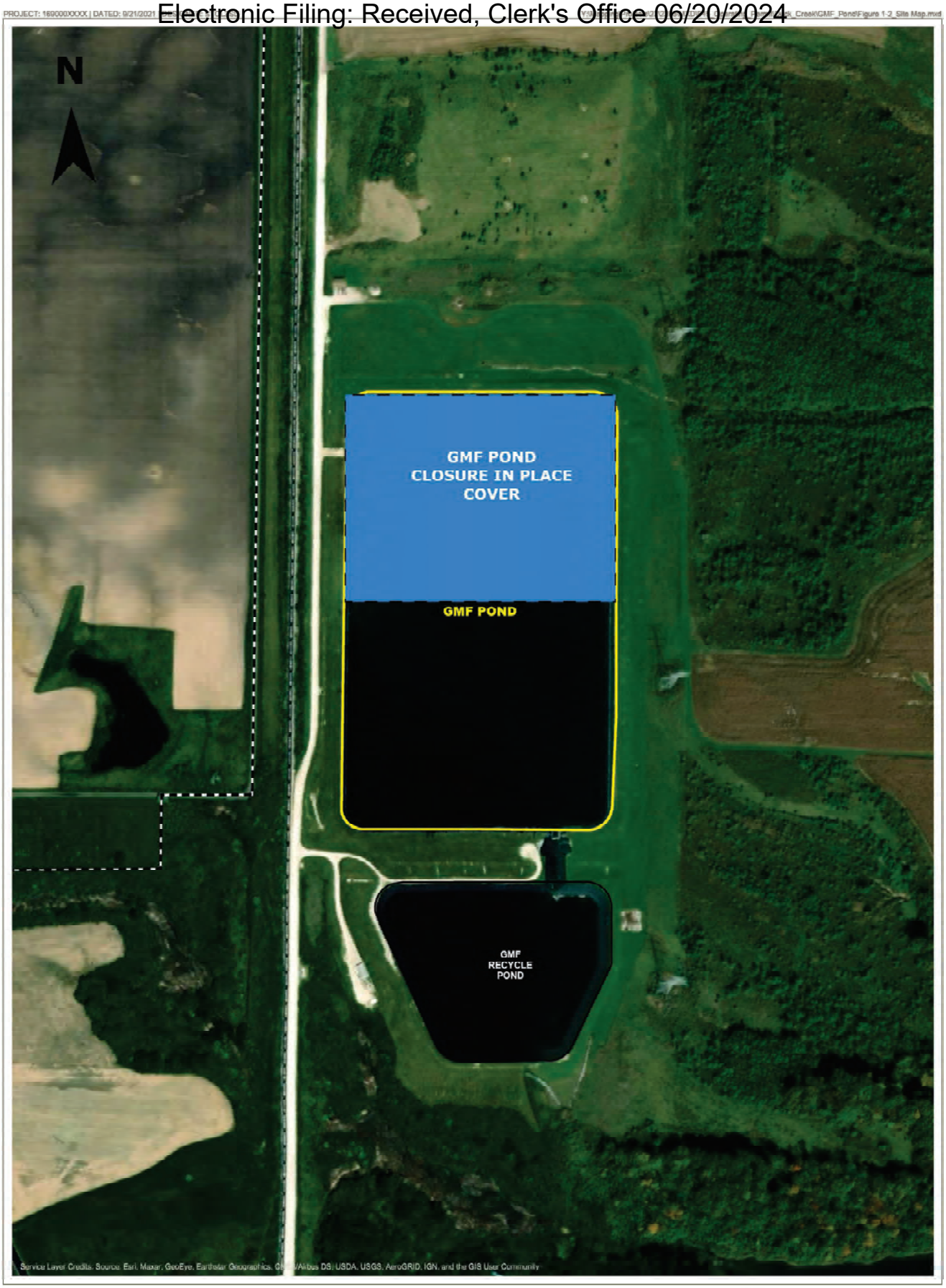


FIGURE 5-15 GROUNDWATER ELEVATION CONTOURS FOR LAYER 4 OF THE CALIBRATED NUMERICAL MODEL. WELL ERROR BARS INDICATE THE SIZE OF THE RESIDUAL BETWEEN SIMULATED AND OBSERVED GROUNDWATER LEVEL (GWL), AND THE COLOR INDICATES IF THE SIMULATED GWL IS ±1 (GREEN), ±2 (ORANGE) OR GREATER THAN ±3 (RED) STANDARD DEVIATIONS FROM THE OBSERVED GWL DATA

Electronic Filing: Received, Clerk's Office 06/20/2024



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

CLOSURE IN PLACE MODELING SCENARIO

FIGURE 6-1

GROUNDWATER MODELING REPORT
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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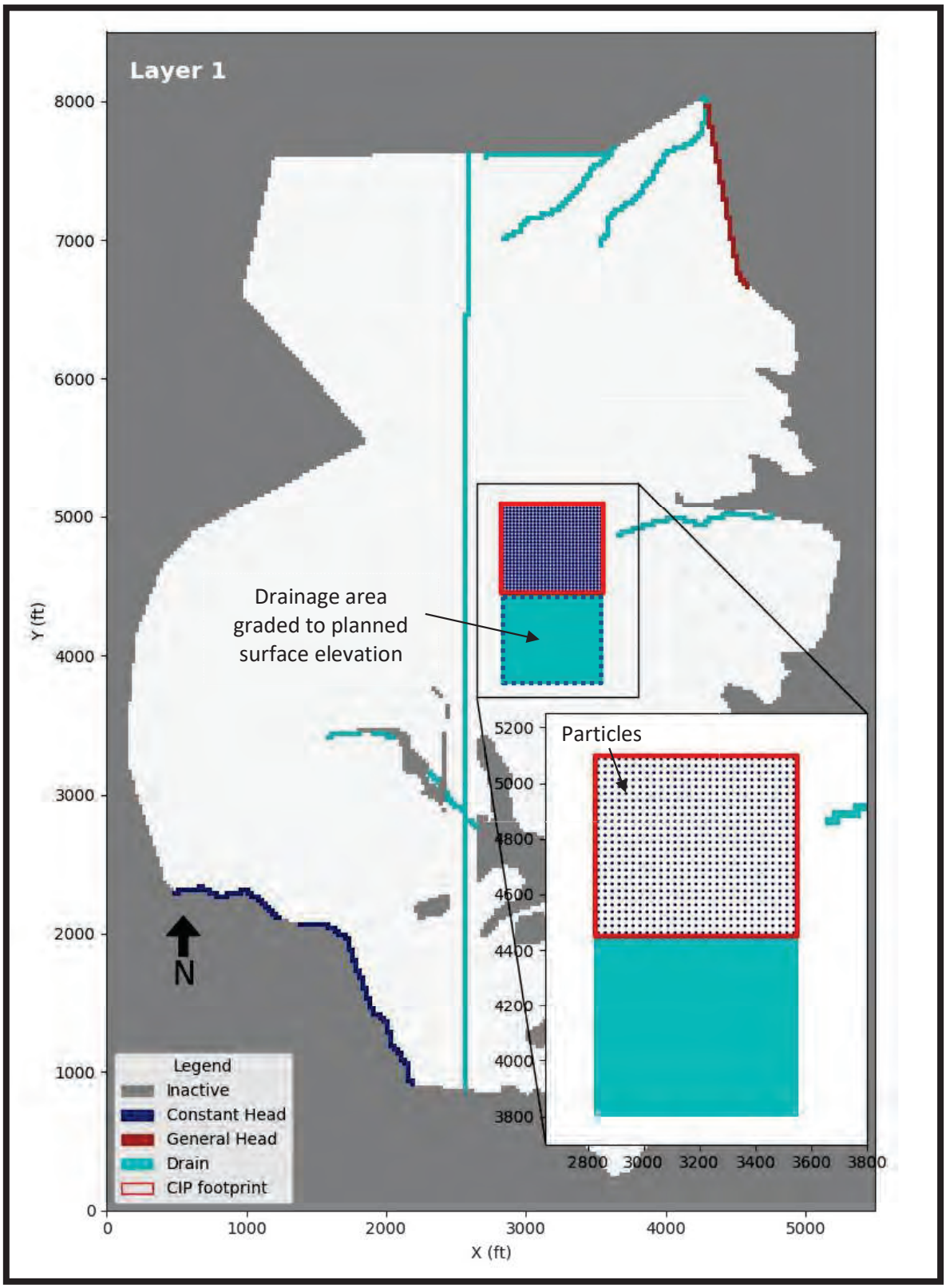

FIGURE 6-2 CLOSURE-IN-PLACE SCENARIO PARTICLE DISTRIBUTION

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APPENDIX A
EVALUATION OF POTENTIAL GWPS EXCEEDANCES

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GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE October 15, 2021 **Project No.** 21454831

TO David Mitchell, Stu Cravens, Vic Modeer
Illinois Power Resources Generating, LLC

CC Brian Hennings - Ramboll

FROM Roberta Russell, Jeffrey Ingram, Pat Behling - Golder

EVALUATION OF POTENTIAL GWPS EXCEEDANCES, GYPSUM MANAGEMENT FACILITY POND, DUCK CREEK POWER PLANT, FULTON COUNTY, ILLINOIS

1.0 INTRODUCTION

Illinois Power Resource Generating, LLC (IPRG) formerly operated the Duck Creek Power Plant (DCPP) located in Fulton County, Illinois. The Gypsum Management Facility Pond (GMFP, Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04) is a surface impoundment used to manage gypsum and related coal combustion residuals (CCRs) at the DCPP. The GMFP is regulated under Part 845 *"Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments"* (State CCR Rule or Part 845) which was promulgated by the Illinois Pollution Control Board (IPCB) on April 21, 2021.

IPRG is currently preparing an Operating Permit application for the GMFP as required under Section 845.230 which requires that known exceedances of groundwater protection standards (GWPS) be documented as a part of the Operating Permit application. In October 2021, Ramboll Americas Engineering Solutions, Inc. (Ramboll) identified potential GWPS exceedances for pH, arsenic, and lead in groundwater samples collected from selected monitoring wells in the vicinity of the GMFP as presented in the Operating Permit application for the GMFP. This Technical Memorandum was developed to further evaluate these potential GWPS exceedances.

1.1 Site Setting, Geology and Hydrogeology

The Duck Creek Power Plant (Site) is an inactive power plant in Fulton County, located in central Illinois, approximately 9 miles southeast of the town of Canton. The GMFP is located north of the power plant (see Figure 1). Agricultural land surrounds the DCPP.

Regionally, the Site is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems (NRT/OBG 2017).

Several large former surface coal mines are present in the vicinity; unlithified materials are present in the excavated strip mine spoils and have been mixed due to the surface mining activities. Mining operations in the area have ceased.

The uppermost bedrock stratum in the area is the Carbondale Formation of the Kewanee Group of the Pennsylvanian System. Bedrock in the area is identified as Pennsylvanian-age shale deposits. Bedrock occurs within approximately 50 feet (ft) of the ground surface in this area.

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The following two unlithified water-bearing units are present beneath the GMF Pond (beginning at the ground surface):

- Loess Zone – Moderate to high permeability silts and clayey silts, including: the Peoria and Roxanna Silt (Loess Units); underlain by the low permeability clayey diamictons of the Berry Clay and upper Radnor Till Members of the Glasford Formation.
- Shallow Sand Unit – Thin to moderately thick (6 to 18 ft), moderate to high permeability, medium-grained sand to silt with intercalated till seams; underlain by till sequences of the lower Radnor Till Member of the Glasford Formation.

The Uppermost Aquifer in the area consists of the Loess and Shallow Sand. These hydraulically connected units are underlain by the lower Radnor Till Member of the Glasford Formation. As shown on Figure 1, groundwater typically flows from northwest to southeast in the Uppermost Aquifer (NRT/OBG 2017).

1.2 Gypsum Management Facility Pond Design and Operation History

The GMFP is a 1,500-foot by 900-foot earthen berm double-lined CCR surface impoundment. Construction of the dual composite liner system and a leak detection system layer was completed in 2007-2009 under a rigorous construction quality assurance program (Hanson, 2009), which is an important determinant of liner system performance. The GMFP consists of the following components from top to bottom:

- Primary Composite Liner
  - SOLMAX 460T-1000 60-mil (0.06-inch thick) textured high-density polyethylene (HDPE) geomembrane
  - 1-foot cushion soil layer (2 feet in selected areas on the side slopes)
- Leak detection layer
  - SKAPS GT-142 4-0z/yd^2 geotextile separator
  - 1-foot granular drainage layer
  - SKAPS FE-110 10-oz/yd^2 geotextile cushion
- Secondary composite liner
  - Solmax 460T-4013 60-mil texture HDPE geomembrane
  - CETCO Bentomat SDN reinforced geosynthetic clay liner (GCL)
  - 3-foot compacted clay layer placed in 8-inch lifts, compacted to at least 95% of the standard Proctor maximum dry density at a moisture content between the standard Proctor optimum moisture content (OMC) and 5% of the wet OMC

The GMFP was used to store gypsum and to clarify gypsum transport water for reuse in the wet scrubber system at the DCPP until the plants retirement in 2019. Gypsum materials are the only waste managed in the GMFP.

2.0 POTENTIAL GWPS EXCEEDANCES REVIEW

As required by Section 845.230 (d)(2)(M), an evaluation of the history of potential GWPS exceedances was competed for the Operating Permit application by Ramboll. Data collected from groundwater samples collected from the GMFP monitoring well network since January 30, 2015, were evaluated and potential exceedances of the GWPSs are summarized below.

- Field pH at monitoring well G52L: A field pH GWPS exceedance was noted in a single sample collected from this well in February 2021. The pH value of 6.4 standard units (s.u.) measured in the sample is outside the Part 845 GWPS pH range of 6.5-9.0 s.u. G52L is located cross-gradient/up-gradient from the GMF pond and the screening interval is completed within the Loess unit.
- Field pH at monitoring well G60L: Field pH GWPS exceedances were noted in this well for each of the nine samples collected from this well from March-July 2021. The average pH for the nine samples was 6.1 s.u., which is outside the Part 845 GWPS pH range of 6.5-9.0 s.u. The well is located down-gradient on the east side of the GMFP and the screening interval is completed within the Loess unit.
- Arsenic at monitoring well P60: A total arsenic GWPS exceedance was noted in a single sample collected from this well in March 2021. The arsenic concentration of 0.02 milligrams per liter (mg/L) measured in the sample slightly exceeds the Part 845 GWPS of 0.01 mg/L. P60 is located down-gradient on the east side of the GMFP and the screening interval is completed within the Loess unit.
- Lead at monitoring well P60: A total lead GWPS exceedance was noted in a single sample collected from this well in March 2021. The lead concentration of 0.036 mg/L measured in the sample slightly exceeds the Part 845 GWPS of 0.015 mg/L. P60 is located down-gradient on the east side of the GMFP and the screening interval is completed within the Loess unit.

3.0 EVIDENCE THAT POTENTIAL GWPS EXCEEDANCES ARE NOT RELATED TO THE GMFP

Groundwater data for samples collected from monitoring wells that exhibited potential GWPS exceedances, background monitoring wells and pore water samples from the GMFP were evaluated. The review of these data indicates that the GWPS exceedances are not related to the GMFP, as described in the lines of evidence (LOE) below:

- **The ionic composition of groundwater collected from G52L, G60L and P60 is similar to groundwater collected from background wells G02S, G50S and G52S.**

A Piper diagram is a graphical technique used to classify and compare different groundwater sources based on their ionic composition in aqueous solution. As shown on the Piper diagram presented as Figure 2, the ionic composition of groundwater samples collected from G52L, G60L and P60 is similar to groundwater samples collected from the background wells – both groups of samples exhibit a calcium-bicarbonate water-type. Pore

and surface water samples collected from the GMFP exhibit a magnesium-chloride water-type, which is distinctly different to the background wells and monitoring wells G52L, G60L and P60. It would be expected that if there were a release from the GMFP, the ionic composition of the monitoring wells would show a mixing pattern towards the pore water ionic composition. However, as shown on Figure 2, the compositions of the monitoring wells are clustered with the background well compositions and distant from the pore and surface water compositions. These data support that the GWPS standard exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP.

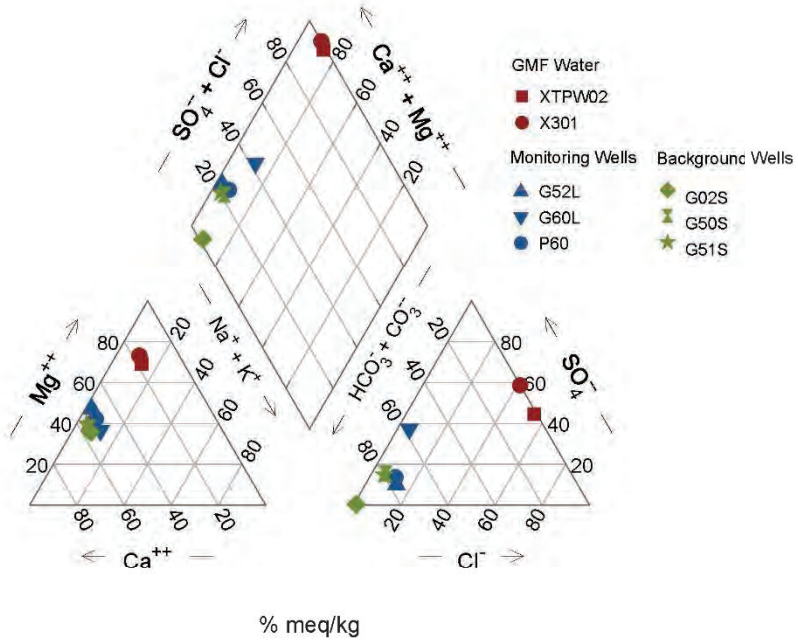


Figure 2: Piper diagram showing water chemistry of GMF Surface and Pore Water, monitoring wells G52L, G60L and P60, and background wells.

- **Concentrations of key GMFP constituents differ significantly in GMFP pore water samples and groundwater samples from monitoring wells G52L, G60L and P60.**

Concentrations of key constituents typically associated with CCR gypsum waste (boron, calcium, chloride, fluoride, sodium and sulfate) differ significantly between pore water/surface water in the GMFP and groundwater samples collected from the monitoring wells (Table 1, Figures 3 and 4). For example, boron, a typical gypsum indicator that is very mobile and non-reactive within a groundwater matrix, is elevated in GMF surface water and pore water samples (29 - 98 mg/L), whereas the monitoring wells G52L, G60L and P60 contain significantly lower concentrations (0.022 – 0.068 mg/L) that are more consistent with background results. Given the geochemical behavior of boron, it would be expected that elevated boron concentrations above background values would be observed in monitoring wells had a release occurred from the GMF pond. Similarly, fluoride and sulfate, other very mobile GMF constituents, would be expected to be observed in monitoring wells above the site GWPS in the event of a release from the GMF Pond. Figures 3 and 4 below and Table 1 show the

differences in concentrations between GMF surface water/pore water and monitoring wells for other key GMF constituents. Table 1 also contains site background and the Part 845 GWPSs. These data support that the GWPS standard exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP.

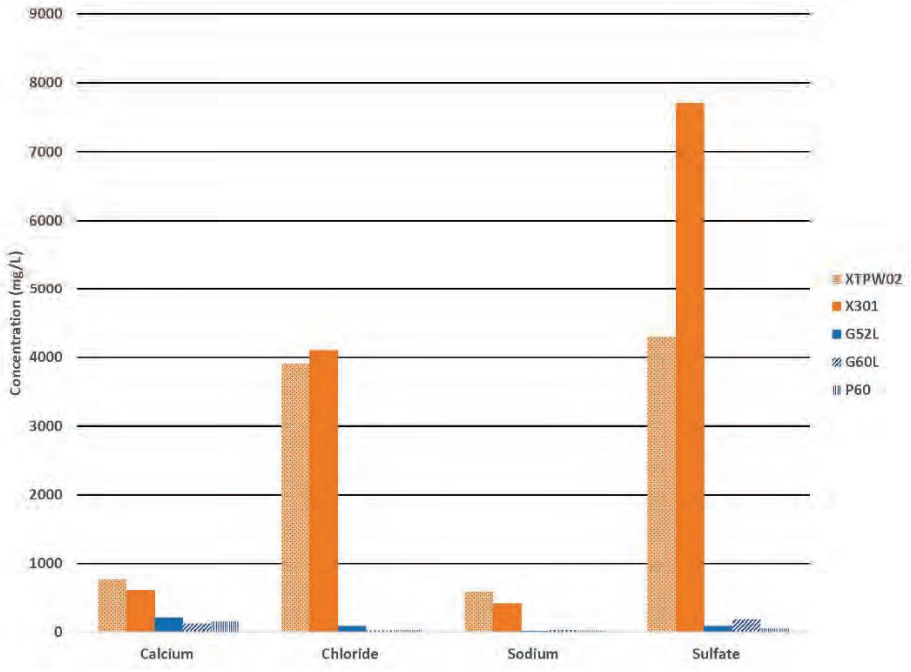


Figure 3: Bar chart showing GMFP constituent concentration comparisons between GMFP Surface and Pore Water and monitoring wells G52L, G60L and P60.

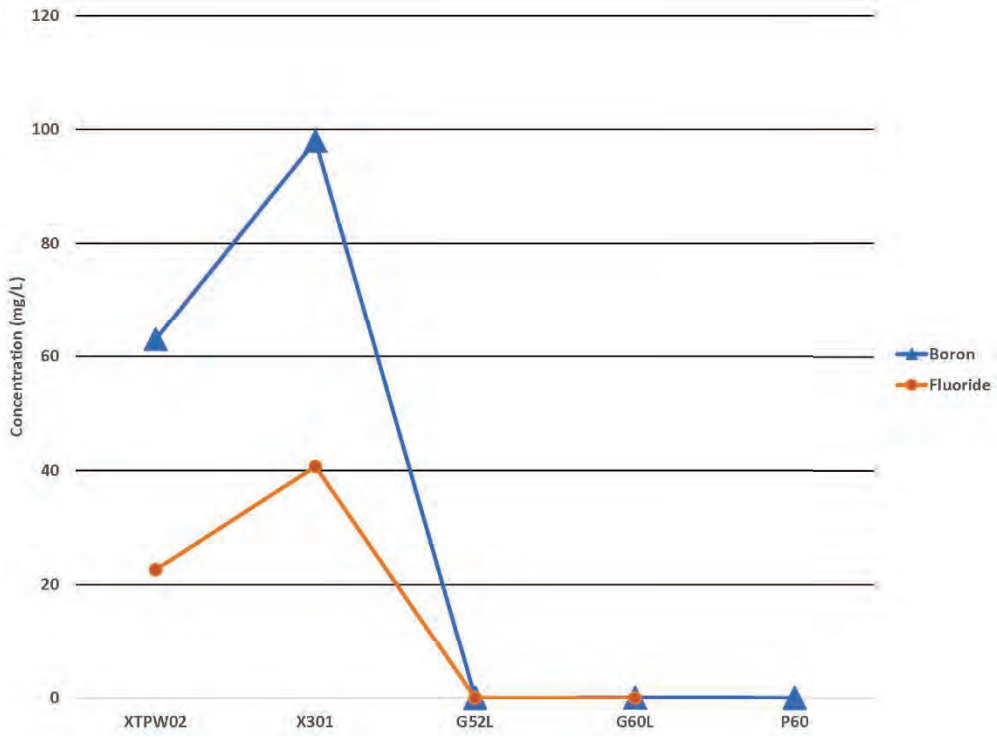


Figure 4: Line chart showing GMFP constituent concentration comparisons between GMFP Surface and Pore Water and monitoring wells G52L, G60L and P60.

- **High turbidity was recorded on the groundwater sampling record for the sample collected from P60.**

The arsenic and lead GWPS exceedances were based on a single sample collected from P60 in March 2021. The groundwater sampling record indicated an unusually high turbidity reading just before sample collection (1620 nephelometric turbidity units (NTU)). According to the sampling record, the sample did not appear to be field filtered, nor was it filtered in the lab. Thus, the arsenic and lead sample concentrations are likely elevated due to the presence of excessive soil and/or colloidal particles in the sample and are not representative of actual groundwater conditions in the vicinity of this well. These circumstances support the conclusion that GWPS standard exceedances of lead and arsenic in P60 are not related to the GMFP.

- **A peat layer ranging in thickness from 1 to 4 feet is present in the immediate vicinity of P60.**

Peat was recorded in the boring log of P60 within the saturated zone (approximately 19.5-20.5 and 24-24.2 feet below ground surface (ft bgs)), but above the screened interval of the well (approximately 29.5-34.5 feet bgs) (Appendix A). Approximately 4 feet of peat was recorded within the saturated zone in a nearby soil boring, B-55 (approximately 13.5-17.5 feet bgs). Given the interconnected nature of the unlithified water-bearing units, it is possible that the peat layer is interacting with the groundwater-bearing unit in the immediate vicinity. Peat is typically associated with low pH and is known to sequester certain metals, including arsenic and lead. In combination with a high turbidity and unfiltered sample, this may be the cause of the slightly elevated arsenic

and lead concentrations in P60. Thus, the GWPS standard exceedances of pH in G60L and the arsenic lead exceedance in P60 may be associated with the peat layer encountered in the immediate vicinity of those wells.

- **Arsenic and lead are not typical CCR indicators and are not present in GMFP pore and surface water above the GWPS.**

Arsenic and lead are not typical coal ash or gypsum indicators (EPRI, 2017). As shown on Table 1, arsenic and lead have been either not detected or detected below the applicable GWPS in GMFP pore and surface water samples. In addition, concentrations in GMFP pore and surface water are lower than concentrations measured in the groundwater sample collected from P60. These data support that GWPS exceedances of lead and arsenic in P60 are not related to the GMFP, as the unit is not a source of elevated arsenic or lead.

- **The GMFP liner was constructed with a dual composite liner system with a leak detection system, has undergone rigorous construction quality assurance and has indicated strong performance**

As discussed in Section 2.0, the GMFP liner was constructed with a primary and secondary liner system with a leak detection layer between the primary and secondary liners. The construction process underwent a detailed construction quality assurance program (Hanson, 2009). The leak detection system has to date shown excellent performance of the primary liner system. Pumps in the leak detection system designed to operate to remove water from the primary liner have only run for a few hours for the lifetime of the facility (beginning in 2009). This indicates that a release from the GMFP has likely not occurred and that the GWPS standard exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP.

4.0 SUMMARY

The evaluation presented in this document demonstrates that the GWPS exceedances of pH in G52L and G60; the arsenic exceedance in P60; and the lead exceedance in P60 are not related to the GMFP. The following lines of evidence demonstrate the GWPS exceedances are not related to the GMFP:

- The ionic composition of groundwater collected from G52L, G60L and P60 is similar to groundwater collected from background wells G02S, G50S and G52S and not the pore water/surface water in the GMFP.
- Concentrations of key gypsum constituents differ significantly between GMFP pore water samples and groundwater samples collected from monitoring wells G52L, G60L and P60.
- High turbidity was recorded on the groundwater sampling record for the sample collected from P60, which likely resulted in arsenic and lead concentrations that are not representative of actual groundwater conditions in the vicinity of this well.
- Arsenic and lead are not CCR indicators for this CCR unit and are not present in GMFP pore and surface water above their corresponding GWPS.
- The GMFP liner was constructed with a dual composite liner system with a leak detection system, has undergone rigorous construction quality assurance and has indicated strong performance.

- Naturally occurring peat is present within the saturated zone in the immediate vicinity of P60 and G60L and may be causing naturally occurring lower pH in G60L and slightly elevated arsenic and lead concentrations in P60, particularly in a high-turbidity, unfiltered groundwater sample.

5.0 REFERENCES

Electric Power Research Institute (EPRI). 2017, Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites, Report 3002010920, October 2017

Hanson (Hanson) Professional Services Inc. 2009 Acceptance Report, Gypsum Stack, Gypsum Management Facility, AERG Duck Creek Power Generating Station. December.

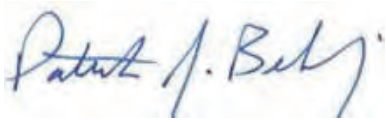
Natural Resource Technology, an OBG Company (NRT/OBG), October 17, 2017b. Hydrogeologic Monitoring Plan. Duck Creek GMF Pond – CCR Unit ID 203, Duck Creek Landfill – CCR Unit ID 204. Duck Creek Power Station, Canton, Illinois. Illinois Power Resources Generating, LLC.

6.0 CLOSING

Golder appreciates the opportunity to serve as your consultant on this project. If you have any questions concerning this Technical Memorandum or need additional information, please contact the undersigned.

Golder Associates Inc.





Roberta Russell
Senior Geologist
RR/JSI/PJB

Pat Behling
Principal, Practice Leader

Attachments: Table 1 – GMF Pond Surface Water, Pore Water, and Groundwater Monitoring Data
Figure 1 – Gypsum Management Facility Pond Well Locations and Typical Groundwater Flow Direction
Appendix A – Boring Logs

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Table

Table 1

GMF Pond Surface Water, Pore Water and Groundwater Monitoring Data

Duck Creek Power Plant

Canton, Illinois

Sampling Information		Potential Exceedance Constituents			Key Flue Gas Desulfurization Material (Gypsum) Constituents					
Well ID	Sampling Date	pH	Arsenic (Total)	Lead (Total)	Boron (Total)	Calcium (Total)	Chloride (Total)	Fluoride (Total)	Sodium (Total)	Sulfate (Total)
Units		SU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Part 845 Groundwater Protection Standards										
Site Background	NA	6.6 - 7.4	0.0092	0.015	0.21	NA	17	0.5	NA	55
Part 845 Standard	NA	6.5 - 9.0	0.01	0.0075	2	NA	200	4	NA	400
Part 845 GWPS	NA	6.5 - 9.0	0.01	0.015	2	NA	200	4	NA	400
GMF Pond Surface Water and Pore Water Samples										
XTPW02	6/23/2021	6.55	0.0026	ND < 0.001	63	750	3,900	22.6	570	4,300
X301	2/24/2021	5.50	NS	NS	29	180	1,200	14.4	110	2,300
X301	4/14/2021	6.70	0.0031	0.0013	97	580	3,700	35.4	390	7,300
X301	4/29/2021	6.60	0.0025	ND < 0.001	88	560	3,600	36.9	400	7,200
X301	5/12/2021	6.48	0.0024	ND < 0.001	84	560	4,100	40.7	410	7,700
X301	6/1/2021	6.64	0.0029	ND < 0.001	98	550	3,700	36.8	400	7,300
X301	7/26/2021	6.22	0.0018	ND < 0.001	85	600	3,600	38.1	370	6,900
Monitoring Wells										
G52L*	2/19/2021	6.39	ND < 0.001	ND < 0.001	0.037	210	30	ND < 0.25	13	87
G60L	4/14/2021	6.20	ND < 0.001	ND < 0.001	0.034	110	19	ND < 0.25	29	ND < 250
G60L	4/29/2021	6.10	ND < 0.001	ND < 0.001	0.029	120	19	ND < 0.25	31	160
G60L	5/13/2021	6.19	ND < 0.001	ND < 0.001	0.025	110	19	ND < 0.25	30	180
G60L	6/1/2021	6.26	ND < 0.001	ND < 0.001	0.029	110	20	ND < 0.25	30	170
G60L	6/15/2021	6.18	ND < 0.001	ND < 0.001	0.029	110	16	ND < 0.25	32	180
G60L	6/21/2021	6.16	ND < 0.001	ND < 0.001	0.068	110	18	ND < 0.25	29	180
G60L	7/12/2021	5.98	ND < 0.001	ND < 0.001	0.027	110	18	ND < 0.25	30	180
G60L	7/28/2021	6.22	ND < 0.001	ND < 0.001	0.022	110	15	ND < 0.25	29	160
P60	3/24/2021	6.60	0.02	0.036	0.056	150	32	NS	22	53

Notes:

1) GMF - Gypsum Management Facility, SU - standard unit, mg/L - milligrams per liter, ND - non-detect, NS - not sampled.
2) X301 samples are collected from a riser pipe from the ring drain beneath the pond.
3) XTPW02 results represent a porewater sample.
4) * - G52L data displays dissolved values.
5) Site background values based on Ramboll Determination of Potential Exceedances Table.
6) GWPS - Groundwater Protection Standard.
7) NA - Not Available.

Created by: BTT
Checked by: GM
Reviewed by: PJB

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Figure

R002740

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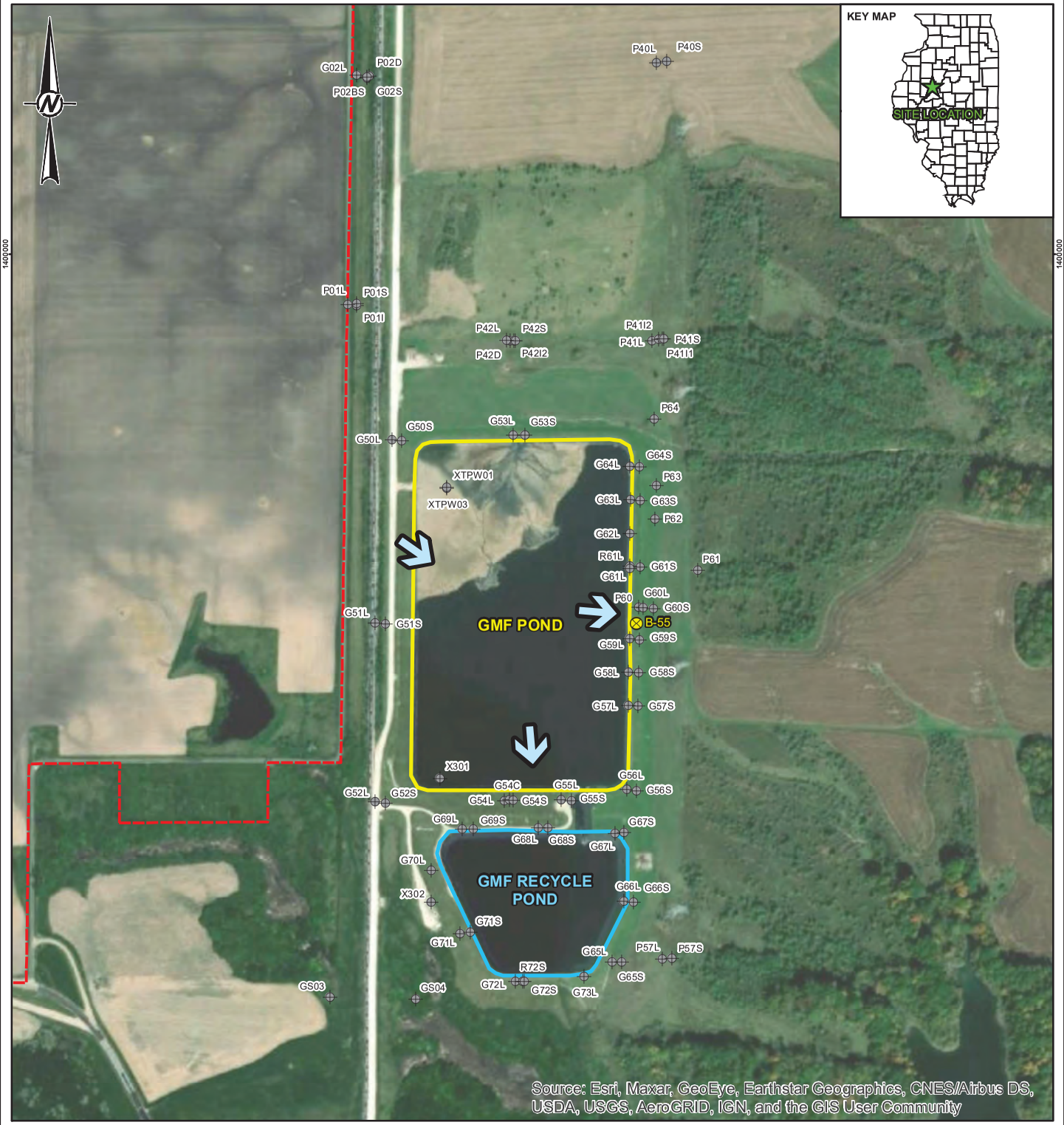

LEGEND

- WELL LOCATION
- SOIL BORING LOCATION
- APPROXIMATE PROPERTY BOUNDARY
- TYPICAL GROUNDWATER FLOW DIRECTION

0 250 500 1,000 Feet

NOTE(S)

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GMF - GYPSUM MANAGEMENT FACILITY.

REFERENCE(S)

1. RAMBOLL 2020. ILLINOIS ADMINISTRATIVE CODE PART 845 DATA GAP ANALYSIS AND WORK PLAN, DUCK CREEK GYPSUM MANAGEMENT FACILITY AND RECYCLE POND - CCR UNIT 203 AND 206.

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC.
DUCK CREEK POWER PLANT

PROJECT
MONITORED NATURAL ATTENUATION EVALUATION

TITLE
GYPSUM MANAGEMENT FACILITY POND WELL LOCATIONS AND TYPICAL GROUND WATER FLOW DIRECTION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-14
DESIGNED	JSI
PREPARED	ETF
REVIEWED	BTT
APPROVED	PJB

PROJECT NO.	PHASE	REV.	FIGURE
21454831	0001	0	1

PATH: C:\Users\EVFomey\Golder Associates\21454831 Vistra IL MNA Part 845 Support - 5 Technical Work\Phase I - Duck Creek\1.10 - Figures\Production\Duck Creek Well Locations.mxd PRINTED ON: 2021-10-14 AT 11:35:53 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0

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Appendix A
Boring Logs

FIELD BORING LOG

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HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: **Start:** 4/1/407
Finish: 4/4/2007
WEATHER: Overcast, cool

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler

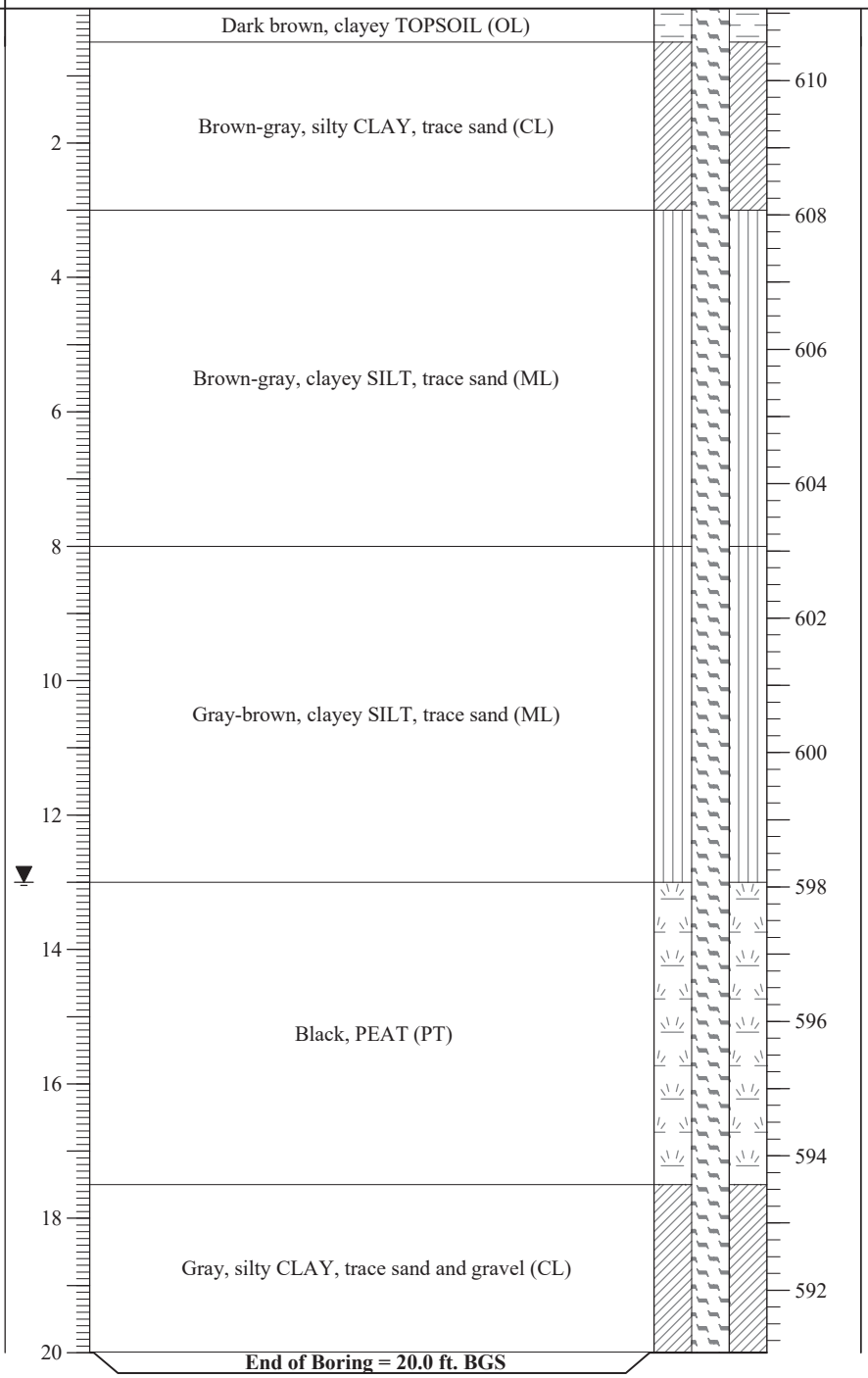
FIELD STAFF: **Driller:** B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-55
Well ID: hole abandoned
Surface Elev: 611.07 ft. MSL
Completion: 20.00 ft. BGS
Station: 15,438.7N
987.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
1A	15/18 *83%*	ss	*2-3 3* N=6	29		1.75 *B*
2A	16/18 *89%*	ss	*3-4 5* N=9	22		0.78 *BSh*
3A	16/18 *89%*	ss	*3-4 4* N=8	26		
4A	15/18 *83%*	ss	*3-4 5* N=9	26		1.94 *BSh*
5A	18/18 *100%*	ss	*2-3 4* N=7	33		1.32 *B*
6A	18/18 *100%*	ss	*3-4 5* N=9	20		1.16 *BSh*



NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL
1A	14/24 58%	SS	2-3 3-4 N=6				0	FILL - Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.	620
2A	18/24 75%	SS	3-6 8-11 N=14	17.5			2		618
3A	15/24 63%	SS	3-4 6-7 N=10	19.6			4		616
4A	20/24 83%	SS	6-8 11-14 N=19	18.5			6		614
5A	22/24 92%	SS	3-5 6-7 N=11	26.8			8	Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.	612
6A	21/24 88%	SS	2-4 5-5 N=9	23.8			10	Yellowish brown (10YR5/8) with 30% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.	610
7A	20/24 83%	SS	4-4 6-7 N=10	22.8			12		608
8A	21/24 88%	SS	5-6 7-7 N=13	22.1			14	Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, moist, medium, SILT with few clay and trace sand.	606
9A	21/24 88%	SS	5-5 6-6 N=11	21.0			16	▼	604
10A	24/24 100%	SS	2-3 4-7 N=7	28.1			18	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, medium, SILT with few clay and trace sand.	602
10B				61.7				Dark yellowish brown (10YR3/4), moist, medium, SILT with few clay and trace sand, trace organics.	
							20	Dark brown (10YR3/3), moist, medium, PEAT.	

Borehole Detail

Remarks

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark brown (10YR3/3), moist, medium, PEAT. *[Continued from previous page]*		600	
11A	20/24 *83%*	SS	*2-5* *6-7* N=11	31.4			22	Very dark gray (10YR3/1), moist, medium, SILT with some clay and trace sand, trace organics.		598	
12A	24/24 *100%*	SS	*9-8* *7-6* N=15	33.7			24	Very dark gray (10YR3/1), wet, medium, SILT with some clay and trace sand, trace organics.		596	
								Dark brown (10YR3/3), moist, medium, PEAT.			
13A	20/24 *83%*	SS	*4-3* *4-4* N=7	23.0			26	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand and gravel.		594	
14A	22/24 *92%*	SS	*4-5* *6-6* N=11	20.6			28			592	
15A	24/24 *100%*	SS	*3-3* *4-5* N=7	17.5			30	Greenish gray (5G6/1), moist, medium, CLAY with some silt and trace sand and gravel.		590	
16A	24/24 *100%*	SS	*1-3* *3-3* N=6	20.2			32			588	
17A	24/24 *100%*	SS	*5-6* *6-7* N=12	15.9			34	Greenish gray (5G6/1), wet, soft, SILT with few clay, little sand, and trace gravel.		586	
	0/7 *0%*	BD									

End of Boring = 34.62 ft bgs

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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APPENDIX B
MODFLOW AND HELP MODEL FILES
(ELECTRONIC ONLY)

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APPENDIX C
HELP MODEL INPUT AND OUTPUT

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Appendix C: Inputs and Summary of HELP Closure-In-Place cap simulation
(40mil LLDPE and 2ft soil cover)

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/12/2022 9:32

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	6	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.4073	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	18	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.3829	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0338	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	4	%
Drainage Length	=	450	ft

Layer 4

Electronic Filing: Received, Clerk's Office 06/20/2024

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness	=	240	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.105	vol/vol
Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.105	vol/vol
Effective Sat. Hyd. Conductivity	=	6.70E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	90.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	15	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	3.294	inches
Upper Limit of Evaporative Storage	=	3.688	inches
Lower Limit of Evaporative Storage	=	1.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	34.543	inches
Total Initial Water	=	34.543	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	40.5	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days

Electronic Filing: Received, Clerk's Office 06/20/2024

End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	67	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	75	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/12/2022 9:36

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	12.581	[3.246]	685,044.7	34.24
Evapotranspiration	23.227	[2.957]	1,264,727.0	63.21
Subprofile1				
Lateral drainage collected from Layer 3	0.9541	[0.7929]	51,952.6	2.60
Percolation/leakage through Layer 4	0.000247	[0.00019]	13.5	0.00
Average Head on Top of Layer 4	0.0005	[0.0004]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000248	[0.00019]	13.5	0.00
Water storage				
Change in water storage	-0.0142	[1.0912]	-772.6	-0.04

* Note: Average inches are converted to volume based on the user-specified area.

Electronic Filing: Received, Clerk's Office 06/20/2024

Appendix C: Inputs and Summary of HELP Closure-In-Place cap simulation
(40mil LLDPE and 3ft soil cover)

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/13/2022 15:36

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	6	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.4073	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	30	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.3834	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0156	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	4	%
Drainage Length	=	450	ft

Layer 4

Electronic Filing: Received, Clerk's Office 06/20/2024

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness	=	240	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.105	vol/vol
Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.105	vol/vol
Effective Sat. Hyd. Conductivity	=	6.70E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	90.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	15	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	3.294	inches
Upper Limit of Evaporative Storage	=	3.688	inches
Lower Limit of Evaporative Storage	=	1.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	39.149	inches
Total Initial Water	=	39.149	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	40.5	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days

Electronic Filing: Received, Clerk's Office 06/20/2024

End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	67	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	75	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/13/2022 15:40

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	12.581	[3.246]	685,044.7	34.24
Evapotranspiration	23.227	[2.957]	1,264,727.0	63.21
Subprofile1				
Lateral drainage collected from Layer 3	0.9570	[0.8034]	52,108.0	2.60
Percolation/leakage through Layer 4	0.000258	[0.0002]	14.1	0.00
Average Head on Top of Layer 4	0.0005	[0.0004]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000258	[0.0002]	14.1	0.00
Water storage				
Change in water storage	-0.0171	[1.1899]	-928.6	-0.05

* Note: Average inches are converted to volume based on the user-specified area.

Electronic Filing: Received, Clerk's Office 06/20/2024

Appendix C: Inputs and Summary of HELP Closure-In-Place cap simulation
(3ft clay and 3ft soil cover)

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/13/2022 15:07

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	6	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.461	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	30	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.461	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 3
Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 4
Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness	=	240	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.105	vol/vol

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Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.1135	vol/vol
Effective Sat. Hyd. Conductivity	=	6.70E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	90.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	15	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	3.688	inches
Upper Limit of Evaporative Storage	=	3.688	inches
Lower Limit of Evaporative Storage	=	1.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	59.2	inches
Total Initial Water	=	59.2	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	40.5	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days
End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	67	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	75	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for: Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Electronic Filing: Received, Clerk's Office 06/20/2024

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/13/2022 15:10

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	6.844	[2.987]	372,642.1	18.62
Evapotranspiration	27.772	[3.713]	1,512,183.1	75.57
Subprofile1				
Percolation/leakage through Layer 3	2.147626	[0.073824]	116,938.2	5.84
Average Head on Top of Layer 3	26.2293	[2.126]	---	---
Subprofile2				
Percolation/leakage through Layer 4	1.973425	[0.573329]	107,453.0	5.37
Water storage				
Change in water storage	0.1595	[1.2078]	8,686.9	0.43

* Note: Average inches are converted to volume based on the user-specified area.

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APPENDIX H

Final Closure Plan

Electronic Filing: Received, Clerk's Office 06/20/2024

GOLDER
MEMBER OF WSP

APPENDIX H

Final Closure Plan for the Gypsum Management Facility Pond

Duck Creek Power Plant

Submitted to:

Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Submitted by:

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21454861-13-R-1

January 25, 2022

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1.0 INTRODUCTION

This Final Closure Plan has been prepared to address certain requirements of Illinois Administrative Code Title 35, Part 845, Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (Part 845) for Illinois Power Resources Generating, LLC's (IPRG's) Gypsum Management Facility (GMF) Pond at the Duck Creek Power Plant near Canton, Illinois. Specifically, this document addresses requirements pertaining to the development of a Final Closure Plan for the GMF Pond. The GMF Pond has identification codes as follow:

- IPRG ID Number: CCR Unit ID 203
- IEPA ID Number: W0578010001-04
- IDNR Dam ID Number: IL50573

1.1 Selected Closure Method

Part 845.720 (b)(3): The final closure plan must identify the proposed selected closure method, and must include the information required in subsection (a)(1) and the closure alternatives analysis specified in Section 845.710.

IPRG evaluated closure with a final cover system (hereafter referred to as closure in place or CIP) (Section 845.750) and closure by removal of CCR (CBR) (Section 845.740). An analysis of these closure alternatives is summarized in Attachment 1. Based on the Closure Alternatives Analysis, CIP with a final cover system has been identified as the most appropriate closure method. In combination with the existing dual composite liner system beneath the GMF Pond, the final cover system will provide complete encapsulation of gypsum in the GMF Pond, physically isolating it from contact with surrounding soils, groundwater, surface water, and the atmosphere, and minimizing the potential for release of CCR or leachate. The final cover system has been designed to minimize the post-closure infiltration of liquids into the waste.

2.0 FINAL CLOSURE PLAN

2.1 Narrative Closure Description

Part 845.720(a)(1)(A): A narrative description of how the CCR surface impoundment will be closed in accordance with this Part.

Closure grades and details are shown in the Drawings included as Attachment 2. The CIP concept was developed to reduce the gypsum footprint at closure, while also recognizing the complications associated with handling and stacking gypsum materials. Free liquids will be eliminated by removing liquid wastes or solidifying the remaining wastes prior to final cover system installation. The final cover system will have slopes of 4% to accommodate settlement, with an earthen berm constructed at the south end of the closure footprint to enhance stability. The location of the berm, as shown in Drawing 4, has been selected to accommodate the estimated volume of gypsum to be contained within the closure footprint based on the grading plan presented. The general sequencing plan for CIP is as follows:

- Ponded water will be pumped out from the GMF Pond. Approximately 112 million gallons of water were contained in the GMF Pond as of a December 2020 survey by IngenAE, not including the pore water within the roughly 400,000 cubic yards (cy) of gypsum. Pumping out the ponded water will enable gravity drainage of the gypsum to begin. Water pumped out of the GMF Pond will be routed to the Recycle Pond immediately south of the GMF Pond and then to Duck Creek Reservoir, where it will be managed in accordance with the National Pollutant Discharge Elimination System (NPDES) permit for the site.

- The upper gypsum layer will be dewatered within the northern portion of the GMF Pond as necessary to allow mobile equipment traffic across the surface using a series of trenches and sumps. Free liquids in the gypsum will be eliminated by removing liquid wastes or solidifying gypsum remaining in place. Liquid wastes and water flowing to sumps will be managed in accordance with the NPDES permit for the site.
- Where required to allow construction of the new berm in an east–west orientation at the south end of the closure footprint, gypsum will be excavated and relocated. The upstream face of the berm will be lined with a composite liner system, which will tie into the existing liner system. The new liner system will include (from bottom to top):
  - 2-foot-thick compacted soil liner (permeability of 1 x 10^{-7} cm/sec or less)
  - 60-mil high-density polyethylene (HDPE) geomembrane
- Liquid wastes will be removed from the remaining gypsum south of the berm, and the gypsum will be excavated and deposited north of the berm (i.e., within the closure footprint) to achieve the approximate closure grades shown in Attachment 2. This may be accomplished by traditional earthwork methods and/or by washing the material towards sumps at the south end of the GMF Pond, where the material can be collected and liquid wastes can be removed.
- In portions of the GMF Pond that are outside of (i.e., generally south of) the closure footprint, the geosynthetic components of the existing liner system will be removed and disposed in the closure footprint or in the existing permitted on-site landfill. The existing permitted on-site landfill has sufficient capacity to accept the removed materials. The earthen components of the existing primary liner system and leachate collection and removal system will be removed and stockpiled on site. Up to 1 foot of subsoil may also be removed. The subsoils will be visually observed for signs of CCR staining. If subsoils with CCR staining are observed, they will be removed and disposed.
- Once all gypsum is contained within the closure footprint and appropriate grades for closure have been achieved (with grading fill used as necessary), a final cover system will be installed over the closure footprint in accordance with Part 845.750. The final cover system will consist of (from top to bottom) the following:
  - Based on the demonstration provided in Attachment 3, pursuant to Section 845.750(c)(2), a 2-foot-thick final protective layer consisting of locally available soils compacted to between 80% and 95% of the standard Proctor maximum dry density. The uppermost 6 inches of the final protective layer will be tracked in place with a density suitable for establishment of vegetation. Soils are expected to consist primarily of low-plasticity silt or clay based on a review of site geotechnical information.
  - Drainage geocomposite.
  - 40-mil linear low-density polyethylene (LLDPE) geomembrane.
- Surface water channels will be excavated as shown in Attachment 2 to route stormwater flows away from the closure footprint.

2.2 Decontamination of CCR Surface Impoundment

Part 845.720(a)(1)(B): If closure of the CCR surface impoundment will be accomplished through removal of CCR from the CCR surface impoundment, a description of the procedures to remove the CCR and decontaminate the CCR surface impoundment in accordance with Section 845.740.

After gypsum south of the berm has been relocated to within the closure footprint, the geosynthetic components of the existing liner system will be removed and disposed in the closure footprint or in the existing permitted on-site landfill. The earthen components of the existing primary liner system and leachate collection and removal system will be removed and stockpiled on site. Up to 1 foot of subsoil may also be removed. The subsoils will be visually observed for signs of CCR staining. If subsoils with CCR staining are observed, they will be removed and disposed.

2.3 Final Cover System Performance Standards

Part 845.720(a)(1)(C): If closure of the CCR surface impoundment will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with Section 845.750, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in Section 845.750.

The final cover system is described in Section 2.1 and shown in the Drawings (Attachment 2). Documentation in support of the final cover system achieving the performance standards of Section 845.750 is provided in Section 4.7.

2.4 Maximum CCR Inventory Estimate

Part 845.720(a)(1)(D): An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR surface impoundment.

Based on a comparison between the permitted top-of-liner-system grades and the bathymetric and topographic data obtained by IngenAE in December 2020, the estimated volume of gypsum in the GMF Pond is approximately 400,000 cy. No additional CCR will be placed in the GMF Pond before it is closed.

2.5 Largest Surface Area Estimate

Part 845.720(a)(1)(E): An estimate of the largest area of the CCR surface impoundment ever requiring a final cover (see Section 845.750), at any time during the CCR surface impoundment's active life.

In the Closure Plan developed for compliance with the United States Environmental Protection Agency's (USEPA's) CCR Rule (40 CFR 257, Subpart D), the largest area of the GMF Pond ever requiring a final cover system was estimated to be approximately 31 acres. This area represents the entire footprint of the GMF Pond. The area of the closure footprint requiring a final cover system under this Final Closure Plan is approximately 15 acres.

2.6 Closure Completion Schedule

Part 845.720(a)(1)(E): A schedule for completing all activities necessary to satisfy the closure criteria in this Section, including an estimate of the year in which all closure activities for the CCR surface impoundment will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR surface impoundment, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR surface impoundment closure. When preparing the preliminary written closure plan, if the owner or operator of a CCR surface impoundment estimates that the time required to complete closure will exceed the timeframes specified in Section 845.760(a), the preliminary written closure plan must include the site-specific information, factors and considerations that would support any time extension sought under Section 845.760(b).

Table 1: Closure Completion Milestone Schedule

Milestone	Timeframe (all preliminary estimates)
Final Closure Plan Submittal	February 2022
Final Design and Bid Process	6 to 12 months after Final Closure Plan approval
Agency Coordination and Permit Acquisition ▪ State permits for dewatering/water treatment (NPDES), land disturbance, and dam modification	
Dewater and Stabilize CCR ▪ Pump water from GMF Pond ▪ Dewater and stabilize gypsum	12 to 18 months after issuance of necessary permits, design completion, and bid award
Consolidate Gypsum Footprint ▪ Construct berm ▪ Install new liner system on upstream face of berm ▪ Relocate gypsum south of berm to closure footprint	3 to 6 months after dewatering and gypsum stabilization
Installation of Final Cover System ▪ Prepare top of gypsum for final cover system installation ▪ Install geomembrane ▪ Install geocomposite ▪ Place final protective layer	3 to 6 months after gypsum relocation to closure footprint
Site Restoration ▪ Remove existing liner system south of berm ▪ Excavate drainage channel ▪ Seed and mulch final cover system and disturbed areas	3 to 6 months after final cover system installation
Timeframe to Complete Closure	Prior to April 2026

3.0 AMENDMENT OF THE FINAL CLOSURE PLAN

Part 845.720(b)(4): If a final written closure plan revision is necessary after closure activities have started for a CCR surface impoundment, the owner or operator must submit a request to modify the construction permit within 60 days following the triggering event.

IPRG will submit a written request to modify the construction permit within 60 days of a triggering event.

4.0 CLOSURE WITH A FINAL COVER SYSTEM

4.1 Minimization of Post-closure Infiltration and Releases

Part 845.750(a): The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will:

1) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere.

Post-closure infiltration into the GMF Pond will be minimized by the construction of a final cover system. The final cover system will consist of (from top to bottom) the following:

- Based on the demonstration provided in Attachment 3, pursuant to Section 845.750(c)(2), a 2-foot-thick final protective layer consisting of locally available soils compacted to between 80% and 95% of the standard Proctor maximum dry density. The uppermost 6 inches of the final protective layer will be tracked in place with a density suitable for establishment of vegetation. Soils are likely to consist primarily of low-plasticity silt or clay based on a review of site geotechnical information.
- Drainage geocomposite. This layer will provide lateral drainage to limit the potential for the final protective layer to become saturated.
- 40-mil LLDPE geomembrane.

The use of HDPE geomembrane was considered, but LLDPE geomembrane was selected because it can be installed more easily in a wider range of cold-temperature conditions. This final cover system is compliant with the Part 845 requirements, as described in Section 4.7, and will minimize the post-closure infiltration of liquids into the waste. After closure, the gypsum stored in the facility will be completely encapsulated by the final cover and liner systems, physically isolating it from contact with surrounding soils, groundwater, surface water, and the atmosphere, and minimizing the potential for release of CCR or leachate. This is supported by groundwater modeling, as presented in Appendix G to the Part 845 Construction Permit Application for the GMF Pond.

4.2 Preclusion of Future Impoundment

Part 845.750(a): The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will:

2) Preclude the probability of future impoundment of water, sediment, or slurry.

The final cover system will be crowned with 4% slopes to direct surface water away from the facility. Beyond the final cover system, channels will direct surface water away from the GMF Pond to existing site drainages.

4.3 Provisions for Preventing Instability, Sloughing and Movement

Part 845.750(a): The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will:

3) Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period.

An assessment of the GMF Pond structural stability was completed as part of compliance with USEPA's CCR Rule (AECOM 2016). This assessment concluded that the GMF Pond meets stability factor of safety requirements and does not pose a significant risk of instability.

An earthen berm is provided in the closure design to enhance stability along the southern end of the closure footprint. Slope stability calculations are included in Attachment 4 to demonstrate that factors of safety for static and seismic stability after closure are acceptable. The slope stability calculations also considered veneer stability to verify that the final cover system will not be susceptible to instability, sloughing, or movement during the closure and post-closure care period.

4.4 Minimize the Need for Future Maintenance

Part 845.750(a): The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will:

4) Minimize the need for further maintenance of the CCR surface impoundment

The 4% design closure slopes are sufficient to adequately shed water from the facility but are flat enough to limit erosion of the final protective layer. Minor maintenance of the final cover system (potentially including filling of low areas, reseeding, fertilizing, etcetera) will likely be necessary for several years after completion of final cover system construction, as described in the Post-closure Care Plan (Appendix J to the Part 845 Construction Permit Application for the GMF Pond). The need for long-term future maintenance is expected to be minimal after installation of the final cover system has been completed and vegetation has been established.

The channels designed to convey surface water runoff away from the closed facility have been sized to accommodate the 25-year, 24-hour storm event. The design calculations are provided in Attachment 5.

4.5 Be Completed in the Shortest Amount of Time

Part 845.750(a): The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will:

5) Be completed in the shortest amount of time consistent with recognized and generally accepted engineering practices.

The CIP method will require significantly less material handling compared with a CBR approach. Both approaches require the removal of liquid wastes, but the CIP method will require relocation of less than 25% of the gypsum present in the GMF Pond. This reduced material handling volume means that the CIP construction can be completed in approximately 24 to 30 months, compared with 36 to 48 months, or possibly more, for CBR.

4.6 Drainage and Stabilization

Part 845.750(b): Drainage and Stabilization of CCR Surface Impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR surface impoundment must meet the requirements of this subsection (b) before installing the final cover system required by subsection (c).

1) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.

2) Remaining wastes must be stabilized sufficiently to support the final cover system.

Approximately 112 million gallons of water will be pumped from the GMF Pond as the initial step for facility closure. After removal of the ponded water, the gypsum will still be unsuitable for supporting heavy construction traffic over much of the footprint. Careful planning will be required to safely work on the wet gypsum within the GMF Pond. The planned gypsum removal and relocation will rely on a series of trenches or other engineering measures to remove liquid wastes or solidify the remaining wastes. Trenches will shorten drainage routes to facilitate gravity removal of liquid wastes in the gypsum (i.e., liquid that is readily separable from the gypsum under ambient temperature and pressure) in the vicinity of each trench and direct the liquid wastes to sumps. Other engineering measures may be considered to facilitate removal of liquid wastes. Sumps will be used to collect liquid wastes, which will be managed in accordance with the NPDES permit for the site. Using the process described or other engineering measures for removal of liquid wastes or solidification of the remaining wastes, the gypsum remaining in place will be stabilized sufficiently to support the final cover system.

4.7 Final Cover System

Part 845.750(c): Final Cover System. If a CCR surface impoundment is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and, at a minimum, meets the requirements of this subsection (c). The final cover system must consist of a low permeability layer and a final protective layer. The design of the final cover system must be included in the preliminary and final written closure plans required by Section 845.720 and the construction permit application for closure submitted to the Agency.

4.7.1 Low-Permeability Layer

Part 845.750(c)(1) Standards for the Low Permeability Layer. The low permeability layer must have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a hydraulic conductivity no greater than 1 x 10^{-7} cm/sec, whichever is less. The low permeability layer must be constructed in accordance with the standards in either subsection (c)(1)(A) or (c)(1)(B), unless the owner or operator demonstrates that another low permeability layer construction technique or material provides equivalent or superior performance to the requirements of either subsection (c)(1)(A) or (c)(1)(B) and is approved by the Agency.

A) A compacted earth layer constructed in accordance with the following standards:

i) The minimum allowable thickness must be 0.91 meter (three feet); and

ii) The layer must be compacted to achieve a hydraulic conductivity of 1 x 10^{-7} cm/sec or less and minimize void spaces.

B) A geomembrane constructed in accordance with the following standards:

i) The geosynthetic membrane must have a minimum thickness of 40 mil (0.04 inches) and, in terms of hydraulic flux, must be equivalent or superior to a three-foot layer of soil with a hydraulic conductivity of 1 x 10^{-7} cm/sec;

ii) The geomembrane must have strength to withstand the normal stresses imposed by the waste stabilization process; and

iii) The geomembrane must be placed over a prepared base free from sharp objects and other materials that may cause damage.

The final cover system will include a 40-mil LLDPE geomembrane placed on a prepared subgrade of gypsum (see the Drawings in Attachment 2). The prepared subgrade will be free of sharp objects prior to geomembrane installation. The geomembrane material will conform with the specifications of Geosynthetic Institute GRI-GM17 "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes" and will be installed per GRI-GM19a "Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers" to help ensure that the material itself and the seams between panels will withstand the expected normal and tensile stress conditions. Furthermore, a 40-mil LLDPE geomembrane manufactured and installed to these specifications is widely accepted to be equivalent or superior to a 3-foot-thick layer of soil with a hydraulic conductivity of 1 x 10^{-7} cm/sec.

4.7.2 Final Protective Layer

Part 845.750(c)(2): Standards for the Final Protective Layer. The final protective layer must meet the following requirements, unless the owner or operator demonstrates that another final protective layer construction technique or material provides equivalent or superior performance to the requirements of this subsection (c)(2) and is approved by the Agency.

A) Cover the entire low permeability layer;

B) Be at least three feet thick, be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer;

C) Consist of soil material capable of supporting vegetation;

D) Be placed as soon as possible after placement of the low permeability layer; and

E) Be covered with vegetation to minimize wind and water erosion.

Based on the demonstration provided in Attachment 3, pursuant to Section 845.750(c)(2), a 2-foot-thick final protective layer will be installed for the final cover system, immediately overlaying the drainage geocomposite and covering the entire low-permeability layer (see the Drawings in Attachment 2). The final protective layer will comprise locally available soils compacted to between 80% and 95% of the standard Proctor maximum dry density. The uppermost 6 inches of the final protective layer will be tracked in place to a density suitable for establishment of vegetation. This soil is expected to consist primarily of low-plasticity silt or clay based on a review of site geotechnical information. This soil is capable of supporting vegetation, will be placed as soon as possible after placement of the low-permeability layer, and will be covered with vegetation to limit wind and water erosion.

4.8 Final Cover System Settling

Part 845.750(c)(3): The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

The closure slopes are designed at 4% to accommodate settlement while still maintaining positive drainage off the facility. Additional discussion on this subject is provided in Section 4.4.

4.9 Use of CCR in Closure

Part 845.750(d): This subsection specifies the allowable uses of CCR in the closure of CCR surface impoundments closing under Section 845.700. Notwithstanding the prohibition on further placement in Section

845.700, CCR may be placed in these surface impoundments, but only for purposes of grading and contouring in the design and construction of the final cover system, if:

1) The CCR placed was generated at the facility and is located at the facility at the time closure was initiated;

2) CCR is placed entirely above the elevation of CCR in the surface impoundment, following dewatering and stabilization (see subsection (b));

3) The CCR is placed entirely within the perimeter berms of the CCR surface impoundment; and

4) The final cover system is constructed with either:

A) A slope not steeper than 5% grade after allowance for settlement; or

B) At a steeper grade, if the Agency determines that the steeper slope is necessary, based on conditions at the site, to facilitate run-off and minimize erosion, and that side slopes are evaluated for erosion potential based on a stability analysis to evaluate possible erosion potential. The stability analysis, at a minimum, must evaluate the site geology; characterize soil shear strength; construct a slope stability model; establish groundwater and seepage conditions, if any; select loading conditions; locate critical failure surface; and iterate until minimum factor of safety is achieved.

The GMF Pond is not closing under Section 845.700. Nevertheless, closure of the GMF Pond is anticipated to comply with the requirements of Subsection 845.750(d). Following dewatering of the GMF Pond, gypsum currently located within the facility (which was generated at Duck Creek Power Plant) will be relocated to within the closure footprint. A berm will be constructed in an east–west orientation at the south end of the closure footprint. The upstream face of the berm will be lined with a liner system compliant with Section 845.400, which will tie into the existing composite liner system. Gypsum currently located south of this berm (approximately 85,000 cy) will be removed and relocated to within the closure footprint, above the elevation of existing gypsum and completely within the perimeter berms, to achieve final grades. The final cover system has been designed with 4% slopes.

5.0 ADDITIONAL INFORMATION

According to the Hydrogeologic Site Characterization Report by Ramboll (Appendix D to the construction permit application), the base of the closed GMF Pond is within a geologic formation with the following characteristics in the vicinity of the GMF Pond:

- geometric mean hydraulic conductivity of 3.6 x 10^{-4} centimeters per second
- groundwater flow generally in a southeasterly direction
- average groundwater flow velocity of 2.4 x 10^{-1} feet per day

The base and sides of the GMF Pond have a robust dual composite liner system consisting of the following components (from top to bottom):

- primary composite liner system
  - 60-mil textured HDPE geomembrane
  - 1-foot-thick (minimum) cushion soil layer

- leak detection layer
  - geotextile separator
  - 1-foot-thick granular drainage layer
  - geotextile cushion
- secondary composite liner system
  - 60-mil textured HDPE geomembrane
  - reinforced geosynthetic clay liner
  - 3-foot-thick compacted clay layer

The liner system was subjected to a rigorous construction quality assurance program during installation. The leak detection layer has not detected infiltration since initial facility construction, either from the gypsum or from outside the facility (i.e., lateral infiltration). The liner system prevents lateral infiltration of groundwater into the gypsum.

6.0 CERTIFICATION

Part 845.750(c)(4): The owner or operator of the CCR surface impoundment must obtain and submit with its construction permit application for closure a written certification from a qualified professional engineer that the design of the final cover system meets the requirements of this Section.

The undersigned qualified professional engineer registered in Illinois certifies that the design of the final cover system meets the requirements of Section 845.750.



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Signature Page

Golder Associates USA Inc.

I, Mark Haddock, being a registered professional engineer in good standing in the State of Illinois, certify to the best of my knowledge that this Final Closure Plan meets the requirements of Illinois Administrative Code Title 35, Part 845.



Mark Haddock
Principal

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7.0 REFERENCES

AECOM. 2016. CCR Rule Report: Initial Structural Stability Assessment for GMF Pond at Duck Creek Power Station. [Accessed January 25, 2022.] https://www.luminant.com/ccr.

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ATTACHMENT 1

Closure Alternatives Analysis

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Closure Alternatives Analysis
Duck Creek Power Plant
Gypsum Management Facility (GMF) and
Bottom Ash Basin (BAB)
Canton, Illinois

January 28, 2022

GRADIENT

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Appendix A Human Health and Ecological Risk Assessment
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Abbreviations

AACE	Association for the Advancement of Cost Engineering
BAB	Bottom Ash Basin
bgs	Below Ground Surface
BMP	Best Management Practice
CAA	Closure Alternatives Analysis
CBR	Closure-by-Removal
CBR-Offsite	Closure-by-Removal with Off-Site CCR Disposal
CBR-Onsite	Closure-by-Removal with On-Site CCR Disposal
CCR	Coal Combustion Residual
CIP	Closure-in-Place
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EJ	Environmental Justice
GHG	Greenhouse Gas
GMF	Gypsum Management Facility
GWPS	Groundwater Protection Standard
HDPE	High-Density Polyethylene
IAC	Illinois Administrative Code
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
LLDPE	Linear Low-Density Polyethylene
N_2O	Nitrous Oxide
NID	National Inventory of Dams
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
PM	Particulate Matter
SFWA	State Fish and Wildlife Area
TVA	Tennessee Valley Authority
US BLS	United States Bureau of Labor Statistics
US DOT	United States Department of Transportation
US EPA	United States Environmental Protection Agency
US FWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WPC Permit	Water Pollution Control Construction and Operating Permit

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Summary of Findings

Title 35, Part 845, of the Illinois Administrative Code (IAC; IEPA, 2021a) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain surface impoundments containing coal combustion residuals (CCRs) in the State of Illinois. Pursuant to requirements under IAC Section 845.710, this report presents a CAA for the Gypsum Management Facility (GMF) and the Bottom Ash Basin (BAB) located on the Illinois Power Resources Generating, LLC (IPRG) Duck Creek Power Plant property near Canton, Illinois. The GMF contains synthetic gypsum generated historically by the plant's flue gas desulfurization system. No significant volume of CCR remains in the BAB. CCR that was historically contained within the BAB has already been excavated from the impoundment.

The goal of a CAA is to holistically evaluate potential closure scenarios with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IAC Part 845; IEPA, 2021a). For the GMF, Gradient evaluated three closure scenarios: Closure-in-Place (CIP), Closure-by-Removal with On-Site CCR Disposal (CBR-Onsite), and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). For the BAB, Gradient evaluated two closure scenarios: CBR-Onsite and CBR-Offsite. CIP was not evaluated for the BAB because there is no significant CCR remaining in the unit. The CIP scenario for the GMF entails consolidating all of the gypsum in the northern portion of the impoundment, then capping the impoundment with a new cover system. The CBR-Onsite scenario entails excavating the CCR and liner system materials from the GMF and/or the BAB and transporting these materials to an on-Site landfill for disposal. The CBR-Offsite scenario entails excavating the CCR and liner system materials from the GMF and/or the BAB and transporting these materials to an off-Site landfill. IPRG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the GMF as an alternative to disposal.

Table S.1 summarizes the expected impacts of the CIP, CBR-Onsite, and CBR-Offsite closure scenarios at the GMF with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Table S.2 summarizes the expected impacts of the CBR-Onsite and CBR-Offsite closure scenarios at the BAB with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on Table S.1 and the additional details provided in Section 2 of this report, CIP has been identified as the most appropriate closure scenario for the GMF. Key benefits of CIP at the GMF include the more rapid re-development of the Site for use in utility-scale solar generation and reduced impacts on workers, community members, and the environment during construction (*e.g.*, fewer construction-related accidents, lower energy demands, less air pollution and greenhouse gas [GHG] emissions, and less traffic). Based on Table S.2 and the additional details provided in Section 3 of this report, CBR-Onsite has been identified as the most appropriate closure scenario for the BAB. Key benefits of CBR-Onsite at the BAB are that no off-Site hauling is required and, consequently, that this scenario will result in reduced impacts to the community (due to, *e.g.*, accidents, traffic, noise, and air pollution) compared to CBR-Offsite.

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Table S.1 Comparison of Proposed Closure Scenarios for the GMF

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	CBR-Onsite	CBR-Offsite
Closure Alternative Descriptions (Section 2.1; IAC Section 845.710(c))	The CIP scenario would entail consolidating all of the gypsum in the GMF in the northern portion of the impoundment, then capping the impoundment with a new cover system consisting of, from bottom to top, a geomembrane layer, a geocomposite layer, and 24 inches of protective cover soil capable of supporting vegetative growth.	For CBR-Onsite, CCR and existing liner system materials would be excavated from the GMF and sent *via* truck to the on-Site landfill for disposal. The gypsum, the primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the underlying 3-foot compacted clay liner would be hauled to the on-Site landfill for disposal. The on-Site landfill does not have sufficient capacity for these materials and would require expansion. This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a), which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.	For CBR-Offsite, CCR and existing liner system materials would be excavated from the GMF and sent *via* truck to an off-Site landfill for disposal. The gypsum, the primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the underlying 3-foot compacted clay liner would be hauled to the off-Site landfill for disposal. Expansion of the off-Site landfill may be necessary in order to accept all of the CCR and liner materials from the GMF.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 2.2.3; IAC Section 845.710(b)(1)(C))	Monitoring would be performed at the GMF for at least 30 years post-closure, or until GWPSs have been achieved, whichever is longer. The post-closure care plan under the CIP scenario additionally includes periodic inspections and mowing and maintenance of the final cover system for the GMF.	Monitoring would be performed at the GMF for at least 3 years post-closure, or until GWPSs have been achieved, whichever is longer.	Monitoring would be performed at the GMF for at least 3 years post-closure, or until GWPSs have been achieved, whichever is longer.
Magnitude of Reduction of Existing Risks (Section 2.2.1; IAC Sections 845.710(b)(1)(A) and 845.710(b)(1)(F))	There are no current risks to any human or ecological receptors associated with the GMF. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.	There are no current risks to any human or ecological receptors associated with the GMF. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.	There are no current risks to any human or ecological receptors associated with the GMF. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	CBR-Onsite	CBR-Offsite
Likelihood of Future Releases of CCR (Section 2.2.2; IAC Sections 845.710(b)(1)(B) and 845.710(b)(1)(F))	During closure, there would be minimal risk of dike failure occurring (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Post-closure, the risks of overtopping and dike failure would be even smaller than they are currently, due to the installation of a protective soil cover and new stormwater control structures. Dikes, final cover, and stormwater control features have been designed to withstand earthquakes and storm events.	During closure, there would be minimal risk of dike failure occurring (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.	During closure, there would be minimal risk of dike failure occurring (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	CBR-Onsite	CBR-Offsite
Worker Risks (Section 2.2.4.1; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))	An estimated 0.17 injuries and 0.0011 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site will be re-developed for use in utility-scale solar generation. The simultaneous pursuit of two large construction projects may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The CIP scenario is expected to result in less traffic congestion – and, hence, a smaller increase in risks to workers – than the two CBR scenarios.	An estimated 0.30 injuries and 0.0020 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site will be re-developed for use in utility-scale solar generation. The simultaneous pursuit of two large construction projects may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The two CBR scenarios are expected to result in more traffic congestion – and, hence, a greater increase in risks to workers – than the CIP scenario.	An estimated 0.41 injuries and 0.0027 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. An additional estimated 0.42 injuries and 0.0096 fatalities would be expected to occur to workers due to off-Site hauling under this scenario. In total, a minimum of 0.84 worker injuries and 0.012 worker fatalities would be expected under this scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site will be re-developed for use in utility-scale solar generation. The simultaneous pursuit of two large construction projects may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The two CBR scenarios are expected to result in more traffic congestion – and, hence, a greater increase in risks to workers – than the CIP scenario.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Community Risks (Section 2.2.4.2; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Off-Site Impacts on Nearby Residents and Environmental Justice (EJ) Communities*	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be small relative to off-Site impacts under the CBR-Offsite scenario, because no off-Site hauling is required under this scenario. The on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). All possible closure scenarios are therefore associated with potential negative impacts on this EJ community.	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be small relative to off-Site impacts under the CBR-Offsite scenario, because no off-Site hauling is required under this scenario. The on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). All possible closure scenarios are therefore associated with potential negative impacts on this EJ community.	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be large relative to off-Site impacts under the CIP and CBR-Onsite scenarios, because off-Site hauling is required under this scenario. In total, an estimated 1.2 injuries and 0.044 fatalities are expected to occur among community members due to off-Site hauling under this scenario. Additionally, a haul truck is likely to pass a location near the Site every 7.2 minutes on average during working hours for the duration of excavation activities, resulting in substantial traffic demands for an extended period of time. The on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). This EJ community is also located along the primary haul routes from the Site to the off-Site landfill. All possible closure scenarios are therefore associated with potential negative impacts on this EJ community.
Impacts on Scenic, Historical, and Recreational Value	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under any closure scenario.	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under any closure scenario.	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under any closure scenario.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Environmental Risks (Section 2.2.4.3; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Impacts on Greenhouse Gas Emissions and Energy Consumption*	Total energy demands and GHG emissions would be smaller under this closure scenario than under the two CBR scenarios, because the CIP scenario would have the shortest duration of construction activities and require the least amount of CCR dewatering and handling. The CIP scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for the new GMF berm and the final GMF cover system. At the grid scale, construction of a solar facility at the Site will put energy back on the grid and reduce reliance on non-renewable energy sources. Re-development of the Site for solar would occur more rapidly under the CIP scenario than under the two CBR scenarios.	Total energy demands and GHG emissions would be greater under the two CBR closure scenarios than under the CIP scenario, because the two CBR scenarios would have longer durations of construction activities and require a greater amount of CCR dewatering and handling. Because expansion of the on-Site landfill would be necessary in order to accept all of the CCR and liner materials from the GMF, the CBR-Onsite scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for use in the expanded landfill liner. At the grid scale, construction of a solar facility at the Site will put energy back on the grid and reduce reliance on non-renewable energy sources. Re-development of the Site for solar would occur more slowly under the two CBR scenarios than under the CIP scenario.	Total energy demands and GHG emissions would be greater under the two CBR closure scenarios than under the CIP scenario, because the two CBR scenarios would have longer durations of construction activities and require a greater amount of CCR dewatering and handling. If expansion of the off-Site landfill became necessary in order to accept all of the CCR and liner materials from the GMF, then the CBR-Offsite scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for use in the expanded landfill liner. At the grid scale, construction of a solar facility at the Site will put energy back on the grid and reduce reliance on non-renewable energy sources. Re-development of the Site for solar would occur more slowly under the two CBR scenarios than under the CIP scenario.
Impacts on Natural Resources and Habitat	Construction may have a negative short-term impact on terrestrial species in the vicinity of the GMF and the on-Site borrow soil location. The duration of time over which impacts will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months).	Construction may have a negative short-term impact on terrestrial species in the vicinity of the GMF and the on-Site borrow soil location. The duration of time over which impacts will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months).	Construction may have a negative short-term impact on terrestrial species in the vicinity of the GMF and the on-Site borrow soil location. The duration of time over which impacts will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months).

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	CBR-Onsite	CBR-Offsite
Time Until Groundwater Protection Standards Are Achieved (Section 2.2.5; IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))	Based on statistical analysis and evaluation of potential exceedances, it has been determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF.	Based on statistical analysis and evaluation of potential exceedances, it has been determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF.	Based on statistical analysis and evaluation of potential exceedances, it has been determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF.
Long-Term Reliability of the Engineering and Institutional Controls (Section 2.2.7; IAC Section 845.710(b)(1)(G))	CIP would be expected to be a reliable closure alternative over the long term.	CBR-Onsite would be expected to be a reliable closure alternative over the long term.	CBR-Offsite would be expected to be a reliable closure alternative over the long term.
Potential Need for Future Corrective Action (Section 2.2.8; IAC Section 845.710(b)(1)(H))	Corrective action is not expected to be required at this Site.	Corrective action is not expected to be required at this Site.	Corrective action is not expected to be required at this Site.
Effectiveness of the Alternative in Controlling Future Releases (Section 2.3; IAC Section 845.710(b)(2)(A and B))	There are no current or future risks to any human or ecological receptors associated with the GMF. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Post-closure, the risks of overtopping and dike failure would be even smaller than they are currently, due to the installation of a protective soil cover and new stormwater control structures. Dikes, final cover, and stormwater control features have been designed to withstand earthquakes and storm events.	There are no current or future risks to any human or ecological receptors associated with the GMF. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.	There are no current or future risks to any human or ecological receptors associated with the GMF. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Ease or Difficulty of Implementing the Alternative (Section 2.4; IAC Section 845.710(b)(3)) *Degree of Difficulty Associated with Construction*	CIP is a reliable and standard method for closing impoundments. However, dewatering and relocating saturated gypsum as part of closure activities at the GMF may be moderately challenging. Careful planning would be required to work safely on the wet gypsum within the GMF.	Relative to CIP, CBR-Onsite and CBR-Offsite pose additional implementation difficulties due to higher earthwork volumes, higher dewatering volumes, and longer construction schedules, and the need to remove and dispose of the existing bottom liner geomembrane. The construction schedule for excavation may be negatively impacted under the CBR-Onsite scenario, because the on-Site landfill will need to be expanded in order to receive all of the materials excavated from the GMF.	Relative to CIP, CBR-Onsite and CBR-Offsite pose additional implementation difficulties due to higher earthwork volumes, higher dewatering volumes, and longer construction schedules, and the need to remove and dispose of the existing bottom liner geomembrane. Hauling would be more difficult to implement under the CBR-Offsite scenario than under the CBR-Onsite scenario, due to the need to use public roadways for hauling. Because the CCR would be hauled on public roads (*i.e.*, intrastate travel), it would also need to be dewatered to a greater extent than would be necessary under the CBR-Onsite scenario. Off-Site landfilling would additionally require the development of a disposal plan and could raise issues related to the co-disposal of CCR and other non-hazardous wastes. The construction schedule for excavation may be negatively impacted under the CBR-Offsite scenario if, during the course of closure, it is determined that the off-Site landfill must be expanded in order to receive all of the materials excavated from the GMF.
Expected Operational Reliability	Operational reliability would be expected under all closure scenarios.	Operational reliability would be expected under all closure scenarios.	Operational reliability would be expected under all closure scenarios.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Need for Permits and Approvals	Permits required under all closure scenarios include: a modification to the existing NPDES permit; a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the impoundment to be modified; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit.	Permits required under all closure scenarios include: a modification to the existing NPDES permit; a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the impoundment to be modified; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit. The existing on-Site landfill will also require expansion under the CBR-Onsite scenario; however, the on-Site landfill has already been permitted for an expansion of an additional 2 acres of waste disposal area.	Permits required under all closure scenarios include: a modification to the existing NPDES permit; a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the impoundment to be modified; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit. Under the CBR-Offsite scenario, additional permitting may be required for transport of the CCR and to expand the off-Site landfill.
Availability of Equipment and Specialists	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under all scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the two CBR scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site.	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under all scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the two CBR scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site.	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under all scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the two CBR scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Available Capacity and Location of Treatment, Storage, and Disposal Services	Under the CIP scenario, the gypsum currently within the GMF will be consolidated and stored within the existing footprint of the impoundment. The GMF will be unwatered at the start of construction *via* pumping. Pumped water will be managed in accordance with the facility's NPDES permit.	The on-Site landfill does not have sufficient capacity to receive all of the CCR and liner materials that are currently slated for landfilling under the CBR-Onsite scenario. Expansion of the on-Site landfill would thus be necessary. The on-Site landfill is already permitted for a potential expansion, which would create an additional 2 acres of waste disposal area. The landfill expansion could be completed in a single construction season during the removal of ponded water at the GMF.	The Peoria City-County Landfill in Brimfield, Illinois, has sufficient capacity to receive all of the CCR and liner materials from the GMF. However, due to the limited space remaining in this landfill and the short time frame over which CCR would be received at the landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that will be received and the unique CCR waste characteristics. If expansion of the Peoria City-County Landfill is impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A likely alternative to the Peoria City-County Landfill is the Envirofil of IL Landfill in Macomb, Illinois.
Impact of Alternative on Waters of the State (Section 2.5; IAC Section 845.710(d)(4))	No current or future exceedances of any screening benchmarks for surface water would be anticipated.	No current or future exceedances of any screening benchmarks for surface water would be anticipated.	No current or future exceedances of any screening benchmarks for surface water would be anticipated.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	CBR-Onsite	CBR-Offsite
Potential Modes of Transportation Associated with CBR (Section 2.1; IAC Section 845.710(c)(1))	This factor is not relevant for CIP.	This factor is not relevant for CBR-Onsite.	Loadout facilities do not exist on-Site that would facilitate off-Site rail or barge CCR transport. Rail lines or waterbodies connecting to a potential off-Site disposal location also do not exist. Thus, transport *via* rail or barge is considered infeasible. Only transport *via* on-road haul trucks was assumed for the CBR-Offsite scenario. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.
Concerns of Residents Associated with Alternatives (Section 2.6; IAC Section 845.710(b)(4))	Despite the preference for CBR that has been expressed by nonprofits representing community interests near the Site, CIP will effectively address residents' concerns regarding potential impacts to groundwater and surface water quality associated with the GMF. Relative to CBR-Offsite, CIP also presents fewer risks to workers and community members during construction in the form of accidents, traffic, and air pollution. Moreover, under the CIP scenario, the Site could be more rapidly re-developed for use in utility-scale solar generation. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. However, CBR has several disadvantages with regard to potential community concerns. Relative to CIP, the two CBR scenarios present greater risks to workers and community members during construction in the form of accidents, traffic, and air pollution. Moreover, under the two CBR scenarios, the Site could take longer to re-develop for use in utility-scale solar generation. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. However, CBR has several disadvantages with regard to potential community concerns. Relative to CIP, the two CBR scenarios presents greater risks to workers and community members during construction in the form of accidents, traffic, and air pollution. Moreover, under the two CBR scenarios, the Site could take longer to re-develop for use in utility-scale solar generation. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

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Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	CBR-Onsite	CBR-Offsite
Class 4 Cost Estimate (Section 2.7; IAC Section 845.710(d)(1))	The CIP scenario can be implemented at a lower total cost (approximately $6.21 million) than the CBR-Onsite scenario (approximately $8.87 million) and the CBR-Offsite scenario (approximately $82.4 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.	The CIP scenario can be implemented at a lower total cost (approximately $6.21 million) than the CBR-Onsite scenario (approximately $8.87 million) and the CBR-Offsite scenario (approximately $82.4 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.	The CIP scenario can be implemented at a lower total cost (approximately $6.21 million) than the CBR-Onsite scenario (approximately $8.87 million) and the CBR-Offsite scenario (approximately $82.4 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.

Notes:
AACE = Association for the Advancement of Cost Engineering; CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place; EJ = Environmental Justice; GHG = Greenhouse Gas; GMF = Gypsum Management Facility; IAC = Illinois Administrative Code; IDNR = Illinois Department of Natural Resources; IEPA = Illinois Environmental Protection Agency; NPDES = National Pollutant Discharge Elimination System.

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Table S.2 Comparison of Proposed Closure Scenarios for the BAB

Evaluation Factor (Report Section; Part 845 Section)	BAB Closure Scenario	
	CBR-Onsite	CBR-Offsite
Closure Alternative Descriptions (Section 3.1; IAC Section 845.710(c))	For CBR-Onsite, the concrete, compacted clay, and geomembrane components of the existing liner system, and any remaining CCR, will be excavated from the BAB and sent *via* truck to the on-Site landfill for disposal. This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a), which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.	For CBR-Offsite, the concrete, compacted clay, and geomembrane components of the existing liner system, and any remaining CCR, will be excavated from the BAB and sent *via* truck to an off-Site landfill for disposal.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 3.2.3; IAC Section 845.710(b)(1)(C))	Monitoring would be performed at the BAB for at least 3 years post-closure, or until GWPSs have been achieved.	Monitoring would be performed at the BAB for at least 3 years post-closure, or until GWPSs have been achieved.
Magnitude of Reduction of Existing Risks (Section 3.2.1; IAC Sections 845.710(b)(1)(A) and 845.710(b)(1)(F))	There are no current risks to any human or ecological receptors associated with the BAB. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.	There are no current risks to any human or ecological receptors associated with the BAB. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.
Likelihood of Future Releases of CCR (Section 3.2.2; IAC Sections 845.710(b)(1)(B) and 845.710(b)(1)(F))	There is no current or future risk of CCR releases occurring at the BAB under either closure scenario. No significant volume of CCR currently remains in the BAB.	There is no current or future risk of CCR releases occurring at the BAB under either closure scenario. No significant volume of CCR currently remains in the BAB.
Worker Risks (Section 3.2.4.1; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))	An estimated 0.056 injuries and 0.00036 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. Overall, risks to workers would likely be of similar magnitude for both closure scenarios.	An estimated 0.050 injuries and 0.00033 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. An additional estimated 0.0041 injuries and 0.000093 fatalities would be expected to occur to workers due to off-Site hauling. In total, a minimum of 0.054 worker injuries and 0.00042 worker fatalities would be expected under this scenario. Overall, risks to workers would likely be of similar magnitude for both closure scenarios.

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Evaluation Factor (Report Section; Part 845 Section)	BAB Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Community Risks (Section 3.2.4.2; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Off-Site Impacts on Nearby Residents and Environmental Justice (EJ) Communities*	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be smaller than off-Site impacts under the CBR-Offsite scenario, because no off-Site hauling is required under this scenario. The on-Site landfill and the borrow site are both located within the one-mile buffer zone of the nearest EJ community (near Canton). Both closure scenarios are therefore associated with potential negative impacts on this EJ community.	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be larger than off-Site impacts under the CBR-Onsite scenario, because off-Site hauling is required under this scenario. In total, an estimated 0.012 injuries and 0.00043 fatalities are expected to occur among community members due to off-Site hauling under this scenario. A haul truck is likely to pass a location near the Site every 49 minutes on average during working hours for the duration of excavation activities under this scenario. The on-Site landfill and the borrow site are both located within the one-mile buffer zone of the nearest EJ community (near Canton). This EJ community is also located along the primary haul routes from the Site to the off-Site landfill. Both closure scenarios are therefore associated with potential negative impacts on this EJ community.
Impacts on Scenic, Historical, and Recreational Value	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the BAB, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under either closure scenario.	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the BAB, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under either closure scenario.
Environmental Risks (Section 3.2.4.3; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Impacts on Greenhouse Gas Emissions and Energy Consumption*	Total energy demands and GHG emissions would likely be similar under the CBR-Onsite and CBR-Offsite scenarios, because both scenarios would have the same expected duration of construction activities and required earthwork volumes.	Total energy demands and GHG emissions would likely be similar under the CBR-Onsite and CBR-Offsite scenarios, because both scenarios would have the same expected duration of construction activities and required earthwork volumes.

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Evaluation Factor (Report Section; Part 845 Section)	BAB Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Impacts on Natural Resources and Habitat	Construction may have a negative short-term impact on terrestrial species in the vicinity of the BAB and the on-Site borrow soil location and may also cause long-term shifts in the habitat atop these locations. Both BAB closure scenarios are expected to have similar short- and long-term impacts on natural resources and habitat.	Construction may have a negative short-term impact on terrestrial species in the vicinity of the BAB and the on-Site borrow soil location and may also cause long-term shifts in the habitat atop these locations. Both BAB closure scenarios are expected to have similar short- and long-term impacts on natural resources and habitat.
Time Until Groundwater Protection Standards Are Achieved (Section 3.2.5; IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))	There are no exceedances of potentially applicable groundwater standards attributable to the BAB.	There are no exceedances of potentially applicable groundwater standards attributable to the BAB.
Long-Term Reliability of the Engineering and Institutional Controls (Section 3.2.7; IAC Section 845.710(b)(1)(G))	CBR-Onsite would be expected to be a reliable closure alternative over the long term.	CBR-Offsite would be expected to be a reliable closure alternative over the long term.
Potential Need for Future Corrective Action (Section 3.2.8; IAC Section 845.710(b)(1)(H))	Corrective action is not expected to be required at this Site.	Corrective action is not expected to be required at this Site.
Effectiveness of the Alternative in Controlling Future Releases (Section 3.3; IAC Section 845.710(b)(2)(A and B))	There are no current or future risks to any human or ecological receptors associated with the BAB. There is no current or future risk of sudden CCR releases occurring at the BAB under either closure scenario. There is no significant volume of CCR remaining in the BAB.	There are no current or future risks to any human or ecological receptors associated with the BAB. There is no current or future risk of sudden CCR releases occurring at the BAB under either closure scenario. There is no significant volume of CCR remaining in the BAB.
Ease or Difficulty of Implementing the Alternative (Section 3.4; IAC Section 845.710(b)(3))	Hauling would be easier to implement under the CBR-Onsite scenario than under the CBR-Offsite scenario, since it would not require the use of public roadways.	Hauling would be more difficult to implement under the CBR-Offsite scenario than under the CBR-Onsite scenario, since it would require the use of public roadways.
Degree of Difficulty Associated with Construction		

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Evaluation Factor (Report Section; Part 845 Section)	BAB Closure Scenario	
	CBR-Onsite	CBR-Offsite
Expected Operational Reliability	Operational reliability would be expected under both closure scenarios.	Operational reliability would be expected under both closure scenarios.
Need for Permits and Approvals	A construction stormwater permit through IEPA may be required for closure. A joint water pollution control construction and operating permit may also be needed. Under the CBR-Onsite scenario, a landfill permit modification would be needed for the landfill to receive the BAB contents.	A construction stormwater permit through IEPA may be required for closure. A joint water pollution control construction and operating permit may also be needed. Additional permitting and approvals may be required under the CBR-Offsite scenario for waste transport.
Availability of Equipment and Specialists	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under both closure scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the materials that will be hauled from the Site.	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under both closure scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the materials that will be hauled from the Site.
Available Capacity and Location of Treatment, Storage, and Disposal Services	The on-Site landfill has sufficient capacity to receive all of the materials that would be excavated from the BAB.	The Peoria City-County Landfill in Brimfield, Illinois has sufficient capacity to receive all of the materials that would be excavated from the BAB.
Impact of Alternative on Waters of the State (Section 3.5; IAC Section 845.710(d)(4))	No current or future exceedances of any screening benchmarks for surface water would be anticipated.	No current or future exceedances of any screening benchmarks for surface water would be anticipated.

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Evaluation Factor (Report Section; Part 845 Section)	BAB Closure Scenario	
	CBR-Onsite	CBR-Offsite
Potential Modes of Transportation Associated with CBR (Section 3.1; IAC Section 845.710(c)(1)	This factor is not relevant for CBR-Onsite.	Loadout facilities do not exist on-Site that would facilitate off-Site rail or barge transport of materials excavated from the BAB. Rail lines or waterbodies connecting to a potential off-Site disposal location also do not exist. Thus, transport *via* rail or barge is considered infeasible. Only transport *via* on-road haul trucks was assumed for the CBR-Offsite scenario. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.
Concerns of Residents Associated with Alternatives (Section 3.6; IAC Section 845.710(b)(4))	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. Both closure scenarios are equally responsive to this concern. Nearly all of the CCR that was historically contained within the BAB has already been excavated from the impoundment. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. Both closure scenarios are equally responsive to this concern. Nearly all of the CCR that was historically contained within the BAB has already been excavated from the impoundment. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.
Class 4 Cost Estimate (Section 3.7; IAC Section 845.710(d)(1))	The CBR-Onsite scenario can be implemented at a lower total cost (approximately $479,000) than the CBR-Offsite scenario (approximately $1,360,000). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.	The CBR-Onsite scenario can be implemented at a lower total cost (approximately $479,000) than the CBR-Offsite scenario (approximately $1,360,000). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.

Notes:
AACE = Association for the Advancement of Cost Engineering; BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place; CY = Cubic Yard; EJ = Environmental Justice; GHG = Greenhouse Gas; IAC = Illinois Administrative Code; IEPA = Illinois Environmental Protection Agency; NPDES = National Pollutant Discharge Elimination System.

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1 Introduction

1.1 Site Description and History

1.1.1 Site Location and History

The Illinois Power Resources Generating, LLC (IPRG) Duck Creek Power Plant is an electric-power-generating facility with coal-fired units located approximately 9 miles southeast of the City of Canton in Fulton County, Illinois (AECOM, 2016a; Ramboll, 2021a). Beginning in the 1930s, strip mining took place within the boundaries of the Site. Mining operations on the property have since ceased (AECOM, 2016a; Ramboll, 2021b). The Duck Creek Power Plant began operating in 1976 and was retired in December 2019 (AECOM, 2016a; Appendix B).

1.1.2 CCR Impoundments

The Duck Creek Power Plant produced and stored coal combustion residuals (CCRs) as a part of its historical operations. The subjects of this report are the Gypsum Management Facility (GMF; Vistra CCR Unit ID No. 203; Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04; National Inventory of Dams [NID] No. IL50573) and the Bottom Ash Basin (BAB; Vistra CCR Unit ID No. 205; IEPA ID No. W0578010001-03; NID No. 50716) (Figure 1.1).

The GMF is a 31-acre lined surface impoundment constructed between 2007 and 2009 that operated from 2009 until the plant was retired in 2019. This facility was historically used to store gypsum and to clarify gypsum transport water for reuse (Appendix B; Golder, 2022a). The GMF has a dual-composite liner system with a leak detection layer (Appendix B). The GMF Recycle Pond, which is located immediately south of the GMF, historically received decanted water from the GMF and leachate from the on-Site landfill (described below). The GMF Recycle Pond never received CCR. A set of pumps on the western side of the GMF Recycle Pond were used to transport decanted water back to the flue gas desulfurization system for re-use (Appendix B). The GMF Recycle Pond has a liner system consisting of a 60-mil high-density polyethylene (HDPE) geomembrane, a reinforced bentonite mat, and a 36-inch layer of compacted clay (Natural Resource Technology, 2017). The GMF Recycle Pond has been closed, and the closure was approved by IEPA.

The BAB is a 2.2-acre lined surface impoundment constructed in late 2007 or early 2008 for the management of sluiced bottom ash. It operated from 2008 until the plant was retired in 2019 (Appendix B; Golder, 2022b). There are three cells within the BAB: Primary Pond 1, Primary Pond 2, and the Secondary Pond (Appendix B). Historically, ash was sluiced to either Primary Pond 1 or Primary Pond 2. The Secondary Pond received decanted water from the two primary ponds (Appendix B; Golder, 2022b). Decanted water from the Secondary Pond flowed to the Duck Creek Cooling Pond *via* a discharge channel to the south of the pond (Appendix B). During operation of the BAB, Primary Ponds 1 and 2 were cleaned out frequently *via* excavation, and excavated bottom ash was sent to the on-Site landfill for disposal (Appendix B; Golder, 2022b). Bottom ash was also removed from the BAB when the plant was retired in 2019, such that no significant bottom ash currently remains (Appendix B). The BAB is a lined impoundment. The components of the liner system include (from bottom to top): compacted native soils,

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a 60-mil HDPE geomembrane, a 1-foot compacted clay layer, and an 8-inch reinforced concrete layer (Appendix B).



Figure 1.1 Site Location Map. Adapted from Stantec (2017).

1.1.3 Surface Water Hydrology

Surface water bodies on the Site include the Duck Creek Cooling Pond, which is the cooling water impoundment for the plant, and various small ponds resulting from historical surface mining on the property, including Long Lake (AECOM, 2016a; Natural Resource Technology, 2017). Surface water in the vicinity of the GMF and the BAB drains into the Duck Creek Cooling Pond (Natural Resource Technology, 2017), which drains to the Illinois River *via* National Pollutant Discharge Elimination System (NPDES)-permitted outfalls (IEPA, 2013). Other surface water bodies in the vicinity of the Site include various backwater lakes of the Illinois River, including Buckheart Creek to the west and Rice Lake, Miserable Lake, Big Lake, and Goose Lake to the east (Ramboll, 2021b,c).

1.1.4 Hydrogeology

1.1.4.1 GMF

Three major hydrostratigraphic units have been identified near the GMF: (a) the uppermost aquifer, (b) the lower Radnor till/lower confining unit, and (c) the bedrock confining unit. The first of these layers, the uppermost aquifer, is composed of three units: (i) the Peoria/Roxanna loess, (ii) the upper Radnor till, and (iii) the shallow sand unit (Ramboll, 2021c). The Peoria/Roxanna loess zone is composed of silt, clayey silt, and minor amounts of sand. The upper Radnor till is composed of clayey silt with minor amounts of sand and gravel. The shallow sand unit is composed of medium-grained sand and silt with interbedded till seams. The shallow sand unit, which varies from less than 1- to 18-feet thick in the vicinity of the GMF, is the primary conduit for horizontal migration of shallow groundwater near the impoundment (Ramboll, 2021c). The Peoria/Roxanna loess has also been identified as a potential migration pathway (Ramboll, 2021c). The lower Radnor till layer has high silt content with varying amounts of clay, sand, and gravel. The bedrock confining unit is composed primarily of low-

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permeability, shaley siltstone and silty shale. The Hydrogeological Site Characterization Report prepared by Ramboll for the GMF (Ramboll, 2021c) provides more details regarding the hydrostratigraphic units in the vicinity of the GMF.

Near the GMF, shallow groundwater flows southeast through the uppermost aquifer toward the Duck Creek Cooling Pond (Natural Resource Technology, 2017; Ramboll, 2021a,c). The preferential flow of groundwater is horizontal rather than vertical because the underlying till and shale bedrock layers restrict vertical groundwater flow (Natural Resource Technology, 2017). Groundwater within the uppermost aquifer near the GMF flows into the Duck Creek Cooling Pond. No other potential groundwater transport pathways exist. Because the Duck Creek Cooling Pond serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the Duck Creek Cooling Pond is unlikely (Ramboll, 2021c).

Groundwater monitoring is ongoing at the GMF. The Hydrogeologic Site Characterization Report prepared by Ramboll for the GMF includes a summary of the groundwater data collected from GMF monitoring wells between 2015 and 2021 (Ramboll, 2021c).

1.1.4.2 BAB

Two distinct hydrostratigraphic units have been identified near the BAB: the uppermost aquifer and a confining shale bedrock unit (Ramboll, 2021b). The first of these layers, the uppermost aquifer, consists of the Peoria/Roxanna loess, which is characterized by medium to very stiff silt with little clay and trace very fine- to fine-grained sand, and the Radnor till, which is characterized by silty clay with trace very fine- to coarse-grained sand and trace small gravel to hard clay with little silt, few very fine- to coarse-grained sand, and trace small gravel (Ramboll, 2021b). The most permeable portion of the uppermost aquifer is the shallow sand unit, a two- to seven-foot-thick sand zone located within the Radnor till. The shallow sand unit, which is encountered at a depth of 18-40 feet below ground surface (bgs), forms the primary conduit for horizontal migration of shallow groundwater near the BAB (Ramboll, 2021b). The Peoria/Roxanna loess has also been identified as a potential migration pathway. A confining unit composed of Pennsylvanian shaley siltstone and silty shale bedrock underlies the uppermost aquifer from approximately 26-46 feet bgs (top of bedrock; Ramboll, 2021b). The bedrock acts as an aquitard due to its low hydraulic conductivity (AECOM, 2016a; Ramboll, 2021b). The Hydrogeological Site Characterization Report prepared by Ramboll for the BAB (Ramboll, 2021b) provides more details regarding the hydrostratigraphic units in the vicinity of the BAB.

Near the BAB, shallow groundwater flows southwards through the uppermost aquifer toward an unnamed drainage channel, which leads to the Duck Creek Cooling Pond (Ramboll, 2021b). Groundwater flows horizontally rather than vertically through the uppermost aquifer because: (i) vertical hydraulic conductivities within the uppermost aquifer are several orders of magnitude lower than horizontal hydraulic conductivities, and (ii) the underlying shale bedrock acts as an aquitard (AECOM, 2016a; Ramboll, 2021b). Groundwater within the uppermost aquifer near the BAB flows into the Duck Creek Cooling Pond. No other potential groundwater transport pathways exist. Because the Duck Creek Cooling Pond serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the Duck Creek Cooling Pond is unlikely (Ramboll, 2021b).

Groundwater monitoring is ongoing at the BAB. The Hydrogeologic Site Characterization Report prepared by Ramboll for the BAB includes a summary of the groundwater data collected from BAB monitoring wells between 2015 and 2021 (Ramboll, 2021b).

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1.1.5 Site Vicinity

The Duck Creek property is surrounded by agricultural fields, pastures, and forests (Ramboll, 2021b). There are several scenic, recreational, and historical areas within a few miles of the Site, including the Rice Lake State Fish and Wildlife Area (SFWA) to the east and the Orendorf and Rice Lake Terrace Archaeological Sites to the east/northeast. The Rice Lake SFWA, which spans approximately 5,660 acres, was established in 1945 and includes Big Lake, Slim Lake, Goose Lake, Pond Lily Lake, Lock Pond, and the Copperas Creek Management Unit. Popular activities at the Rice Lake SFWA include picnicking, fishing, camping, and hunting (IDNR, c. 2008). The Orendorf Archaeological Site, which was added to the National Register of Historic Places in 1977 (National Park Service, 2021), encompasses at least four distinct Middle Mississippian settlement areas with known trade and migration linkages to the Mississippian city of Cahokia, the largest archaeological site in North America (Archaeological Institute of America, 2021; Emerson, c. 2016). The Rice Lake Terrace Archaeological Site is located south of the Orendorf Archaeological Site on the shore of Rice Lake and includes evidence of Archaic (8000-500 BC), Woodland (500 BC-1000 AD) and Mississippian (1000-1673 AD) cultures (Archaeological Institute of America, 2021). In addition to the sites listed above, there are several high-value scenic and recreational areas within 10 miles downstream along the Illinois River, including the Spring Lake SFWA, the Sand Ridge State Forest, the Chautauqua National Wildlife Refuge, and the Emiquon Preserve.

1.2 Part 845 Regulatory Review and Requirements

Title 35, Part 845, of the Illinois Administrative Code (IAC; IEPA, 2021a) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain CCR-containing surface impoundments in the State of Illinois. Section 2 of this report presents a CAA for the GMF pursuant to requirements under IAC Section 845.710. Section 3 of this report presents a CAA for the BAB. The goal of a CAA is to holistically evaluate each potential closure scenario with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IEPA, 2021a). A CAA is a decision-making tool that is designed to aid in the selection of an optimal closure alternative for the impoundments at a site.

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2 Closure Alternatives Analysis – GMF

2.1 Closure Alternative Descriptions (IAC Section 845.710(c))

This section of the report presents a CAA for the GMF pursuant to requirements under IAC Section 845.710 (IEPA, 2021a). Gradient evaluated three closure scenarios: Closure-in-Place (CIP), Closure-by-Removal with On-Site CCR Disposal (CBR-Onsite), and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). Sections 2.1.1 through 2.1.3 describe the CIP, CBR-Onsite, and CBR-Offsite closure scenarios. These scenarios are based on information conveyed to Gradient by Golder (Appendix B; Golder, 2022c,d).

2.1.1 Closure-in-Place

Under the CIP scenario, the gypsum in the GMF will be consolidated in the northern portion of the impoundment and the impoundment will be capped with a new cover system. This scenario includes the following work elements for the closure of the GMF (Appendix B; Golder, 2022c):

- Elimination of free liquids by solidifying waste residues, as needed, or by removing liquid waste, including *via* pumping. Water will be managed in accordance with the NPDES permit for the facility.
- Dewatering of the upper gypsum layer within the northern portion of the GMF *via* trenches and sumps in order to support construction traffic across the surface.
- Construction of a new internal berm with an east-west orientation. The upstream slope of the berm will be lined with a new composite liner, which will tie into the existing primary composite liner system for the facility.
- Consolidation of all gypsum in an approximately 15-acre area north of the berm. All gypsum from the area south of the berm will be removed and placed north of the berm.
- Contouring and grading to promote stormwater management.
- Construction of an alternative cover system north of the berm that will consist of a 40-mil linear low-density polyethylene (LLDPE) geomembrane layer, a geocomposite layer, and 24 inches of protective soil cover suitable for supporting vegetative growth. The performance of this alternative cover system relative to a default cover is presented in Geosyntec Consultants (2022).
- Removal of the geosynthetic components of the dual-composite liner system south of the berm. Liner system materials will be disposed of in the northern portion of the capped GMF. Soil materials located between these components will be removed and stockpiled south of the GMF.
- Excavation of a surface water channel south of the GMF, including removal of sections of the GMF Recycle Pond perimeter dike, in order to promote passive stormwater drainage to the southeast of the impoundment.
- Long-term (post-closure) monitoring and maintenance, including:
    - Groundwater monitoring at the impoundment for a minimum of 30 years, or until groundwater protection standards (GWPSs) are achieved.

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- Post-closure care for the final cover system, including cap inspections, mowing, and maintenance, for a minimum of 30 years.

This CIP plan meets all closure requirements of Part 845.750 (Golder, 2022a). Key closure elements that address the Part 845 closure requirements are summarized below. Further details are provided in the Closure Plan (Golder, 2022a).

- An alternative cover system will be installed over the CCR that remains in the GMF. The cover, consisting of a 40-mil LLDPE geomembrane low-permeability layer, a geocomposite cushion if needed, and 24 inches of soil, will minimize vertical infiltration of precipitation into the basin [Part 845.750(a)(1)].
- The final cover system will be crowned with 4% slopes to direct surface water away from the facility. Beyond the final cover system, channels will direct surface water away from the GMF to existing site drainages [Part 845.750(a)(2)].
- Impounded water will be removed from the GMF and managed in accordance with the NPDES permit for the facility [845.750(b)(1) and 845.750(b)(2)].
- Free liquids in the CCR will be eliminated by removing liquid wastes or solidifying the remaining wastes. Trenches will facilitate gravity drainage of liquid wastes in the gypsum and direct the liquid wastes to sumps. Other engineering measures may be considered to facilitate removal of liquid wastes and stabilization of wastes. Sumps will be used to collect liquid wastes which will be managed in accordance with the NPDES permit for the site [845.750(b)(1) and 845.750(b)(2)].

As an additional consideration, the proposed alternative cover system and the existing bottom liner system will provide complete encapsulation of the CCR, physically isolating it from contact with surrounding soils, groundwater, surface water and the atmosphere. Lateral infiltration of groundwater into the basin will also be controlled due to the presence of the existing dual-composite bottom liner system which will prevent groundwater from flowing into the basin (Golder, 2022a).

Approximately 85,000 cubic yards of gypsum will be relocated from south of the berm to north of the berm under this scenario (an assumed travel distance of 0.2 miles; Appendix B). Hauling will also be required to relocate 17 acres of geosynthetic liner materials north of the berm and 55,700 cubic yards of liner soils excavated from south of the berm to a stockpile located south of the closure footprint (an assumed travel distance of 0.2 miles).

Soil required for construction of the new berm and the final GMF cover system will be sourced from a location on the property; a borrow location will not need to be established off-Site. The selected borrow soil location is approximately 0.4 miles north of the GMF (Appendix B). The estimated volume of borrow soil required for GMF closure *via* CIP is 76,100 cubic yards (Appendix B). Additionally, approximately 81,000 cubic yards of soil will be excavated during construction of the stormwater channel south of the GMF during Site restoration. This material will be hauled to the borrow soil location for stockpiling (Appendix B).

Under the CIP scenario, the expected duration of major construction activities at the GMF is 12-24 months (Appendix B; Golder, 2022c). Key parameters for the CIP scenario are shown in Table 2.1.

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Table 2.1 Key Parameters for the Closure-in-Place Scenario – GMF

Parameter	Value	Notes
Surface Area of Impoundment (acres)	31	
Surface Area of Final Cover System (acres)	15	Area north of the proposed berm.
In-Place Volume of CCR (CY)	400,000	CCR contained in the GMF is gypsum from flue gas desulfurization.
Volume of CCR to be Relocated (CY)	85,000	Amount of gypsum to be removed from the southern portion of the GMF and relocated north of the berm.
Travel Distance for Relocation of CCR (miles)	0.2	
Required Volume of Borrow Soil (CY)	76,100	Required for berm construction and the final cover system.
Volume of Material Stockpiled On-Site (CY)	137,000	Excavated during construction of the stormwater channel and removal of existing liner system components south of the berm (Site restoration).
Distance to the Borrow Soil Location (miles)	0.4	
Duration of Construction Activities (months)	12-24	
Total On-Site Labor Hours for Major Construction[a]	14,600	
Required On-Site Hauling Truckloads (Loaded)	10,200	
Required Off-Site Hauling Truckloads (Loaded)	0	
Required On-Site Hauling Miles	6,270	
Required Off-Site Hauling Miles	0	

Notes:
CCR = Coal Combustion Residual; CY = Cubic Yards; GMF = Gypsum Management Facility.
Sources: Appendix B; Golder (2022c).
(a) Major construction is defined as any operation occurring on-Site that requires one or more of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor is not included if it is limited to the use of one or more of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators is only included in calculations if the hauling occurs on-Site. Workers assigned to relevant activities are assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

2.1.2 Closure-by-Removal with On-Site Disposal

Under the CBR-Onsite scenario, CCR and existing liner system materials will be excavated from the GMF and sent to the on-Site landfill for final disposal. Excavation at the GMF will include all of the gypsum in the impoundment and the existing dual-composite liner system. The gypsum excavated from the GMF is currently expected to be hauled to the on-Site landfill. IPRG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the GMF as an alternative to disposal. The primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the 3-foot compacted clay layer beneath the GMF will also be hauled to the on-Site landfill for disposal.

This scenario includes the following work elements for the closure of the GMF (Appendix B; Golder, 2022c,d):

- Free water removal and dewatering of the GMF.
- Excavation and transport of CCR and liner system materials to the on-Site landfill, as detailed above. All areas affected by CCR releases will be decontaminated, including potential over-excavation below the bottom of the liner system.

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- Grading and filling to convey runoff away from the impoundments. This process will include excavation of a surface water channel south of the GMF and removal of sections of the GMF Recycle Pond perimeter dike in order to promote passive stormwater drainage to the southeast of the impoundment.
- Site restoration, including revegetation with native grasses.
- Monitoring at the impoundments for at least 3 years, or until GWPSs are achieved.

Approximately 31 acres of geosynthetic liner system materials, 283,000 cubic yards of earthen liner system materials, 50,000 cubic yards of subsoil overexcavation, and 400,000 cubic yards of gypsum will be excavated from the GMF and hauled to the on-Site landfill for disposal. The on-Site landfill is located approximately 1.2 miles north of the GMF (Appendix B). Excavated materials will be hauled to the landfill using off-road haul trucks with an assumed capacity of 34 cubic yards. The on-Site landfill currently has approximately 445,000 cubic yards of available capacity. Of this, approximately 7,000 cubic yards may be used for the disposal of materials associated with excavation of the BAB. Thus, the on-Site landfill does not have sufficient capacity to receive all of the CCR and liner materials from the GMF that are slated for disposal under the CBR-Onsite scenario. Expansion of the landfill would thus be necessary. The on-Site landfill is already permitted for a potential expansion, which could create an additional 2-acre landfill cell (Appendix B). This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a), which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.

No borrow soil is required for grading and filling the GMF under the CBR-Onsite scenario (Appendix B). However, approximately 9,700 cubic yards of compacted clay is required for landfill expansion; this material will be hauled in from the borrow site, which is located 0.7 miles from the landfill. Finally, approximately 86,000 cubic yards of soil will be excavated during construction of the stormwater channel south of the GMF during Site restoration. This material will be hauled to the borrow soil location for stockpiling (Appendix B).

Under the CBR-Onsite scenario, the expected duration of major construction activities is expected to be 24-36 months at the GMF (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Onsite scenario are shown in Table 2.2.

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Table 2.2 Key Parameters for the Closure-by-Removal with On-Site Disposal Scenario – GMF

Parameter	Value	Notes
Surface Area of Impoundment (acres)	31	
In-Place Volume of CCR (CY)	400,000	CCR contained in the GMF is gypsum from flue gas desulfurization.
Volume of Earthen Components of Existing Liner System (CY)	283,000	
Distance to the On-Site Landfill (miles)	1.2	
Required Volume of Borrow Soil (CY)	9,700	Required for landfill expansion.
Volume of Soil Stockpiled at Borrow Soil Location (CY)	86,000	Soil excavated south of the impoundment during construction of the stormwater channel (Site restoration).
Distance to the Borrow Soil Location from the GMF (miles)	0.4	
Distance to the Borrow Soil Location from the On-Site Landfill (miles)	0.7	
Duration of Construction Activities (months)	24-36	
Total On-Site Labor Hours for Major Construction[a]	26,400	
Required On-Site Hauling Truckloads (Loaded)	28,000	
Required Off-Site Hauling Truckloads (Loaded)	0	
Required On-Site Hauling Miles	62,100	
Required Off-Site Hauling Miles	0	

Notes:
CCR = Coal Combustion Residual; CY = Cubic Yards; GMF = Gypsum Management Facility.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction is defined as any operation occurring on-Site that requires one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor is not included if it is limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators is only included in calculations if the hauling occurs on-Site. Workers assigned to relevant activities are assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

2.1.3 Closure-by-Removal with Off-Site Disposal

Under the CBR-Offsite scenario, CCR and existing liner system materials will be excavated from the GMF and sent to an off-Site landfill for final disposal. All of the gypsum in the GMF and the primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the 3-feet-thick compacted clay layer underlying the GMF will be hauled to the off-Site landfill for disposal (Golder, 2022c,d). IPRG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the GMF as an alternative to disposal.

Excavated materials will be sent to the Peoria City-County Landfill in Brimfield, Illinois (11501 W Cottonwood Road), which is approximately 33 miles from the Site (Appendix B). As is described below in Section 2.4.5, it is possible that the Peoria City-County Landfill will have to be expanded in order to accept all of the CCR and liner materials.

IAC Section 845.710(c)(1) requires Closure-by-Removal (CBR) alternatives to consider multiple methods for transporting CCR off-site, including rail, barge, and trucks. Golder evaluated the feasibility of transporting CCR to the off-Site landfill *via* rail or barge and found that neither option is viable at this Site. Existing loadout facilities, which would facilitate off-Site rail or barge CCR transport, are not present on the property, and the construction of new loadout facilities is considered infeasible. Only transport *via* on-road haul trucks (with a 16.5-cubic-yard capacity) is considered feasible for CBR-Offsite.

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The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.

The work elements included in this scenario are largely the same as those listed above in Section 2.1.2 for the CBR-Onsite scenario (Appendix B; Golder, 2022c,d):

- Free water removal and dewatering of the GMF.
- Excavation and transport of CCR and liner system materials to the off-Site landfill, as detailed above. All areas affected by CCR releases will be decontaminated, including potential over-excavation below the bottom of the liner system.
- Grading and filling to convey runoff away from the impoundments. This process will include excavation of a surface water channel south of the GMF and removal of sections of the GMF Recycle Pond perimeter dike in order to promote passive stormwater drainage to the southeast of the impoundment.
- Site restoration, including revegetation with native grasses.
- Monitoring at the impoundments for at least 3 years, or until GWPSs are achieved.

Approximately 31 acres of geosynthetic liner system materials, 283,000 cubic yards of earthen liner system materials, 50,000 cubic yards of subsoil overexcavation, and 400,000 cubic yards of gypsum will be excavated from the GMF and hauled to the off-Site landfill for disposal. No borrow soil is required for grading and filling of the GMF under the CBR-Offsite scenario (Appendix B). Finally, approximately 86,000 cubic yards of soil will be excavated during construction of the stormwater channel south of the GMF during Site restoration. This material will be hauled to the borrow soil location for stockpiling (Appendix B).

Under the CBR-Offsite scenario, the expected duration of major construction activities is expected to be 36-48 months at the GMF (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Offsite scenario are shown in Table 2.3.

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Table 2.3 Key Parameters for the Closure-by-Removal with Off-Site Disposal Scenario – GMF

Parameter	Value	Notes
Surface Area of Impoundment (acres)	31	
In-Place Volume of CCR (CY)	400,000	CCR contained in the GMF is gypsum from flue gas desulfurization.
Volume of Earthen Components of Existing Liner System (CY)	283,000	
Distance to the Off-Site Landfill (miles)	33	Peoria City-County Landfill in Brimfield, IL.
Required Volume of Borrow Soil (CY)	0	
Volume of Soil Stockpiled at Borrow Soil Location (CY)	86,000	Soil excavated south of the impoundment during construction of the stormwater channel (Site restoration).
Distance to the Borrow Soil Location (miles)	0.4	
Duration of Construction Activities (months)	36-48	
Total On-Site Labor Hours for Major Construction[a]	35,700	
Required On-Site Hauling Truckloads (Loaded)	2,980	
Required Off-Site Hauling Truckloads (Loaded)	50,900	
Required On-Site Hauling Miles	2,380	
Required Off-Site Hauling Miles	3,320,000	

Notes:
CCR = Coal Combustion Residual; CY = Cubic Yards; GMF = Gypsum Management Facility.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction is defined as any operation occurring on-Site that requires one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor is not included if it is limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators is only included in calculations if the hauling occurs on-Site. Workers assigned to relevant activities are assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

2.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1))

2.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A))

This section of the report addresses the potential risks to human and ecological receptors due to exposure to CCR-associated constituents in groundwater or surface water. Gradient has performed a Human Health and Ecological Risk Assessment for the Site (Appendix A of this report), which provides a detailed evaluation of the magnitude of existing risks to human and ecological receptors associated with the GMF. This report concluded that there are no current unacceptable risks to any human or ecological receptors. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, there will also be no unacceptable risks to human health or the environment during or following closure at the GMF. Thus, there is no current risk or future risk under any closure scenario at the GMF, and the magnitude of reduction of existing risks is the same under all scenarios.

2.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B))

This section of the report quantifies the risk of future CCR releases that may occur during dike failure and storm-related events.

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Storm-Related Releases and Dike Failure During Flood Conditions

Engineering analyses show that the existing dikes at the GMF are expected to remain stable under static, seismic, and flood conditions (AECOM, 2016b; Burns & McDonnell, 2021a). Prior to closure (*i.e.*, under current conditions), the risk of dike failure occurring during floods or other storm-related events is therefore minimal. Engineering analyses similarly show that the current risk of sudden CCR releases occurring at the GMF due to overtopping during flood conditions is minimal (AECOM, 2016c; Burns & McDonnell, 2021a). Post-closure, the risks of overtopping and dike failure occurring at the GMF will be even smaller than they are currently. Under the CIP scenario, all free water will be pumped from the GMF and a new cover system will be installed, which will include 24 inches of soil and a geomembrane liner. Construction activities at the GMF under the CIP scenario will also result in improved stormwater management. Relative to current conditions, this cover system and the associated stormwater management improvements will provide increased protection against berm and surface erosion, groundwater infiltration, and other adverse effects that could potentially trigger a dike slope failure event. Under the CBR-Onsite and CBR-Offsite scenarios, all of the CCR in the GMF will be excavated and relocated, eliminating the risk of a sudden CCR release occurring under a dike failure or flood overtopping event. In summary, there is minimal risk of sudden CCR releases occurring during or prior to closure (*i.e.*, under current conditions). Additionally, post-closure there is minimal risk of sudden CCR releases occurring under the CIP scenario, and there is no risk of sudden CCR releases occurring under the CBR-Onsite or CBR-Offsite scenarios.

Dike Failure Due to Seismicity

Sites in Illinois may be subject to seismic risks arising from the Wabash Valley Seismic Zone and the New Madrid Seismic Zone (IEMA, 2020). However, the Duck Creek property does not lie within a seismic impact zone. The property is also believed to have a "low risk level" for seismic risks based on the 2018 United States Geological Survey (USGS) National Seismic Hazard Map. Additionally, the GMF does not lie within 200 feet of an active fault or fault damage zone at which displacement has occurred within the current geological epoch (*i.e.*, within the last ~11,650 years; Burns & McDonnell, 2021b,c; Haley & Aldrich, Inc., 2018a,b). The nearest known fault is the Sicily Fault, which is located about 66 miles southeast of the GMF. The Sicily Fault does not have known recent activity (Haley & Aldrich, Inc., 2018a,b). Thus, the risk of dike failure occurring during or following closure activities due to seismic activity is exceedingly low at the GMF.

2.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C))

The long-term operation and management plans for the GMF are described in Section 2.1 for each closure scenario. In summary, under the CIP scenario, the GMF will undergo monitoring for at least 30 years post-closure, or until such time as GWPSs are achieved. The post-closure care plan under the CIP scenario additionally includes periodic inspections and mowing and maintenance of the final cover system for the GMF. Under the CBR-Onsite and CBR-Offsite scenarios, the GMF will undergo monitoring for 3 years post-closure, or until such time as GWPSs are achieved.

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2.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D))

2.2.4.1 Worker Risks

Best practices will be employed during construction in order to ensure worker safety and comply with all relevant regulations, permit requirements, and safety plans. However, it is impossible to completely eliminate risks to workers during construction activities, both on- and off-Site. On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during construction activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization and demobilization, material deliveries, and the hauling of CCR and liner system materials to the on-Site landfill and the off-Site landfill.

Risk of Worker Accidents Occurring On-Site

For the GMF, three closure scenarios were considered: CIP, CBR-Offsite, and CBR-Onsite. Based on labor requirements reported in Appendix B of this report, Gradient estimates that 14,600 total on-Site labor hours are required for major construction activities under the CIP scenario, 26,400 on-Site labor hours are required for major construction activities under the CBR-Onsite disposal scenario, and 35,700 on-Site labor hours are required for major construction activities under the CBR-Offsite scenario. The CIP scenario therefore requires the smallest number of on-Site labor hours for major construction activities across all scenarios.

The United States Bureau of Labor Statistics (US BLS) (US DOL, 2020a,b) provides an estimate of the hourly fatality and injury rates for construction workers. Based on the accident rates reported by US BLS and the on-Site labor hours reported above, we estimate that approximately 0.17 worker injuries and 0.0011 worker fatalities will occur on-Site under the CIP scenario due to major construction activities at the GMF (Table 2.4). Approximately 0.30 worker injuries and 0.0020 worker fatalities are expected to occur under the CBR-Onsite scenario, and approximately 0.41 worker injuries and 0.0027 worker fatalities are expected to occur under the CBR-Offsite scenario (Table 2.4). Thus, the expected number of worker accidents occurring on-Site due to major construction activities is smallest under the CIP scenario and is largest under the CBR-Offsite scenario. Note that the calculations presented here focus on major construction activities (*e.g.*, excavation, loading, and hauling). They therefore do not account for the additional accidents that could occur on-Site during less intensive construction activities (*e.g.*, surveying, erosion control, and hydroseeding).

Table 2.4 Expected Number of On-Site Worker Accidents Under Each Closure Scenario – GMF

Closure Scenario	Injuries	Fatalities
CIP	0.17	0.0011
CBR-Onsite	0.30	0.0020
CBR-Offsite	0.41	0.0027

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal; CIP = Closure-in-Place; GMF = Gypsum Management Facility.

Concurrently with closure activities, a utility-scale solar facility will be constructed on the Duck Creek Site. The simultaneous pursuit of closure-related construction and solar facility construction may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from closure or solar re-development alone. Conflicts are particularly likely to arise during GMF closure (relative to BAB closure), because it is expected to take 1-4 years to complete and involve major

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earthmoving operations. For the GMF, the CIP scenario requires less total hauling activity than either of the two CBR scenarios (Tables 2.1-2.3). The CIP scenario can also be completed within a shorter time frame than the two CBR scenarios (12-24 months *versus* 24-48 months). The CIP scenario is therefore expected to result in less congestion on Site access roads during Site re-development – and, hence, a smaller increase in the risks to workers – than either the CBR-Onsite or CBR-Offsite scenarios.

Risk of Worker Accidents Occurring Off-Site

The CBR-Offsite scenario is the only scenario which requires any off-Site hauling. Under the CBR-Offsite scenario, 3,320,000 vehicle travel miles are required to haul excavated materials from the GMF to the off-Site landfill (Tables 2.1-2.3). The United States Department of Transportation (US DOT, 2020) provides an estimate of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks. Based on US DOT's statistics, an estimated 0.42 injuries and 0.0096 fatalities are expected to occur to drivers and passengers of haul trucks due to off-Site hauling under the CBR-Offsite scenario during closure of the GMF (Table 2.5).

Table 2.5 Expected Number of Off-Site Worker Accidents Due to Hauling Under Each Closure Scenario – GMF

Closure Scenario	Injuries	Fatalities
CIP	0	0
CBR-Onsite	0	0
CBR-Offsite	0.42	0.0096

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal; CIP = Closure-in-Place; Gypsum Management Facility.

These estimates reflect the minimum number of worker accidents that are likely to occur off-Site under each scenario, because they do not account for the additional vehicle accidents that may occur during non-hauling activities such as labor mobilization and demobilization, equipment mobilization and demobilization, and material deliveries. The vehicle mileages associated with these off-Site activities are not known. However, the mileages associated with these activities are expected to scale with the duration and intensity of the planned construction activities under each scenario. The CIP scenario is the closure scenario with the shortest expected duration of construction activities, the smallest required volume of CCR dewatering and handling, the least amount of total on-Site labor hours for major construction, and the least amount of required hauling truckloads (Tables 2.1-2.3). This scenario is therefore also likely to have the smallest amount of off-Site activity due to labor and equipment mobilization/demobilization and material deliveries – and, hence, the smallest number of off-Site vehicle accidents arising from these activities.

Taking into account both (i) accidents occurring on-Site due to major construction activities and (ii) accidents occurring off-Site due to hauling, a minimum of 0.17 worker injuries and 0.0011 worker fatalities are expected to occur during GMF closure under the CIP scenario. An estimated 0.30 worker injuries and 0.0020 worker fatalities are expected to occur during GMF closure under the CBR-Onsite scenario, and an estimated 0.84 worker injuries and 0.012 worker fatalities are expected to occur during GMF closure under the CBR-Offsite scenario. Thus, for the GMF, the overall risks to workers are likely to be highest under the CBR-Offsite scenario and lowest under the CIP scenario.

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2.2.4.2 Community Risks

Accidents

Vehicle accidents that occur off-Site can result in injuries or fatalities among community members, as well as workers. Based on the accident statistics for large trucks reported by US DOT (2020) and the off-Site haul truck mileages reported above for the GMF, haul truck accidents could result in an estimated 1.2 injuries and 0.044 fatalities among community members (*i.e.*, people involved in haul truck accidents that are neither haul truck drivers nor passengers, including pedestrians, drivers of other vehicles, *etc.*) under the CBR-Offsite scenario due to hauling of excavated materials from the GMF (Table 2.6). In contrast, no fatalities or injuries are expected to occur among community members under the CBR-Onsite or CIP scenarios due to haul truck accidents, because borrow soil will be taken from a location on the property and any excavated materials will be hauled to an off-Site landfill.

Table 2.6 Expected Number of Community Accidents Due to Hauling Under Each Closure Scenario – GMF

Closure Scenario	Injuries	Fatalities
CIP	0	0
CBR-Onsite	0	0
CBR-Offsite	1.2	0.044

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal; CIP = Closure-in-Place; GMF = Gypsum Management Facility.

In addition to impacts due to off-Site hauling, all scenarios may have off-Site impacts due to labor mobilization and demobilization, equipment and vehicle mobilization and demobilization, and material deliveries. As described above (Risk of Worker Accidents Occurring Off-Site), the CIP scenario is likely to require the smallest amount of off-Site activity due to these off-Site vehicle uses – and, hence, the smallest number of off-Site vehicle accidents arising from these activities – across all scenarios evaluated for the GMF.

Traffic

Haul routes are expected to use major arterial roads and highways wherever possible, which will reduce the incidence of traffic. However, the heavy use of local roads for construction operations may result in traffic near the Site and, in the case of the CBR-Offsite scenario, the off-Site landfill.

Traffic may increase temporarily around the Site under all three closure scenarios due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. However, these impacts are expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries). These impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site under the CBR-Offsite scenario.

Under the CBR-Offsite scenario, Golder estimates that approximately 50,900 truckloads will be required to transport excavated materials from the GMF to the off-Site landfill over 1,220 hauling days (Appendix B). Assuming a 10-hour work day, 6 work days per week, and 26 work days per month, a haul truck would therefore need to pass a given location near the Site once every 7.2 minutes on average for the duration of excavation activities under the CBR-Offsite scenario for the GMF. Thus, traffic demands are

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considerable. This level of traffic (one truck passing a location approximately once every 7.2 minutes) could potentially cause traffic delays on local roads and cause damage to local roadways. It could also cause delays in the re-development of the Site for use in utility-scale solar generation.

Noise

Construction generates a great deal of noise, both in the vicinity of the Site and along haul routes. In a closure impact analysis performed by the Tennessee Valley Authority (TVA, 2015), the authors found that "[T]ypical noise levels from construction equipment used for closure are expected to be 85 dBA or less when measured at 50 ft. These types of noise levels would diminish with distance … at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 ft." Because there are no residences or businesses within 1,500 feet of any of the construction areas on the Site (the GMF, the proposed borrow site, and the on-Site landfill), we do not anticipate that any residences or businesses will be adversely impacted by noise pollution at the Site under any closure scenario. Moreover, although there are several scenic, recreational, and historical areas located within a few miles of the Site (the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites), there are no notable scenic or recreational areas located within 1,500 feet of any of the construction areas on the Site. Noise impacts are therefore expected to be relatively minor under all closure scenarios.

In addition to impacts in the immediate vicinity of the GMF, local roads near the Site and the off-Site landfill (CBR-Offsite scenario only) may experience noise pollution due to high volumes of truck traffic. As described above (Traffic), the construction schedule under the CBR-Offsite scenario requires haul trucks to pass by a given location every 7.2 minutes on average for 10 hours each day while excavation is occurring at the GMF. Dump trucks generate significant noise pollution, with noise levels of approximately 88 decibels or higher expected within a 50-foot radius of the truck (Exponent, 2018). This noise level is similar to the noise level of a gas-powered lawnmower or leaf blower (CDC, 2019). Decibel levels above 80 can damage hearing after 2 hours of exposure (CDC, 2019). In addition to haul truck impacts, noise pollution may also arise along local roads from the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. These impacts are expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries); these impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site.

Air Quality

Construction can adversely impact air quality. Air pollution can occur both on-Site and off-Site (*e.g.*, along haul routes), potentially impacting workers as well as community members. With regards to construction activities, two categories of air pollution are of particular concern: equipment emissions and fugitive dust. The equipment emissions of greatest concern are those found in diesel exhaust. Most construction equipment is diesel-powered, including the dump trucks used to haul material to and from the Site. Diesel exhaust contains hundreds of air pollutants, including nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOCs) (Hesterberg *et al.*, 2009; Mauderly and Garshick, 2009). Fugitive dust, another major air pollutant at construction sites, is generated by earthmoving operations and other soil- and CCR-handling activities. Along haul routes, an additional source of fugitive dust is road dust along unpaved dirt roads. Careful planning and the use of Best Management Practices (BMPs) such as wet suppression are used to minimize and control fugitive dust during construction activities; however, it is not possible to prevent dust generation entirely.

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The air pollutant mass released under a given closure scenario will be proportional to the expected duration and intensity of construction activities under that scenario. As initially described in Section 2.2.4.1 (Worker Risks), the CIP scenario is the GMF closure scenario with the shortest expected duration of construction activities, the smallest required volumes of CCR dewatering and handling, the least amount of total on-Site labor hours for major construction, and the least amount of required hauling truckloads. This scenario is therefore likely to result in the least amount of air emissions of the three closure scenarios.

Environmental Justice

The State of Illinois defines environmental justice (EJ) communities to be those communities with a minority population above twice the state average and/or a total population below twice the state poverty rate (IEPA, 2019). Relative to other communities, EJ communities experience an increased risk of adverse health impacts due to environmental pollution and other factors associated with remediation activities (US EPA, 2016).

As shown in a map of EJ communities throughout the state (Figure 2.1; IEPA, 2019), the on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). Due to its close proximity to the Site, the EJ community near Canton may be disproportionately impacted by air emissions, traffic, accidents and other factors arising from various closure activities occurring on or near the Site. Activities occurring near the GMF, the borrow site, and the on-Site landfill may have particularly negative impacts. Unfortunately, each of the evaluated closure scenarios requires significant construction activity in at least one of these three on-Site areas.

In addition to impacts arising from construction activity on or near the Site, EJ communities may be also impacted by off-Site activities, including the hauling of CCR and liner materials from the Site to the off-Site landfill, labor and equipment mobilization/demobilization, and material deliveries. Unfortunately, in addition to being located near the on-Site landfill, the borrow site, and the GMF, the EJ community near Canton is also located along the three primary haul routes from the Site to the off-Site landfill suggested by Google Maps (Google LLC, 2021). In summary, due to both on-Site and off-Site activities, all possible closure scenarios are associated with potential negative impacts on the EJ community near Canton (Figure 2.1).

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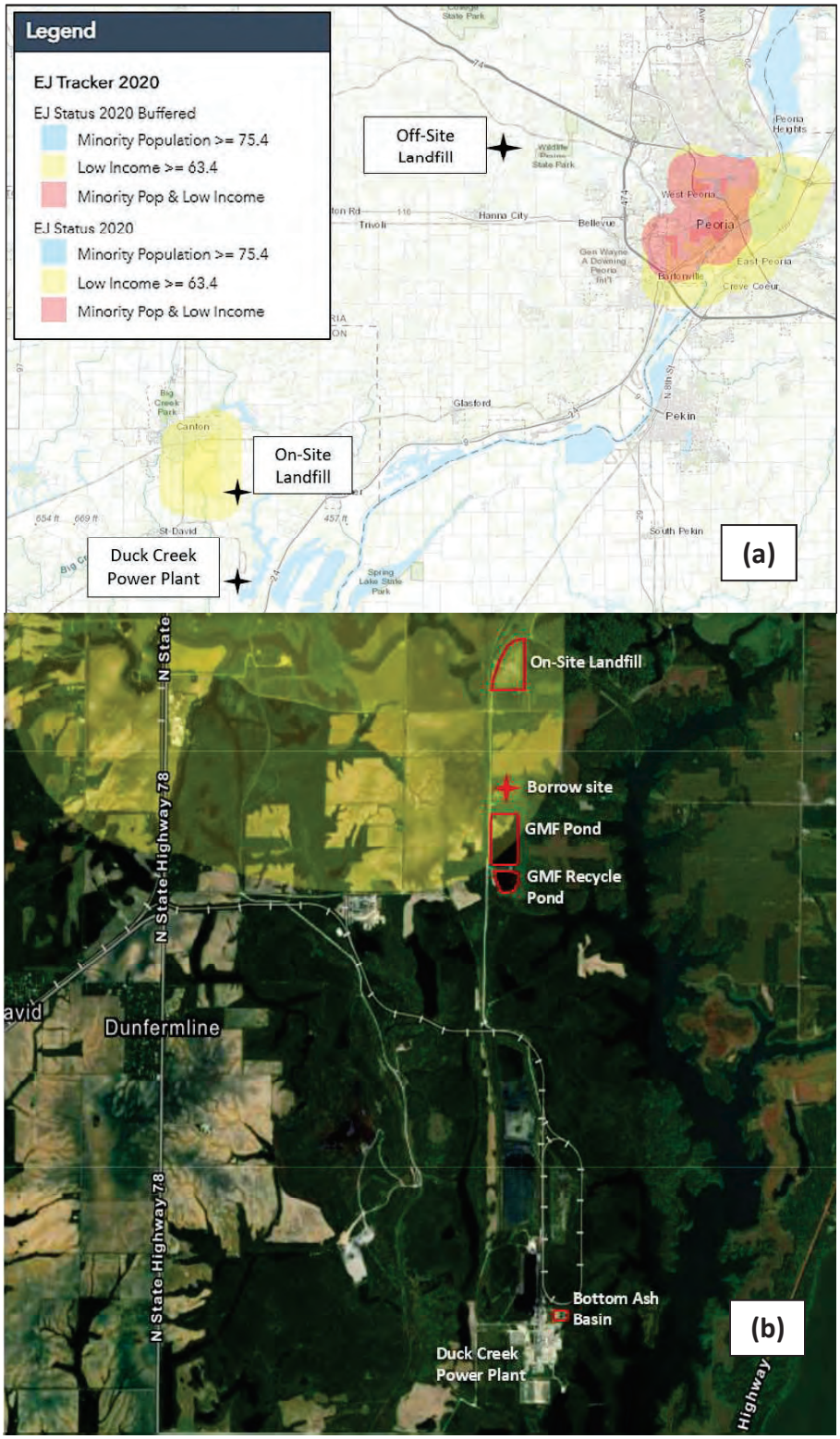

Figure 2.1 Environmental Justice Communities in the Vicinity of Site Features and the Off-Site Landfill – GMF. Adapted from IEPA (2019). (a) Regional map. (b) Site map.

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Scenic, Historical, and Recreational Value

There are several scenic, recreational, and historical areas located within a few miles of the Site, including the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites (Google LLC, 2021; Ramboll, 2021b,c). However, there are no notable scenic or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. The nearest scenic, recreational, or historical area is the Rice Lake SFWA, which is located over 2.5 miles from the GMF, the borrow soil location, and the on-Site landfill. We therefore do not expect construction activities at the Site to have any direct negative impacts on the scenic, historical, or recreational value of the areas listed above (due to, *e.g.*, noise, obstructions of the view, or restricted access), regardless of the closure scenario.

2.2.4.3 Environmental Risks

Greenhouse Gas Emissions

In addition to the air pollutants listed above in Section 2.2.4.2, construction equipment emits greenhouse gas emissions (GHGs), including carbon dioxide (CO_2) and possibly nitrous oxide (N_2O). The potential impact of each closure scenario on GHG emissions is similar to the potential impact of each closure scenario on other emissions from construction vehicles and equipment, as described above in Section 2.2.4.2. For the GMF, the CIP scenario has the shortest duration of construction activities and requires the least amount of CCR dewatering and handling; this scenario is therefore likely to have the lowest amount of predicted GHG emissions.

We did not quantify the carbon footprint of the approximately 31 acres of 40-mil LLDPE geomembrane liner required for the final GMF cover system under the CIP scenario, or the carbon footprint of the additional composite liner that will be required for the upstream slope of the berm to be constructed under this scenario (Appendix B). The carbon footprint of these geomembranes (*i.e.*, the fossil fuel emissions required to manufacture them) is an additional source of GHG emissions at the Site under the CIP scenario. Expansion of the on-Site landfill and the potential expansion of the off-Site landfill under the CBR-Onsite and CBR-Offsite scenarios would have an additional, unquantified carbon footprint due to the manufacture of geomembranes used in the expanded landfill liners.

Energy Consumption

Energy consumption at a construction site is synonymous with fossil fuel consumption, because the energy to power construction vehicles and equipment comes from the burning of fossil fuels. Fossil fuel demands considered in this analysis include the burning of diesel fuel during construction activities and the carbon footprint of manufacturing geomembrane textiles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed above with respect to GHG emissions also apply to the evaluation of energy demands. In summary, for the GMF, the energy requirements of construction are expected to be smallest under the CIP scenario. We did not quantify the energy demands of the geomembranes required for the construction of the final GMF cover system or the new GMF berm under the CIP scenario, the geomembranes required for the expansion of the on-Site landfill under the CBR-Onsite scenario, or, potentially, the geomembranes required for expansion of the off-Site landfill under the CBR-Offsite scenario.

The Duck Creek Site is slated for re-development as a utility-scale solar power generating facility. At the grid scale, solar generation will add energy back onto the grid and reduce reliance on non-renewable energy sources. In the short-term, closure activities at the Site may delay and obstruct these re-development efforts. The magnitude of expected delays will scale with the expected duration and

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intensity of construction activities during closure. For the GMF, the CIP scenario requires less total hauling activity than either of the two CBR scenarios (Tables 2.1-2.3). The CIP scenario can also be completed within a shorter time frame than the two CBR scenarios (12-24 months *versus* 24-48 months). The CIP scenario is therefore expected to result in fewer delays to re-development than either the CBR-Onsite or CBR-Offsite scenarios.

Natural Resources and Habitat

Construction is likely to have a negative short-term impact on the natural resources and habitat in the vicinity of the GMF and the on-Site borrow soil location. For example, excavation of the impoundment and the borrow soil location could result in the destruction of some habitat that may currently overlie these areas under all closure scenarios. Closure could also result in long-term shifts in the habitat overlying the impoundment and the borrow soil location (*e.g.*, areas of the impoundment that are not currently grassland would be converted to grassland). Use of the on-Site and off-Site landfill under the CBR-Onsite and CBR-Offsite scenarios, in contrast, is not expected to result in significant habitat changes, because these landfills are already in use.

In addition to direct impacts on the existing habitat atop the impoundment and the borrow soil location, construction activities may have indirect impacts by causing alarm and escape behavior in wildlife near these locations. For the GMF, the duration of time over which the direct and indirect habitat impacts of construction will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months). Thus, negative short-term impacts on natural resources and habitat are expected to be smallest under the CIP scenario.

The GMF is not located immediately adjacent to wetlands or notable surface water bodies, such as rivers or lakes (US FWS, 2021). For this reason, construction activities in the vicinity of the GMF are not expected to have a significant negative impact on any wetland or aquatic species (due to, *e.g.*, erosion and sediment runoff). Impacts are expected to be limited to terrestrial species. According to the Illinois Department of Natural Resources (IDNR) Natural Heritage Database and the United States Fish & Wildlife Service (US FWS) Environmental Conservation Online System, there are 11 state threatened species, 12 state endangered species, three federally threatened species, and one federally endangered species within Fulton County (Ramboll, 2021b,c). To our knowledge, however, no threatened or endangered species have been identified at the Site (Ramboll, 2021b,c). Based on the information that is currently available, we do not expect construction activities to have negative impacts on any threatened or endangered species.

2.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))

The primary groundwater migration pathway near the GMF is within the shallow sand unit within the uppermost aquifer. Groundwater flow in the shallow sand unit is generally in a northwest to southeast direction. Seasonal variation in groundwater levels at the GMF occurs and can result in groundwater elevation fluctuations of approximately 1-10 feet. There is no observable seasonal variation in groundwater flow direction at the GMF associated with these groundwater elevation changes. Groundwater flows toward the Duck Creek Cooling Pond, which is located approximately 2,100 feet east of the GMF (Ramboll, 2022).

Based on a statistical analysis and evaluation of potential exceedances, it was determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF (Ramboll, 2022). However, a groundwater model was developed to evaluate whether groundwater

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concentrations would maintain compliance with the GWPSs post-closure under the CIP scenario. For this evaluation, a groundwater flow model was developed and calibrated in MODFLOW. Contaminant transport was evaluated using MODPATH, and vertical percolation from the GMF into groundwater was evaluated using the HELP model (Ramboll, 2022).

The results of contaminant transport modeling *via* particle tracking for the CIP scenario at the GMF indicate that all particles will remain within the footprint of the GMF. Over a model-simulated period of 100 years following closure by CIP, the mean travel distance of all particles within the liner system and gypsum in the GMF was 0.29 feet horizontally and 0.03 feet vertically (Ramboll, 2022). Based on these modeling results, it was concluded that groundwater concentrations under the CIP scenario are expected to maintain compliance with the GWPSs well into the future (Ramboll, 2022).

2.2.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.710(b)(1)(F))

Section 2.2.1 evaluates potential risks to human and ecological receptors arising from the potential leaching of CCR-associated constituents from the GMF. Section 2.2.2 evaluates the potential for sudden CCR releases to occur at the GMF due to, *e.g.*, dike failure or overtopping during floods or other storm-related events. In summary, under all evaluated closure scenarios, there is no current or future risk to any human or ecological receptors associated with the GMF. Additionally, there is minimal current or future risk of overtopping due to flood conditions. Dike failure due to, *e.g.*, seismic activity and storm-related events is also exceedingly unlikely.

Section 2.2.4 evaluates several potential risks to human health and the environment during closure activities, including risks of accidents occurring among workers; risks to nearby residents and EJ communities related to accidents, traffic, noise, and air pollution; and risks to natural resources and wildlife. The findings from this section of the text are summarized in Table S.1.

2.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G))

As described in Section 2.2.2, there is minimal risk of engineering or institutional failures leading to sudden releases of CCR from the GMF post-closure under the CIP scenario. Under the CBR-Onsite and CBR-Offsite scenarios, there is no risk of engineering or institutional failures leading to sudden releases of CCR post-closure. Additionally, there are no current or future unacceptable risks to any human or ecological receptors associated with the GMF under any of the closure scenarios (see Section 2.2.1 above). Moreover, reliable engineering and institutional controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) will be implemented at the on-Site and off-Site landfills under the CBR-Onsite and CBR-Offsite scenarios. All of the evaluated closure scenarios are therefore reliable with respect to long-term engineering and institutional controls.

2.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H))

At this time, we do not anticipate a need for corrective action at the GMF under any closure scenario.

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2.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2))

2.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A))

The gypsum in the GMF currently poses no unacceptable risks to human health or the environment (Section 2.2.1). Because current conditions do not present a risk to human health or the environment, and groundwater concentrations are expected to remain stable and/or decline post-closure, there will also be no unacceptable risks to human health or the environment following closure of the impoundments, regardless of the closure scenario.

Section 2.2.2 discussed the potential for dike failure or flood overtopping to occur during or following closure activities, resulting in a sudden release of CCR. That analysis showed that there is minimal risk of CCR releases occurring at the GMF following closure under any closure scenario.

2.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B))

At this time, we do not anticipate a need for the use of treatment technologies other than source control (*i.e.*, CIP, CBR-Onsite, and CBR-Offsite) at the GMF under any closure scenario.

2.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3))

2.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative

CIP using a final cover system is a reliable and standard method for closing impoundments. However, dewatering and relocating saturated gypsum as part of closure activities at the GMF may be moderately challenging. Careful planning will be required to work safely on the wet gypsum within the GMF.

Excavation and landfilling of CCR is also a reliable and standard method for closing impoundments. However, relative to CIP, CBR-Onsite, and CBR-Offsite pose additional implementation difficulties due to higher earthwork volumes, higher dewatering volumes, and longer construction schedules. Dewatering the gypsum in the GMF prior to excavation will require considerable effort and time. Removal and disposal of the existing bottom liner geomembranes may also prove challenging during CBR activities. Specifically, it may be difficult to remove and handle the geomembranes. Additionally, the geomembranes may need to be decontaminated prior to disposal. Finally, the geomembranes may not be accepted for disposal at the off-Site landfill.

Hauling will be easier to implement under the CBR-Onsite scenario than under the CBR-Offsite scenario, due to less haul traffic on public roadways. Additionally, because the CBR-Offsite scenario involves hauling CCR off-Site (*i.e.*, intrastate travel), a higher level of dewatering will be required compared to the CBR-Onsite scenario. As described in Section 2.2.4.2 ("Community Risks"), off-Site hauling may also have detrimental community impacts due to an increased incidence of vehicle accidents, truck traffic, noise, and air pollution.

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In addition to off-Site hauling, off-Site landfilling under the CBR-Offsite scenario may pose particular challenges. A disposal plan will need to be developed between IPRG and the owner/operator of the third-party landfill in order to outline acceptable waste conditions upon delivery, daily waste production rates, and the expected duration of the project. Off-Site landfilling may additionally raise issues related to the co-disposal of CCR and liner materials and other non-hazardous wastes. Finally, the construction schedule for excavation may be negatively impacted if, during the course of closure, it is determined that the off-Site landfill must be expanded in order to receive all of the materials excavated from the GMF.

2.4.2 Expected Operational Reliability of the Closure Alternative

The operational reliability of the CIP scenario, the CBR-Onsite scenario, and the CBR-Offsite scenario is expected to be similar. The GMF currently includes a bottom liner system, and CIP will utilize a final cover system that includes a geomembrane. Under the CIP scenario, the gypsum in the GMF will therefore be surrounded by an engineered containment system on the top, sides, and bottom. The CBR-Offsite and CBR-Onsite scenarios similarly involve placing the gypsum from the GMF in an engineered landfill system that has a bottom liner, leachate collection system, and final cover system, resulting in the gypsum being surrounded by an engineered containment system on the top, sides, and bottom. The operational reliability of all three closure scenarios is therefore expected to be similar for both impoundments. Moreover, high operational reliability is expected under all scenarios due to the full containment of CCR and liner materials.

2.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies

Permits and approvals will be needed under all closure scenarios. Components of the three closure scenarios that are expected to require a permit include:

- A modification to the existing NPDES permit through IEPA to allow the disposal of water generated from unwatering and dewatering operations to the Illinois River *via* the existing NPDES-permitted outfall for the Site;
- A construction permit from the IDNR, Office of Water Resources, Dam Safety Program to allow the embankment and spillways of the impoundment to be modified as part of closure;
- A construction stormwater permit through IEPA, including construction stormwater controls and other BMPs such as silt fences and other measures; and
- A joint water pollution control construction and operating permit (WPC permit).

As discussed below in Section 2.4.5, the existing on-Site landfill will require expansion under the CBR-Onsite scenario in order to accommodate all of the material excavated from the GMF. The on-Site landfill has already been permitted for an expansion of an additional 2 acres of waste disposal area. Under the CBR-Offsite scenario, it may similarly be necessary to expand the off-Site landfill. Additional permitting may be required under this scenario for transport of the CCR and to expand the off-Site landfill. It may also be necessary to modify the operating plan for the off-Site landfill in order to accommodate the increased rate of filling of the landfill and the likely need for additional equipment and personnel to manage the receipt and disposal of the CCR and liner system materials.

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2.4.4 Availability of Necessary Equipment and Specialists

CIP, CBR-Onsite, and CBR-Offsite are reliable and standard methods for managing waste that rely on common construction equipment and materials and typically do not require the use of specialists, outside of typical construction labor and equipment operators. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment under all scenarios, if supply chain resilience does not improve by the time of construction. Alternatively, extended downtime may be required for equipment repairs and maintenance. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the CBR-Onsite and CBR-Offsite scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR-Onsite and CBR-Offsite scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site. If sufficient trucks and truck drivers are not available, the construction schedule at both impoundments may lengthen based on hauling-related delays.

The availability of critical materials such as metal, wood, and electronic chips has also been impacted by the COVID-19 pandemic. However, soil materials and geomembrane liner materials have generally been available during 2021 for landfill development and closure projects.

2.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services

Under the CIP scenario, the gypsum currently within the GMF will be consolidated and stored within the existing footprint of the impoundment. The GMF will be unwatered at the start of construction *via* pumping. Pumped water will be managed in accordance with the facility's NPDES permit. Treatment is not expected to be necessary prior to discharge.

The existing landfill on the Duck Creek property does not have sufficient capacity to receive all of the CCR and liner materials that are currently slated for landfilling under the CBR-Onsite scenario. Expansion of the on-Site landfill would thus be necessary. The on-Site landfill is already permitted for added waste disposal capacity, which would create an additional 2 acres of landfill area (Appendix B). The landfill expansion could be completed in a single construction season during the removal of ponded water at the GMF.

Under the CBR-Offsite scenario, up to 733,000 cubic yards of gypsum, liner materials, and additional subsoil overexcavation and 31 acres of geosynthetic liner system materials excavated from the GMF will require disposal at an off-Site landfill. An additional 7,000 cubic yards of material excavated from the BAB would also require disposal at the off-Site landfill, if CBR-Offsite were selected for the BAB. According to the IEPA "Illinois Landfill Disposal Capacity Report" for 2020 (IEPA, 2021b), the closest third-party landfill with the ability to receive and dispose of CCR from the Site is the Peoria City-County Landfill in Brimfield, Illinois. This facility has 750,000 cubic yards of remaining capacity in its current permitted footprint. It receives 230,000 cubic yards of waste annually, and is located 33 miles from the Site. The Peoria City-County Landfill therefore has sufficient capacity to receive all of the CCR and liner materials from the GMF. However, due to the limited space remaining in this landfill and the short time frame over which CCR would be received at the landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that will be received and the unique CCR and liner system waste characteristics. Elements of this disposal plan might include increasing daily operational capacity and procedures, expediting planned airspace construction, and potentially expediting landfill expansion. If

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expansion of the Peoria City-County Landfill is impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A likely alternative to the Peoria City-County Landfill is the Envirofil of IL Landfill in Macomb, Illinois. It has 7,700,000 cubic yards of remaining capacity in its current permitted footprint, receives 97,000 cubic yards of waste annually, and is located approximately 45 miles from the Site (IEPA, 2021b).

2.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4))

As demonstrated in Gradient's Human Health and Ecological Risk Assessment (Appendix A of this report), modeled surface water concentrations in the Illinois River in the vicinity of the Site are all below relevant human health and ecological screening benchmarks. Due to closure activities, surface water concentrations of CCR-associated constituents are expected to remain stable and/or decline over time under all three closure scenarios. Thus, no future exceedances of any human health or ecological screening benchmarks are anticipated under any closure scenario. Additionally, the lined landfills that will receive any materials excavated from the GMF under the CBR-Onsite and CBR-Offsite scenarios will be managed to ensure that no surface water impacts occur in the vicinity of the landfills.

2.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4))

Several nonprofits representing community interests near the Site have raised concerns regarding the potential impacts of coal ash impoundments at this Site on groundwater and surface water quality, including Earthjustice, the Prairie Rivers Network, and the Sierra Club (Earthjustice *et al*., 2018; Sierra Club, 2014; Sierra Club and CIHCA, 2014). These parties generally prefer CBR to CIP, citing fears that allowing CCR to remain in place "allows the widespread groundwater contamination to continue indefinitely" (Earthjustice *et al*., 2018, p. 24). For the GMF, both CIP and CBR are being considered; however, it is not the case that closing the GMF *via* CIP rather than CBR would result in undue risks to groundwater and surface water post-closure. As described in Sections 2.2.1 and 2.2.2, no current or future unacceptable risks to human or ecological receptors are associated with the GMF under any closure scenario. There is also minimal risk of future CCR releases occurring under any closure scenario. Furthermore, based on a model-simulated period of 100 years, groundwater concentrations under the CIP scenario are expected to maintain compliance with the GWPSs post-closure (Ramboll, 2022). In summary, all closure scenarios are responsive to residents' concerns regarding groundwater and surface water quality.

For the GMF, the CIP scenario has advantages over the CBR-Offsite and CBR-Onsite scenarios with regard to likely community concerns. Specifically, compared to the other evaluated alternatives, CIP presents fewer risks to workers and community members during construction in the form of accidents, traffic, and air pollution (Section 2.2.4 above) and is also associated with the shortest time to closure. By minimizing the expected time to closure, CIP minimizes the duration of negative impacts arising from construction activities and minimizes the time required to re-develop the Site for use in utility-scale solar generation. Re-development of the Site for use in solar generation and storage will bring new jobs to the community and contribute positively to Illinois's growing renewable energy portfolio.

A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

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2.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1))

A cost estimate has been prepared for each of the closure scenarios (Appendix B). A summary of these estimates is provided in Table 2.7. The total expected cost of closure under the CIP scenario is $6,210,000. The total expected cost of closure under the CBR-Onsite scenario is $8,870,000. The total expected cost of closure under the CBR-Offsite scenario is $82,400,000. Costs under the CIP scenario are therefore considerably smaller than costs under the CBR-Onsite and CBR-Offsite scenarios.

Table 2.7 Expected Costs of Closure – GMF

Work Element	CIP	CBR-Onsite	CBR-Offsite
Mobilization/Demobilization	$488,000	$727,000	$6,810,000
Surveying and Site Preparation	$125,000	$50,000	$25,000
Dewatering, Unwatering, and Stormwater Management	$2,260,000	$2,310,000	$2,280,000
Impoundment Closure and Site Restoration	$2,800,000	$4,660,000	$65,800,000
Landfill Expansion	$0	$331,000	$0
Miscellaneous Construction	$537,000	$800,000	$7,490,000
Total:	**$6,210,000**	**$8,870,000**	**$82,400,000**

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal; CIP = Closure-in-Place; GMF = Gypsum Management Facility.
Costs are for comparative purposes only. Actual costs will be paid based on actual quantities and may vary from those calculated.
Source: Appendix B.

All three closure scenarios meet or exceed a Class 4 estimate under the Association for the Advancement of Cost Engineering (AACE) Classification Standard (or a comparable classification practice as provided in the AACE Classification Standard), as required by IAC Section 845.710 (IEPA, 2021a).

2.8 Summary

Table S.1 (Summary of Findings) summarizes the expected impacts of the CIP, CBR-Onsite, and CBR-Offsite closure scenarios with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on this evaluation and the details provided in Section 2 above, CIP has been identified as the most appropriate closure scenario for the GMF. Key benefits relative to other closure scenarios include the more rapid re-development of the Site for use in utility-scale solar generation and reduced impacts on workers, community members, and the environment during construction (*e.g.*, fewer constructed-related accidents, lower energy demands, less air pollution and GHG emissions, and less traffic).

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3 Closure Alternatives Analysis – BAB

3.1 Closure Alternative Descriptions (IAC Section 845.710(c))

This section of the report presents a CAA for the BAB pursuant to requirements under IAC Section 845.710 (IEPA, 2021a). For the BAB, Gradient evaluated two closure scenarios: CBR-Onsite and CBR-Offsite. CIP was not evaluated for the BAB because no significant CCR remains in the impoundment. Sections 3.1.1 and 3.1.2 describe the CBR-Onsite and CBR-Offsite closure scenarios. These scenarios are based on information and analyses conveyed to Gradient by Golder (Appendix B; Golder, 2022c,d).

3.1.1 Closure-by-Removal with On-Site Disposal

Under the CBR-Onsite scenario, CCR and existing liner system materials will be excavated from the BAB and sent to the on-Site landfill for final disposal. Excavation activities at the BAB will include any residual CCR that is still present in the impoundment; the concrete, compacted clay, and geomembrane components of the existing liner system; and additional subsoil overexcavation (Golder, 2022c,d). Excavated materials from the BAB will be hauled to the on-Site landfill (Appendix B; Golder, 2022d).

The on-Site landfill is located approximately 3.7 miles north of the BAB *via* Site roads (Appendix B). Excavated materials will be hauled to the landfill using haul trucks. The landfill on the property is currently expected to have sufficient capacity to receive all of the materials from the BAB slated for disposal under the CBR-Onsite scenario. This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a) which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.

This scenario includes the following work elements for the closure of the BAB (Appendix B; Golder, 2022c,d):

- Excavation and transport of CCR and liner system materials to the on-Site landfill, as detailed above.
- Grading and filling to convey runoff away from the impoundments.
- Site restoration, including revegetation with native grasses.
- Three years of monitoring at the impoundments, or until such time as GWPSs are achieved.

In total, approximately 3,550 cubic yards of concrete and compacted clay, 1 acre of geomembrane materials from the existing liner system, and 3,200 cubic yards of overexcavated subsoil will be excavated from the BAB under the CBR-Onsite scenario and hauled to the on-Site landfill for disposal. The selected borrow soil location is approximately 3.4 miles north of the BAB *via* Site roads (Appendix B). A total of 17,500 cubic yards of borrow soil are required for grading and filling of the BAB (Appendix B).

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Under the CBR-Onsite scenario, the expected duration of major construction activities is approximately 12-18 weeks (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Onsite scenario are shown in Table 3.1.

Table 3.1 Key Parameters for the Closure-by-Removal with On-Site Disposal Scenario – BAB

Parameter	Value	Notes
Surface Area of Impoundment (acres)	2.2	Includes all three cells and the area around the cells.
In-Place Volume of CCR (CY)	Minimal	The CCR in the impoundment has been excavated previously.
Distance to the On-Site Landfill (miles)	3.7	
Required Volume of Borrow Soil (CY)	17,500	Required for grading and filling.
Volume of Soil Stockpiled at Borrow Soil Location (CY)	0	
Distance to the Borrow Soil Location (miles)	3.4	
Duration of Construction Activities (weeks)	12-18	
Total On-Site Labor Hours for Major Construction[a]	4,820	
Required On-Site Hauling Truckloads (Loaded)	843	
Required Off-Site Hauling Truckloads (Loaded)	0	
Required On-Site Hauling Miles	5,870	
Required Off-Site Hauling Miles	0	

Notes:
BAB = Bottom Ash Basin; CCR = Coal Combustion Residual; CY = Cubic Yards.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction was defined as any operation occurring on-Site that required one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor was not included if it was limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators was only included in calculations if the hauling occurred on-Site. Workers assigned to relevant activities were assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

3.1.2 Closure-by-Removal with Off-Site Disposal

Under the CBR-Offsite scenario, CCR and existing liner system materials will be excavated from the BAB and sent to an off-Site landfill for final disposal. Excavation activities at the BAB will include any residual CCR that is still present in the impoundment; the concrete, compacted clay, and geomembrane components of the existing liner system; and additional subsoil overexcavation (Golder, 2022c,d). Excavated materials in the BAB will be sent to the Peoria City-County Landfill (11501 W Cottonwood Road, Brimfield, IL 61517), which is approximately 33 miles from the Site (Appendix B).

IAC Section 845.710(c)(1) requires CBR alternatives to consider multiple methods for transporting excavated materials off-Site, including rail, barge, and trucks. Golder evaluated the feasibility of transporting excavated materials to the off-Site landfill *via* rail or barge and found that neither option is viable at this Site. Existing loadout facilities, which would facilitate off-Site rail or barge transport, are not present on the property, and the construction of new loadout facilities is considered infeasible. Only transport *via* on-road haul trucks (with a 16.5-cubic-yard capacity) is considered feasible for CBR-Offsite. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.

The work elements included in this scenario are largely the same as those listed above in Section 3.1.1 for the CBR-Onsite scenario (Appendix B; Golder, 2022c,d):

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- Excavation and transport of CCR and liner system materials to the off-Site landfill, as detailed above. All areas affected by CCR releases will be decontaminated, including potential over-excavation below the bottom of the liner system.
- Grading and filling to convey runoff away from the impoundments.
- Site restoration, including revegetation with native grasses.
- Three years of monitoring at the impoundments, or until such time as GWPSs are achieved.

In total, approximately 3,550 cubic yards of concrete and compacted clay, 1 acre of geomembrane materials from the existing liner system, and 3,200 cubic yards of overexcavated subsoil will be excavated from the BAB under the CBR-Offsite scenario and hauled to the off-Site landfill for disposal. The selected borrow soil location is approximately 3.4 miles north of the BAB *via* Site roads (Appendix B). A total of 17,500 cubic yards of borrow soil are required for grading and filling of the BAB (Appendix B).

Under the CBR-Offsite scenario, the expected duration of major construction activities is expected to be approximately 12 to 18 weeks for the BAB (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Offsite scenario are shown in Table 3.2.

Table 3.2 Key Parameters for the Closure-by-Removal with Off-Site Disposal Scenario – BAB

Parameter	Value	Notes
Surface Area of Impoundment (acres)	2.2	Includes all three cells and the area around the cells.
In-Place Volume of CCR (CY)	Minimal	The CCR in the impoundment has been excavated previously.
Distance to the Off-Site Landfill (miles)	33	Peoria City-County Landfill in Brimfield, IL.
Required Volume of Borrow Soil (CY)	17,500	Required for grading and filling.
Volume of Soil Stockpiled at Borrow Soil Location (CY)	0	
Distance to the Borrow Soil Location (miles)	3.4	
Duration of Construction Activities (weeks)	12 to 18	
Total On-Site Labor Hours for Major Construction[a]	4,360	
Required On-Site Hauling Truckloads (Loaded)	606	
Required Off-Site Hauling Truckloads (Loaded)	489	
Required On-Site Hauling Miles	4,120	
Required Off-Site Hauling Miles	31,900	

Notes:
BAB = Bottom Ash Basin; CCR = Coal Combustion Residual; CY = Cubic Yards.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction was defined as any operation occurring on-Site that required one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor was not included if it was limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators was only included in calculations if the hauling occurred on-Site. Workers assigned to relevant activities were assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

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3.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1))

3.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A))

This section of the report addresses the potential risks to human and ecological receptors due to exposure to CCR-associated constituents in groundwater or surface water. Gradient has performed a Human Health and Ecological Risk Assessment for the Site (Appendix A of this report), which provides a detailed evaluation of the magnitude of existing risks to human and ecological receptors associated with the BAB. This report concluded that there are no current unacceptable risks to any human or ecological receptors associated with the BAB. Moreover, because groundwater concentrations are expected to remain stable and/or decline over time under both closure scenarios, there will also be no unacceptable risks to human health or the environment during or following closure. Thus, there is no current risk or future risk under either closure scenario at the BAB, and the magnitude of reduction of existing risks is the same under both scenarios.

3.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B))

This section of the report quantifies the risk of future releases of CCR that may occur during dike failure and storm-related events.

Storm-Related Releases and Dike Failure During Flood Conditions

There is no current or future risk of sudden CCR releases occurring at the BAB under either closure scenario. No significant amount of CCR remains in the impoundment.

Dike Failure Due to Seismicity

Sites in Illinois may be subject to seismic risks arising from the Wabash Valley Seismic Zone and the New Madrid Seismic Zone (IEMA, 2020). However, the Duck Creek property does not lie within a seismic impact zone. The property is also believed to have a "low risk level" for seismic risks based on the 2018 USGS National Seismic Hazard Map. Additionally, the BAB does not lie within 200 feet of an active fault or fault damage zone at which displacement has occurred within the current geological epoch (*i.e.*, within the last ~11,650 years; Burns & McDonnell, 2021b,c; Haley & Aldrich, Inc., 2018a,b). The nearest known fault is the Sicily Fault, which is located about 64 miles southeast of the BAB. The Sicily Fault does not have known recent activity (Haley & Aldrich, Inc., 2018a,b). Thus, the risk of dike failure occurring during or following closure activities due to seismic activity is exceedingly low at the BAB.

3.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C))

The long-term operation and management plans for the BAB are described in Section 3.1 for each closure scenario. Under both the CBR-Onsite and CBR-Offsite scenarios, the BAB will undergo monitoring for 3 years post-closure, or until such time as GWPSs are achieved.

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3.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D))

3.2.4.1 Worker Risks

Best practices will be employed during construction in order to ensure worker safety and comply with all relevant regulations, permit requirements, and safety plans. However, it is impossible to completely eliminate risks to workers during construction activities, both on- and off-Site. On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during construction activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization and demobilization, material deliveries, and the hauling of CCR and liner system materials to the on-Site landfill and the off-Site landfill.

Risk of Worker Accidents Occurring On-Site

For the BAB, two closure scenarios were considered: CBR-Offsite and CBR-Onsite. Based on labor requirements reported in Appendix B of this report, Gradient estimates that 4,820 total on-Site labor hours are required for major construction activities under the CBR-Onsite scenario and 4,360 total on-Site labor hours are required for major construction activities under the CBR-Offsite scenario. The labor requirements under both scenarios are therefore similar. Slightly fewer on-Site labor hours are required under the CBR-Offsite scenario than under the CBR-Onsite scenario, because a greater percentage of hauling (a major construction activity) occurs off-Site rather than on-Site under the former scenario. Based on these values and US BLS labor statistics (US DOL, 2020a,b), we estimate that approximately 0.056 worker injuries and 0.00036 worker fatalities will occur on-Site under the CBR-Onsite scenario due to major construction activities at the BAB (Table 3.3). A slightly smaller number of worker injuries and fatalities (0.050 worker injuries and 0.00033 worker fatalities) are expected to occur on-Site under the CBR-Offsite scenario (Table 3.3). Note that the calculations presented here focus on major construction activities (*e.g.*, excavation, loading, and hauling). They therefore do not account for the additional accidents that could occur on-Site during less intensive construction activities (*e.g.*, surveying, erosion control, and hydroseeding).

Table 3.3 Expected Number of On-Site Worker Accidents Under Each Closure Scenario – BAB

Closure Scenario	Injuries	Fatalities
CBR-Onsite	0.056	0.00036
CBR-Offsite	0.050	0.00033

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

Risk of Worker Accidents Occurring Off-Site

The CBR-Offsite scenario is the only scenario which requires any off-Site hauling. Under the CBR-Offsite scenario, 31,900 vehicle travel miles are required to haul excavated materials to the off-Site landfill (Table 3.2). The US DOT (2020) provides an estimate of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks. Based on US DOT's statistics, 0.0041 injuries and 0.000093 fatalities are expected to occur to drivers and passengers of haul trucks due to hauling under the CBR-Offsite scenario (Table 3.4).

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Table 3.4 Expected Number of Off-Site Worker Accidents Due to Hauling Under Each Closure Scenario – BAB

Closure Scenario	Injuries	Fatalities
CBR-Onsite	0	0
CBR-Offsite	0.0041	0.000093

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

These estimates reflect the minimum number of worker accidents that are likely to occur off-Site under each scenario, because they do not account for the additional vehicle accidents that may occur during non-hauling activities such as labor mobilization and demobilization, equipment mobilization and demobilization, and material deliveries. The vehicle mileages associated with these off-Site activities are not known. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities, the same required earthwork volumes, similar on-Site labor hours for major construction, and a similar total number of required hauling truckloads (on-Site + off-Site). These two scenarios are therefore likely to have similar impacts with regard to off-Site vehicle accidents arising from labor and equipment mobilization/demobilization and material deliveries.

Taking into account both (i) accidents occurring on-Site due to major construction activities and (ii) accidents occurring off-Site due to hauling, an estimated 0.056 worker injuries and 0.00036 worker fatalities are expected under the CBR-Onsite scenario, and an estimated 0.054 worker injuries and 0.00042 worker fatalities are expected to occur under the CBR-Offsite scenario. Thus, overall risks to workers are likely to be of similar magnitude for both closure scenarios.

3.2.4.2 Community Risks

Accidents

Vehicle accidents that occur off-Site can result in injuries or fatalities among community members, as well as workers. Based on the accident statistics for large trucks reported by US DOT (2020) and the off-Site haul truck mileages reported above for the BAB, haul truck accidents could result in an estimated 0.012 injuries and 0.00043 fatalities among community members (Table 3.5). In contrast, no fatalities or injuries are expected to occur among community members under the CBR-Onsite scenarios due to haul truck accidents, because borrow soil will be taken from a location on the property and any excavated materials will be hauled to an on-Site landfill.

Table 3.5 Expected Number of Community Accidents Due to Hauling Under Each Closure Scenario – BAB

Closure Scenario	Injuries	Fatalities
CBR-Onsite	0	0
CBR-Offsite	0.012	0.00043

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

In addition to impacts due to off-Site hauling, both scenarios may have off-Site impacts due to labor mobilization and demobilization, equipment and vehicle mobilization and demobilization, and material deliveries. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities, the same required earthwork volumes, similar on-Site labor hours for major

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construction, and a similar total number of required hauling truckloads (on-Site + off-Site). Both scenarios are therefore also likely to have similar impacts with regard to these off-Site activities.

Traffic

Haul routes are expected to use major arterial roads and highways wherever possible, which will reduce the incidence of traffic. However, the heavy use of local roads for construction operations may result in traffic near the Site and, in the case of the CBR-Offsite scenario, the off-Site landfill.

Traffic may increase temporarily around the Site under both closure scenarios due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. However, these impacts are expected to largely occur at the beginning or end of each work day (arrival/departure of the work force), at the beginning or end of the construction period (equipment mobilization/demobilization), and at specific times throughout the construction period (material deliveries). These impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site under the CBR-Offsite scenario.

Under the CBR-Offsite scenario, Golder estimates that approximately 489 truckloads will be required to transport materials excavated from the BAB to the off-Site landfill over approximately 80 hauling days (Appendix B). Assuming a 10-hour work day, 6 work days per week, and 26 work days per month, a haul truck would need to pass a given location near the Site once every 49 minutes on average for the duration of excavation activities.

Noise

Construction generates a great deal of noise, both in the vicinity of the Site and along haul routes. In a closure impact analysis performed by the TVA (2015), the authors found that "[T]ypical noise levels from construction equipment used for closure are expected to be 85 dBA or less when measured at 50 ft. These types of noise levels would diminish with distance … at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 ft." Because there are no residences or businesses within 1,500 feet of any of the construction areas on the Site (the BAB, the proposed borrow site, and the on-Site landfill), we do not anticipate that any residences or businesses will be adversely impacted by noise pollution at the Site under either closure scenario. Moreover, although there are several scenic, recreational, and historical areas located within a few miles of the Site (the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites), there are no notable scenic or recreational areas located within 1,500 feet of any of the construction areas on the Site. Noise impacts are therefore expected to be relatively minor at the BAB under both closure scenarios.

In addition to impacts in the immediate vicinity of the BAB, local roads near the Site and the off-Site landfill (CBR-Offsite scenario only) may experience noise pollution due to truck traffic. As described above (Traffic), a haul truck must pass a given location every 49 minutes on average for 10 hours a day while excavation is occurring. Dump trucks generate significant noise pollution, with noise levels of approximately 88 decibels or higher expected within a 50-foot radius of the truck (Exponent, 2018). This noise level is similar to the noise level of a gas-powered lawnmower or leaf blower (CDC, 2019). Decibel levels above 80 can damage hearing after 2 hours of exposure (CDC, 2019). In addition to haul truck impacts, noise pollution may also arise along local roads from the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. These impacts are expected to largely occur at the beginning or end of each work day (arrival/departure of the work force), at the beginning or end of the construction period (equipment mobilization/demobilization), and at specific times throughout the construction period (material deliveries); these impacts will therefore likely be less

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disruptive to community members than the constant and steady movement of haul trucks to and from the Site.

Air Quality

Construction can adversely impact air quality. Air pollution can occur both on-Site and off-Site (*e.g.*, along haul routes), potentially impacting workers as well as community members. With regards to construction activities, two categories of air pollution are of particular concern: equipment emissions and fugitive dust. The equipment emissions of greatest concern are those found in diesel exhaust. Most construction equipment is diesel-powered, including the dump trucks used to haul material to and from the Site. Diesel exhaust contains hundreds of air pollutants, including NO_x, PM, CO, and VOCs (Hesterberg *et al*., 2009; Mauderly and Garshick, 2009). Fugitive dust, another major air pollutant at construction sites, is generated by earthmoving operations and other soil- and CCR-handling activities. Along haul routes, an additional source of fugitive dust is road dust along unpaved dirt roads. Careful planning and the use of BMPs such as wet suppression are used to minimize and control fugitive dust during construction activities; however, it is not possible to prevent dust generation entirely.

The air pollutant mass released under a given closure scenario will be proportional to the expected duration and intensity of construction activities under that scenario. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities, the same required earthwork volumes, similar on-Site labor hours for major construction, and a similar total number of required hauling truckloads (on-Site + off-Site). These two scenarios therefore most likely have similar impacts with regard to air emissions.

Environmental Justice

The State of Illinois defines EJ communities to be those communities with a minority population above twice the state average and/or a total population below twice the state poverty rate (IEPA, 2019). Relative to other communities, EJ communities experience an increased risk of adverse health impacts due to environmental pollution and other factors associated with remediation activities (US EPA, 2016).

As shown in a map of EJ communities throughout the state (Figure 3.1; IEPA, 2019), the on-Site landfill and the borrow site are located within the 1-mile buffer zone of the nearest EJ community (near Canton). The BAB lies approximately 2.5 miles from the outer perimeter of this buffer zone. Due to its close proximity to the Site, the EJ community near Canton may be disproportionately impacted by air emissions, traffic, accidents and other factors arising from various closure activities occurring on or near the Site. Each of the evaluated closure scenarios requires some construction activity in at least one of these on-Site areas.

In addition to impacts arising from construction activity on or near the Site, EJ communities may be also impacted by off-Site activities, including the hauling of CCR and liner materials from the Site to the off-Site landfill, labor and equipment mobilization/demobilization, and material deliveries. Unfortunately, in addition to being located near the on-Site landfill and the borrow site, the EJ community near Canton is also located along the three primary haul routes from the Site to the off-Site landfill suggested by Google Maps (Google LLC, 2021). In summary, due to both on-Site and off-Site activities, both closure scenarios are associated with potential negative impacts on the EJ community near Canton (Figure 3.1).

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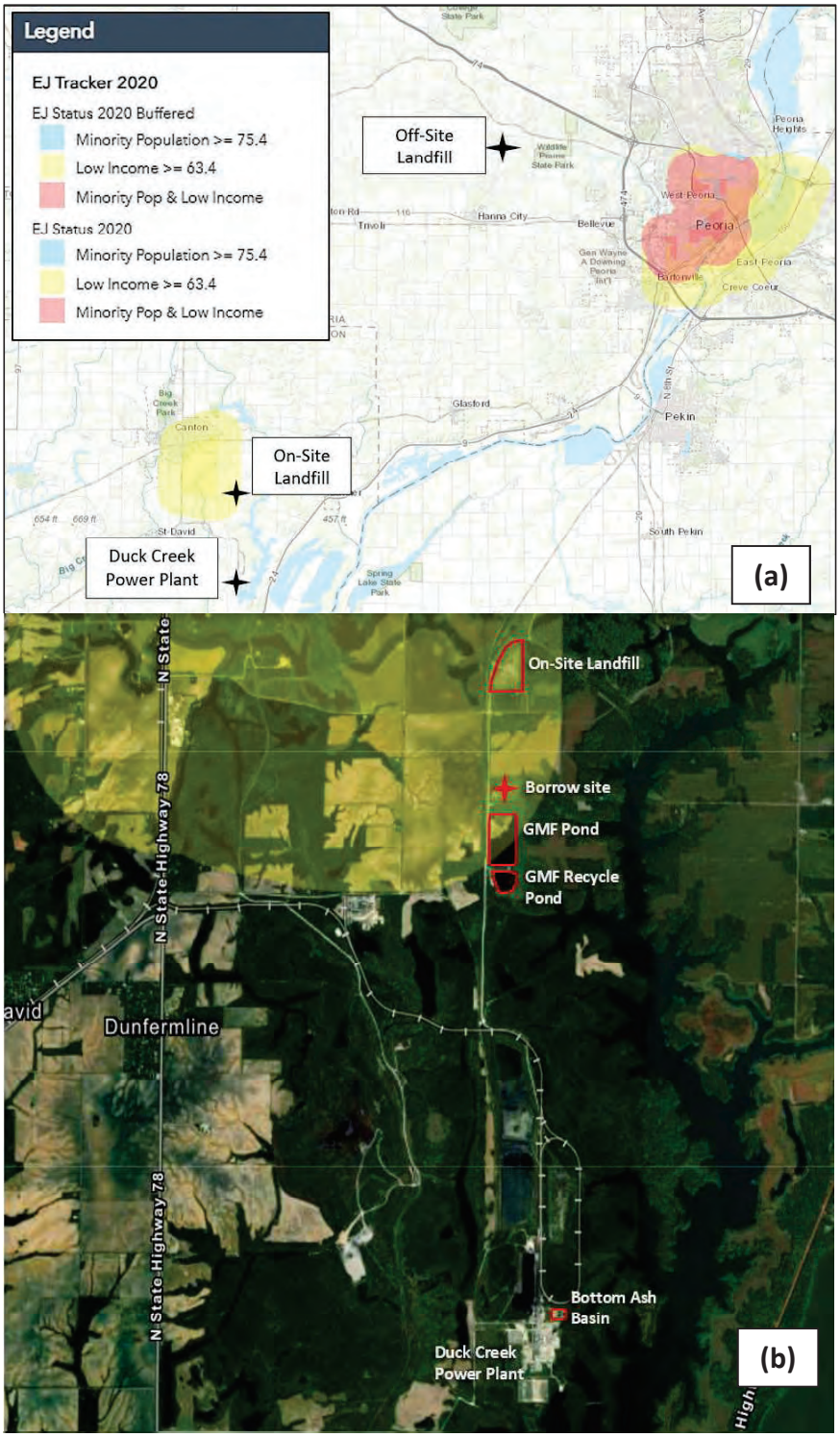

Figure 3.1 Environmental Justice Communities in the Vicinity of Site Features and the Off-Site Landfill – BAB. Adapted from IEPA (2019). (a) Regional map. (b) Site map.

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Scenic, Historical, and Recreational Value

There are several scenic, recreational, and historical areas located within a few miles of the Site, including the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites (Google LLC, 2021; Ramboll, 2021b,c). However, there are no notable scenic or recreational areas located in the immediate vicinity of the BAB, the borrow soil location, or the on-Site landfill. The nearest scenic, recreational, or historical area is the Rice Lake SFWA, which is located over a mile away from the BAB and even further away from the borrow soil location and the on-Site landfill. We therefore do not expect construction activities at the Site to have any direct negative impacts on the scenic, historical, or recreational value of the areas listed above (due to, *e.g.*, noise, obstructions of the view, or restricted access), regardless of the closure scenario.

3.2.4.3 Environmental Risks

Greenhouse Gas Emissions

In addition to the air pollutants listed above in Section 3.2.4.2, construction equipment emits GHGs, including CO_2 and possibly N_2O. The potential impact of each closure scenario on GHG emissions is similar to the potential impact of each closure scenario on other emissions from construction vehicles and equipment, as described above in Section 3.2.4.2. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities and the same required earthwork volumes. These two scenarios therefore most likely have similar impacts with regard to GHG emissions.

Energy Consumption

Energy consumption at a construction site is synonymous with fossil fuel consumption, because the energy to power construction vehicles and equipment comes from the burning of fossil fuels. Fossil fuel demands considered in this analysis include the burning of diesel fuel during construction activities and the carbon footprint of manufacturing geomembrane textiles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed above with respect to GHG emissions also apply to the evaluation of energy demands. For the BAB, energy requirements are expected to be similar under both the CBR-Onsite and CBR-Offsite scenarios.

Natural Resources and Habitat

Construction is likely to have a negative short-term impact on the natural resources and habitat in the vicinity of the BAB and the on-Site borrow soil location (due to, *e.g.*, the temporary destruction of any existing habitat atop these locations, and/or alarm and escape behavior in wildlife found near these locations). For BAB closure, the duration of time over which short-term negative impacts will occur (*i.e.*, the duration of construction activities) is limited to 12-18 weeks under both closure scenarios. Because both closure scenarios have the same expected duration of construction, both scenarios are expected to have similar short-term impacts on natural resources and habitat.

In addition to short-term impacts, closure may also result in long-term shifts in the habitat overlying the BAB and the borrow soil location (*i.e.*, any areas that are not currently grassland will be converted to grassland). Since both BAB closure scenarios (CBR-Onsite and CBR-Offsite) entail excavation followed by site restoration, both scenarios are also expected to have similar long-term impacts on natural resources and habitat.

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The BAB is not located immediately adjacent to wetlands or notable surface water bodies, such as rivers or lakes (US FWS, 2021). For this reason, construction activities are not expected to have a significant negative impact on any wetland or aquatic species (due to, *e.g.*, erosion and sediment runoff). Impacts are expected to be limited to terrestrial species. According to the IDNR Natural Heritage Database and the US FWS Environmental Conservation Online System, there are 11 state threatened species, 12 state endangered species, three federally threatened species, and one federally endangered species within Fulton County (Ramboll, 2021b,c). To our knowledge, however, no threatened or endangered species have been identified at the Site (Ramboll, 2021b,c). Based on the information that is currently available, we do not expect construction activities to have negative impacts on any threatened or endangered species.

3.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))

Based on a statistical analysis and evaluation of potential exceedances, it was determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the BAB. Because there are no exceedances of the GWPSs and there is no significant CCR remaining within the impoundment, modeling was not performed for either of the closure scenarios. Because groundwater concentrations are expected to remain stable and/or decline post-closure, groundwater exceedances of applicable groundwater standards that are attributable to the BAB are also not expected to occur in the future, regardless of the closure scenario.

3.2.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.710(b)(1)(F))

Section 3.2.1 evaluates potential risks to human and ecological receptors arising from the leaching of CCR-associated constituents from the BAB. Section 3.2.2 evaluates the potential for sudden CCR releases to occur at the BAB due to, *e.g.*, dike failure or overtopping during floods or other storm-related events. In summary, under both closure scenarios, there is no current or future risk to any human or ecological receptors associated with the BAB. Additionally, there is minimal current or future risk of overtopping due to flood conditions. Dike failure due to, *e.g.*, seismic activity and storm-related events is also exceedingly unlikely.

Section 3.2.4 evaluates several potential risks to human health and the environment during closure activities, including risks of accidents occurring among workers; risks to nearby residents and EJ communities related to accidents, traffic, noise, and air pollution; and risks to natural resources and wildlife. The findings from this section of the text are summarized in Table S.2.

3.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G))

As described in Section 3.2.2, there is no risk of engineering or institutional failures leading to sudden releases of CCR from the BAB post-closure under either closure scenario. Additionally, there are no current or future unacceptable risks to any human or ecological receptors associated with the BAB under either closure scenario (see Section 3.2.1 above). Moreover, reliable engineering and institutional controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) will be

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implemented at the on-Site and off-Site landfills under the CBR-Onsite and CBR-Offsite scenarios. Both closure scenarios are therefore reliable with respect to long-term engineering and institutional controls.

3.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H))

At this time, we do not anticipate a need for corrective action at the BAB under any closure scenario.

3.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2))

3.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A))

There are no unacceptable risks to human health or the environment associated with the BAB (Section 3.2.1). Because current conditions do not present a risk to human health or the environment, and because groundwater concentrations are expected to remain stable and/or decline post-closure, there will also be no unacceptable risks to human health or the environment following closure of the BAB, regardless of the closure scenario.

Section 3.2.2 discussed the potential for dike failure or flood overtopping to occur during or following closure activities, resulting in a sudden release of CCR. That analysis showed that there is no risk of CCR releases occurring at the BAB following closure under either closure scenario.

3.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B))

At this time, we do not anticipate a need for the use of treatment technologies other than source control (*i.e.*, CBR-Onsite and CBR-Offsite) at the BAB under either closure scenario.

3.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3))

3.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative

Excavation and landfilling are reliable and standard methods for closing impoundments; we therefore do not expect these activities to pose any special challenges during BAB closure.

Hauling will be more difficult to implement under the CBR-Offsite scenario than under the CBR-Onsite scenario, due to greater haul traffic on public roadways. As described in Section 3.2.4.2 ("Community Risks"), off-Site hauling may also have detrimental community impacts due to an increased incidence of vehicle accidents, truck traffic, noise, and air pollution.

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3.4.2 Expected Operational Reliability of the Closure Alternative

CCR and liner system materials excavated from the BAB will be fully contained after final disposal, regardless of which closure scenario is chosen (CBR-Onsite or CBR-Offsite). The operational reliability of both closure scenarios is therefore expected to be similar. Moreover, high operational reliability is expected under both scenarios due to the full containment of CCR and liner materials.

3.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies

A construction stormwater permit through IEPA may be needed under both closure scenarios; this permit would include construction stormwater controls and BMPs such as silt fences and other measures. A joint WPC permit may also be needed under both closure scenarios. Under the CBR-Onsite scenario, a landfill permit modification would additionally be needed for the landfill to receive the material excavated from the BAB. Under the CBR-Offsite scenario, an additional permit and approval may be required for waste transport.

3.4.4 Availability of Necessary Equipment and Specialists

CBR-Onsite and CBR-Offsite are reliable and standard methods for managing waste that rely on common construction equipment and materials and typically do not require the use of specialists, outside of typical construction labor and equipment operators. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment under all scenarios, if supply chain resilience does not improve by the time of construction. Alternatively, extended downtime may be required for equipment repairs and maintenance. A national shortage of truck drivers has also developed during the COVID-19 pandemic. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the materials that will be hauled from the Site. If sufficient trucks and truck drivers are not available, delays in the construction schedule may arise.

3.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services

The existing landfill on the Duck Creek property has sufficient capacity to receive all of the CCR and liner materials that are currently slated for landfilling under the CBR-Onsite scenario. Under the CBR-Offsite scenario, approximately 7,000 cubic yards of materials excavated from the BAB will require disposal at an off-Site landfill. According to the IEPA "Landfill Disposal Capacity Report" for 2020 (IEPA, 2021b), the closest nearby third-party landfill with the ability to receive and dispose of CCR from the Site is the Peoria City-County Landfill in Brimfield, Illinois. This facility has 750,000 cubic yards of remaining capacity in its current permitted footprint. It receives 230,000 cubic yards of waste annually and is located 33 miles from the Site. The Peoria City-County Landfill therefore has sufficient capacity to receive all of the CCR and liner materials excavated from the BAB.

3.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4))

As demonstrated in Gradient's Human Health and Ecological Risk Assessment (Appendix A of this report), modeled surface water concentrations in the Illinois River in the vicinity of the Site are all below

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relevant human health and ecological screening benchmarks. Post-closure, surface water concentrations of CCR-associated constituents are expected to remain stable and/or decline over time under both closure scenarios. Thus, no future exceedances of any human health or ecological screening benchmarks are anticipated under either closure scenario. Additionally, the lined landfills that will receive any materials excavated from the BAB under the CBR-Onsite and CBR-Offsite scenarios will be managed to ensure that no surface water impacts occur in the vicinity of the landfills.

3.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4))

Several nonprofits representing community interests near the Site have raised concerns regarding the potential impacts of coal ash impoundments at this Site on groundwater and surface water quality, including Earthjustice, the Prairie Rivers Network, and the Sierra Club (Earthjustice *et al*., 2018; Sierra Club, 2014; Sierra Club and CIHCA, 2014). These parties generally prefer CBR to CIP, citing fears that allowing CCR to remain in place "allows the widespread groundwater contamination to continue indefinitely" (Earthjustice *et al*., 2018, p. 24). Most of the CCR that was historically contained within the BAB has already been excavated from the impoundment; no significant CCR remains. Moreover, only CBR is being considered at this impoundment. Thus, both closure scenarios (CBR-Offsite and CBR-Onsite) are equally responsive to community concerns regarding potential groundwater and surface water impacts.

A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

3.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1))

A cost estimate has been prepared for each of the closure scenarios (Appendix B). A summary of these estimates is provided in Table 3.6. The total expected cost of closure under the CBR-Onsite scenario is $479,000; the total expected cost of closure under the CBR-Offsite scenario is $1,360,000. Costs under the CBR-Onsite scenario are smaller than costs under the CBR-Offsite scenario.

Table 3.6 Expected Costs of Closure – BAB

Work Element	CBR-Onsite	CBR-Offsite
Mobilization/Demobilization	$37,500	$110,000
Surveying and Site Preparation	$25,000	$25,000
Dewatering, Unwatering, and Stormwater Management	$5,000	$5,000
Impoundment Closure and Site Restoration	$370,000	$1,100,000
Miscellaneous Construction	$41,300	$122,000
Total:	**$479,000**	**$1,360,000**

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal.
Costs are for comparative purposes only. Actual costs will be paid based on actual quantities, and may vary from those calculated.
Source: Appendix B.

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Both closure scenarios meet or exceed a Class 4 estimate under the AACE Classification Standard (or a comparable classification practice as provided in the AACE Classification Standard), as required by IAC Section 845.710 (IEPA, 2021a).

3.8 Summary

Table S.2 (Summary of Findings) summarizes the expected impacts of the CBR-Onsite and CBR-Offsite closure scenarios for the BAB with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on this evaluation and the details provided in Section 3 above, the CBR-Onsite scenario has been identified as the most appropriate closure scenario for the BAB. Key benefits of the CBR-Onsite scenario at the BAB include that off-Site hauling would not be required and, consequently, this scenario would result in reduced impacts to the community (due to, *e.g.*, accidents, traffic, noise, and air pollution) compared to the CBR-Offsite scenario.

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References

AECOM. 2016a. "Closure and Post-Closure Care Plan for Ash Ponds Nos. 1 and 2 at Illinois Power Resources Generating, LLC, Duck Creek Power Station, 17751 North Cilco Road, Canton, IL 61520." Report to Illinois Power Resources Generating, LLC, March.

AECOM. 2016b. "CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station." Report to Illinois Power Resource Generating, LLC, October.

AECOM. 2016c. "CCR Rule Report: Initial Structural Stability Assessment for GMF Pond at Duck Creek Power Station." Report to Illinois Power Resource Generating, LLC, October.

Archaeological Institute of America. 2021. "The Orendorf and Rice Lake Terrace Prehistoric Archaeological Sites [Western Illinois University (WIU) Archaeological Field School project description]." Accessed on September 28, 2021 at https://www.archaeological.org/fieldwork/western-illinois-university-archaeological-field-school.

Burns & McDonnell. 2021a. "Initial Operating Permit, Duck Creek Gypsum Pond." Report to Dynegy Midwest Generation.

Burns & McDonnell. 2021b. Technical Memorandum to V. Modeer (Dynegy Midwest Generation, LLC) re: IEPA Part 845 – Seismic Impact Zone Certification for GMF Pond at Duck Creek Power Plant.

Burns & McDonnell. 2021c. Technical Memorandum to V. Modeer (Dynegy Midwest Generation, LLC) re: IEPA Part 845 – Seismic Impact Zone Certification for Bottom Ash Basin at Duck Creek Power Plant.

Centers for Disease Control and Prevention (CDC). 2019. "What noises cause hearing loss?" National Center for Environmental Health (NCEH), October 7. Accessed on April 30, 2021 at https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html.

Earthjustice; Prairie Rivers Network; Environmental Integrity Project (EIP); Sierra Club. 2018. "Cap and Run: Toxic Coal Ash Left Behind by Big Polluters Threatens Illinois Water."

Emerson, TE. [Illinois State Archaeological Survey (ISAS)]. c. 2016. "Memorable Emerson Milestones: Commemorating over 40 Years in Cultural Resource Management [Orendorf Site Significance]." Accessed at https://www.isas.illinois.edu/UserFiles/Servers/Server_260627/File/pdfs/news/TEE-Timeline.pdf.

Exponent. 2018. "Community Impact Analysis of Ash Basin Closure Options at the Allen Steam Station." Report to Duke Energy Carolinas, LLC. November 15.

Geosyntec Consultants. 2022. Technical Memorandum to V. Modeer (Dynegy Midwest Generation, LLC) re: Proposed Alternative Protective Layer Equivalency Demonstration, Hennepin East Ash Pond and Duck Creek GMF Pond CCR Surface Impoundments.

Electronic Filing: Received, Clerk's Office 06/20/2024

Golder Associates Inc. (Golder). 2022a. "Part 845 Construction Permit Application for the Gypsum Management Facility Pond, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Golder Associates Inc. (Golder). 2022b. "Part 845 Construction Permit Application for the Bottom Ash Basin, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Golder Associates Inc. (Golder). 2022c. "Final Closure Plan for the Gypsum Management Facility Pond, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Golder Associates Inc. (Golder). 2022d. "Final Closure Plan for the Bottom Ash Basin, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Google LLC. 2021. "Google Maps." Accessed on April 30, 2021 at https://www.google.com/maps.

Haley & Aldrich, Inc. 2018a. "Location Restriction Demonstration - Fault Areas, Duck Creek Power Station GMF Pond, Canton, Illinois [Fault area certification]." October 16.

Haley & Aldrich, Inc. 2018b. "Location Restriction Demonstration - Fault Areas, Duck Creek Power Station Bottom Ash Basin, Canton, Illinois [Fault area certification]." October 16.

Hesterberg, TW; Valberg, PA; Long, CM; Bunn, WB III; Lapin, C. 2009. "Laboratory studies of diesel exhaust health effects: Implications for near-roadway exposures." *EM Mag.* August:12-16. Accessed at http://pubs.awma.org/gsearch/em/2009/8/hesterberg.pdf.

Illinois Dept. of Natural Resources (IDNR). c. 2008. "Rice Lake State Fish & Wildlife Area."

Illinois Emergency Management Agency (IEMA). 2020. "Earthquake preparedness." Accessed on September 7, 2021 at https://www2.illinois.gov/iema/Preparedness/Pages/Earthquake.aspx.

Illinois Environmental Protection Agency (IEPA). 2013. "Public Notice/Fact Sheet [re: Draft reissued NPDES Permit No. IL0055620, Duck Creek Power Plant, 17751 North CILCO Road, Canton, Illinois 61520 (Fulton County)]." Bureau of Water, Division of Water Pollution Control, Permit Section. Submitted to Ameren Energy Resources Co., LLC. August 15.

Illinois Environmental Protection Agency (IEPA). 2019. "Illinois EPA Environmental Justice (EJ) Start." Accessed on April 30, 2021 at https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c.

Illinois Environmental Protection Agency (IEPA). 2021a. "Standards for the disposal of coal combustion residuals in surface impoundments." Accessed at https://www.ilga.gov/commission/jcar/admincode/035/03500845sections.html.

Illinois Environmental Protection Agency (IEPA). 2021b. "Illinois Landfill Disposal Capacity Report." August. Accessed at https://www2.illinois.gov/epa/topics/waste-management/landfills/landfill-capacity/Documents/landfill-capacity-report-2021.pdf.

Electronic Filing: Received, Clerk's Office 06/20/2024

Mauderly, JL; Garshick, E. 2009. "Diesel exhaust." In *Environmental Toxicants: Human Exposures and Their Health Effects (Third Edition)*. (Ed.: Lippmann, M), John Wiley & Sons, Inc., Hoboken, NJ, p551-631.

National Park Service. 2021. "National Register of Historic Places asset record for the Orendorf Site, Fulton County, Illinois." Accessed on September 28, 2021 at https://npgallery.nps.gov/NRHP/AssetDetail/7550faf8-14bc-4132-a799-44d14d8fa364.

Natural Resource Technology. 2017. "Hydrogeologic Monitoring Plan, Duck Creek GMF Pond - CCR Unit ID 203, Duck Creek Landfill - CCR Unit ID 204, Duck Creek Power Station, Canton, Illinois." Report to Illinois Power Resources Generating, LLC, October 17.

Ramboll. 2021a. "40 C.F.R. 257.95(g)(3)(ii): Alternative Source Demonstration, Duck Creek Gypsum Management, Facility Pond." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021b. "Hydrogeologic Site Characterization Report, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021c. "Hydrogeologic Site Characterization Report, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2022. "Groundwater Modeling Report, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Sierra Club. 2014. "Dangerous Waters: America's Coal Ash Crisis."

Sierra Club; Central Illinois Healthy Community Alliance (CIHCA). 2014. "Dynegy's Toxic Assets: Legacy Coal Pollution in the Heartland."

Stantec Consulting Services Inc. (Stantec). 2017. "Duck Creek Power Station, Fulton County Illinois Emergency Action Plan (EAP) (40 CFR § 257.73(a)(3) Coal Combustion Residual (CCR) Impoundments & Related Facilities: Ash Pond No. 1 (NID # IL50715); Ash Pond No. 2 (NID # IL50014); Gypsum Management Facility (GMF) Pond (NID # IL50573)) (Revised)." Report to Illinois Power Resources Generating, LLC, April 13.

Tennessee Valley Authority (TVA). 2015. "Draft Ash Impoundment Closure Environmental Impact Statement. Part I - Programmatic NEPA Review." December.

US Dept. of Labor (US DOL). 2020a. "Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2019." Bureau of Labor Statistics, December. Accessed at https://www.bls.gov/iif/oshwc/cfoi/cfoi_rates_2019hb.xlsx.

US Dept. of Labor (US DOL). 2020b. "Table R100. Incidence rates for nonfatal occupational injuries and illnesses involving days away from work per 10,000 full-time workers by occupation and selected events or exposures leading to injury or illness, private industry, 2019." Bureau of Labor Statistics, October. Accessed at https://www.bls.gov/iif/oshwc/osh/case/cd_r100_2019.xlsx.

Electronic Filing: Received, Clerk's Office 06/20/2024

US Dept. of Transportation (US DOT). 2020. "Large Truck and Bus Crash Facts 2018." Federal Motor Carrier Safety Administration, Analysis Division, FMCSA-RRA-19-018, September.

United States Environmental Protection Agency (US EPA). 2016. "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis." June.

US Fish & Wildlife Service (US FWS). 2021. "Wetlands Mapper." National Wetlands Inventory, May 3. Accessed on October 13, 2021 at https://www.fws.gov/wetlands/data/mapper.html.

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Appendix A

Human Health and Ecological Risk Assessment

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Appendix A

Human Health and Ecological Risk Assessment

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Human Health and Ecological Risk Assessment
Duck Creek Power Plant
Gypsum Management Facility (GMF) and
Bottom Ash Basin (BAB)
Canton, Illinois

January 28, 2022

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Appendix A Surface Water and Sediment Modeling

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Abbreviations

BAB	Bottom Ash Basin
bgs	Below Ground Surface
CAA	Closure Alternatives Assessment
CCR	Coal Combustion Residual
CEM	Conceptual Exposure Model
COI	Constituent of Interest
COPC	Constituent of Potential Concern
CSM	Conceptual Site Model
DCCP	Duck Creek Cooling Pond
DCPP	Duck Creek Power Plant
DWW	Drinking Water Watch
ESV	Ecological Screening Value
GMF	Gypsum Management Facility
GWPS	Groundwater Protection Standard
IAC	Illinois Administrative Code
ID	Identification
IEPA	Illinois Environmental Protection Agency
ILWATER	Illinois Water and Related Wells
IPRG	Illinois Power Resources Generating, LLC
ISGS	Illinois State Geological Survey
K_d	Equilibrium Partitioning Coefficient
NGWMN	National Groundwater Monitoring Network
NID	National Inventory of Dams
No.	Number
NPDES	National Pollutant Discharge Elimination System
SDWIS	Safe Drinking Water Information System
SI	Surface Impoundment
TEC	Threshold Effect Concentration
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

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1 Introduction

The Duck Creek Power Plant (DCPP, or "the Site") is an electric power-generating facility with coal-fired units located in Fulton County, Illinois, approximately 6 miles southeast of the town of Canton. The DCPP is owned by Illinois Power Resources Generating, LLC (IPRG). The facility began operation in 1976 and was retired in December 2019 (AECOM, 2016). The DCPP produced and stored coal combustion residuals (CCRs) as a part of its historical operations in several CCR ash ponds located north and east of the power plant. Two ash ponds are planned for closure and are the subject of this report; these include the Gypsum Management Facility (GMF; Vistra identification [ID] number [No.] 203, Illinois Environmental Protection Agency (IEPA) ID No. W0578010001-04, and National Inventory of Dams [NID] No. IL50573) and the Bottom Ash Basin (BAB; Vistra ID No. 205, IEPA ID No. W0578010001-03, and NID No. IL50716). The BAB is an inactive 2.2-acre lined CCR surface impoundment (SI) formerly used to manage CCR and non-CCR waste streams at the DCPP. The BAB consisted of three cells; the bottom and side slopes of all three cells are concrete lined. All bottom ash (*i.e.,* CCR) was removed from the BAB when the plant was retired; thus, the BAB currently contains no impounded water or CCR materials (Ramboll, 2021a). The GMF is located 2.4 miles north of the power plant, in Section 18 of Township 6 North, Range 5 East. The GMF is a 1,500 ft × 900 ft earthen berm double-lined CCR SI, which retains wet-sluiced gypsum produced in the flue-gas scrubber. The decant water from the GMF discharges to the lined GMF Recycle Pond located to the south of the GMF (Ramboll, 2021b). The Duck Creek Cooling Pond (DCCP) is a 719-acre surface water body (US Fish and Wildlife Service, 1983) located downgradient of the BAB and GMF. The DCCP was formed by damming Duck Creek (Ramboll, 2021a,b). The DCCP is part of the plant property and was used as a source of cooling water for the power plant when it was active. Currently, land adjacent to the DCPP is used for agriculture, pasture, and forest with minimal development (Ramboll, 2021b).

This report presents the results of an evaluation that characterizes potential risks to human and ecological receptors that may be exposed to CCR constituents in environmental media potentially impacted by the GMF and BAB. This risk evaluation was performed to support the Closure Alternatives Assessment (CAA) for the GMF and BAB in accordance with requirements in Title 35, Part 845, of the Illinois Administrative Code (IAC) (IEPA, 2021a). While this report specifically evaluates current risks, it also informs potential future risks under the different closure scenarios. Human and ecological risks were evaluated for Site-specific constituents of interest (COIs) that have the potential to migrate to the DCCP and affect DCCP surface water and sediment.

Consistent with United States Environmental Protection Agency (US EPA) guidance (US EPA, 1989), we used a tiered approach to evaluate potential risks, which included the following steps:

1. Identify complete exposure pathways and develop a conceptual exposure model (CEM).
2. Identify Site-related COIs: Compare maximum detected groundwater concentrations over the period from 2015 to 2021 to groundwater protection standards (GWPSs) listed in Title 35, Part 845.600 of the IAC (IEPA, 2021a), and relevant surface water quality standards (IEPA, 2019; US EPA, 2018).
3. Screening-level Risk Analysis: Compare maximum measured or modeled COI concentrations in surface water and sediment to conservative, health-protective benchmarks to determine constituents of potential concern (COPCs).

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4. Refined Risk Analysis: If COPCs are identified, perform a refined analysis to evaluate potential risks associated with the COPCs.
5. Formulate risk conclusions and discuss any associated uncertainties.

This assessment relies on a conservative (*i.e.*, health-protective) approach and is consistent with the risk approaches outlined in US EPA guidance. Specifically, we considered evaluation criteria detailed in IEPA guidance documents (*e.g.*, IEPA, 2013a, 2019), incorporating principles and assumptions consistent with the Federal CCR Rule (US EPA, 2015) and US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014).

Based on the evaluation presented in this report, no unacceptable risks to human and ecological receptors resulting from CCR exposures associated with either the GMF or the BAB were identified. Specific risk assessment results include the following:

- No complete exposure pathways were identified for human receptors such as recreators.
- No unacceptable risks were identified for ecological receptors exposed to surface water or sediment.
- No bioaccumulative ecological risks were identified.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. Moreover, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions when the GMF and BAB are closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and consequently potential exposures to CCR-related constituents in the environment will also decline.

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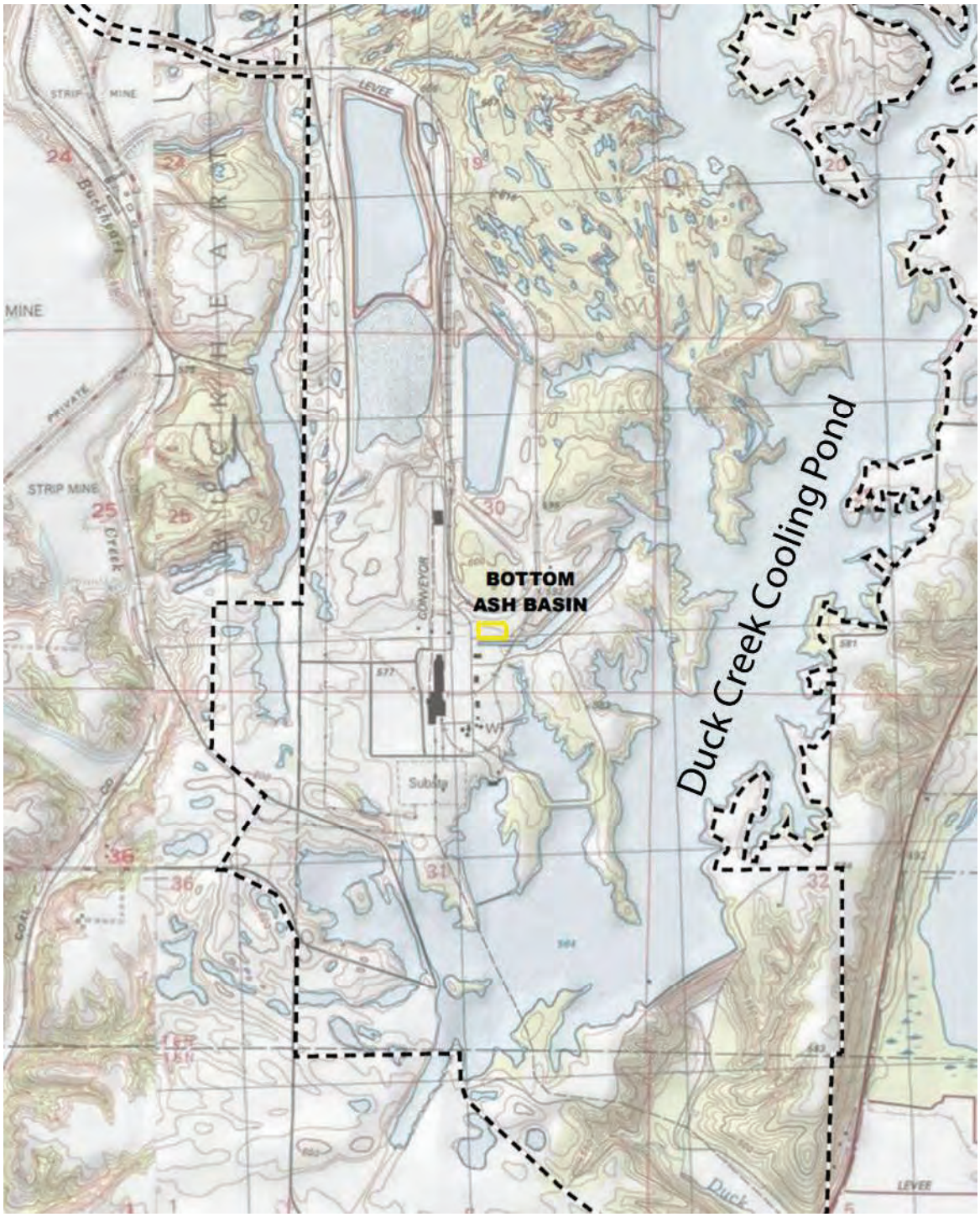

Figure 1.1 Location of BAB. BAB = Bottom Ash Basin; DCPP = Duck Creek Power Plant. DCPP property outline is shown with a dashed line. Source: Ramboll (2021c).

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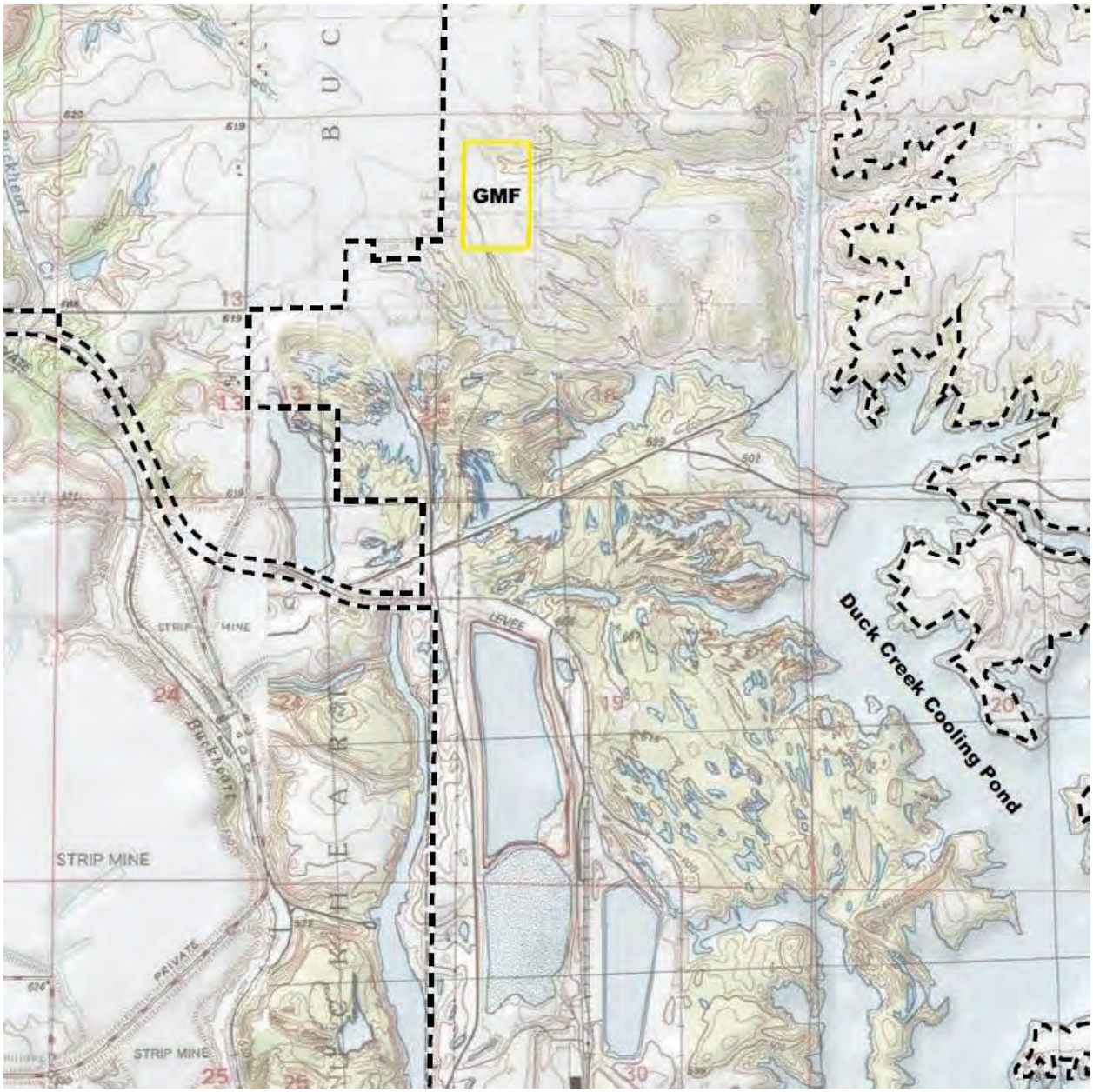

Figure 1.2 Location of GMF. DCPP = Duck Creek Power Plant; GMF = Gypsum Management Facility. DCPP property outline is shown with a dashed line. Source: Ramboll (2021d).

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2 Site Overview

2.1 Site Description

2.1.1 Bottom Ash Basin (BAB)

Geology/Hydrogeology

The BAB is located just northeast of the DCPP. The geology underlying the Site in the vicinity of the BAB primarily consists of unconsolidated unlithified materials of loess and till deposits that overlie a Pennsylvanian-age shale bedrock unit (Ramboll, 2021a). Previous investigations completed outside of the BAB indicate that bedrock in the area is overlain by deposits of coal mine spoils[1] (AECOM, 2016). The DCCP, located approximately 500 ft to the east of the BAB, is the nearest major surface water body that is hydraulically downgradient of the BAB. The DCCP water flows south into Duck Creek *via* National Pollutant Discharge Elimination System (NPDES) outfalls and ultimately drains into the Illinois River (IEPA, 2013b).

Two distinct hydrostratigraphic units were identified near the BAB: (a) the uppermost aquifer and (b) a confining shale bedrock unit. A detailed description of these two units is provided below.

The uppermost aquifer consists of loess and till (Ramboll, 2021a). The most permeable portion of the uppermost aquifer is a 2- to 7-feet-thick sand layer located within the till. This sand unit, encountered at a depth of 18-40 ft below ground surface (bgs), forms the primary conduit for horizontal migration of shallow groundwater near the BAB (Ramboll, 2021a).

The geometric mean of field hydraulic conductivities measured in the uppermost aquifer is about 6.33×10^{-4} cm/sec (Ramboll, 2021a). However, the more permeable sand layer within the till has an average conductivity value of 3.4×10^{-2} cm/sec. Groundwater in the uppermost aquifer flows in the south-southeasterly direction toward the DCCP at a velocity of approximately 0.04 ft/day[2] (Ramboll, 2021a). An average horizontal hydraulic head gradient of approximately 0.01 ft/ft was estimated within the uppermost aquifer near the BAB[3] (Ramboll, 2021a).

Shale bedrock lies beneath the unconsolidated deposits between 26 and 46 ft bgs (Ramboll, 2021a). The bedrock acts as an aquitard with mean hydraulic conductivity values ranging between 2×10^{-6} and 9×10^{-6} cm/sec (AECOM, 2016; Ramboll, 2021a). Bedrock packer tests within the top 100 ft yielded virtually no water (AECOM, 2016). These results, indicate that the shale bedrock is a significant barrier to vertical migration of groundwater.

[1] Several large-scale surface water coal mine operations had been reported in the vicinity of the BAB since the 1930s (AECOM, 2016; Ramboll, 2021); however, those mining activities ceased by 1984 (AECOM, 2016).
[2] The average velocities measured between BA05 and BA04, BA01 and BA03, and BA06 and BA02 were 0.032, 0.050, and 0.030 ft/day, respectively (Ramboll, 2021).
[3] The average head gradients measured between BA05 and BA04, BA01 and BA03, and BA06 and BA02 were 0.0132, 0.0062, and 0.0078 ft/ft, respectively (Ramboll, 2021).

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2.1.2 Gypsum Management Facility (GMF)

Geology/Hydrogeology

The GMF is located 2.4 miles north of the DCPP. The geology underlying the Site near the GMF primarily consists of unlithified materials of loess and till deposits that overlie a Pennsylvanian-age shale bedrock unit (Ramboll, 2021b,e; Natural Resource Technology, 2017). The unlithified deposits are present in former coal mine spoils and form shallow water-bearing units beneath the GMF (Ramboll, 2021e; Natural Resource Technology, 2017).

Much of the surface water drainage in the vicinity of the GMF flows into the DCCP (Natural Resource Technology, 2017). The DCCP water drains into Duck Creek *via* NPDES-permitted outfalls and ultimately discharges to the Illinois River (IEPA, 2013b).

The three major hydrostratigraphic units near the GMF are: (a) the uppermost aquifer, (b) the lower confining unit, and (c) the shale bedrock confining unit. A detailed description of these three units is provided below.

Shallow groundwater occurs within two unconsolidated water-bearing units that form the uppermost aquifer: (i) the Peoria/Roxanna loess zone and (ii) the shallow sand unit (Ramboll, 2021b,e; Natural Resource Technology, 2017). The Peoria/Roxanna loess zone, composed of silt, silty-clay, and minor amounts of sand, is hydraulically connected to the 1- to 18-ft-thick shallow sand unit that is laterally extensive across the Site (Ramboll, 2021b,e; Natural Resource Technology, 2017). The shallow sand unit is the primary conduit for horizontal migration of shallow groundwater (Ramboll, 2021b). The geometric mean of field-measured hydraulic conductivities within the uppermost aquifer in the GMF area is 3.58×10^{-4} cm/sec (Ramboll, 2021b).

Groundwater in the uppermost aquifer flows to the east-southeast toward the DCCP from topographically high- to low-lying areas (Ramboll, 2021b; Natural Resource Technology, 2017). Groundwater in the uppermost aquifer flows at a velocity of approximately 0.24 ft/day[4] (Ramboll, 2021b). An average horizontal hydraulic head gradient of approximately 0.02 ft/ft was estimated within the uppermost aquifer near the GMF[5] (Ramboll, 2021b).

The lower confining unit consists of till that underlies the uppermost aquifer (Natural Resource Technology, 2017). The till layer restricts vertical migration of groundwater due to its low hydraulic conductivity value of 1.9×10^{-7} cm /sec (Ramboll, 2021b; Natural Resource Technology, 2017). Shale bedrock lies beneath the till in this area (Natural Resource Technology, 2017; Ramboll, 2021e). The bedrock is not hydraulically connected to the uppermost aquifer due to the presence of the till (Natural Resource Technology, 2017).

2.2 Conceptual Site Model

A Conceptual Site Model (CSM) describes the sources of contamination, hydrogeological units, and physical processes that control the transport of water and solutes. In this case, the CSM describes how groundwater underlying the BAB and GMF may migrate and interact with surface water and sediment in

[4] The average groundwater velocities measured between G50S and G64S, G50S and G60S, and G51S and G54S were 0.045, 0.625, and 0.041 ft/day, respectively (Ramboll, 2021b). [5] The average head gradients measured between G50S and G64S, G50S and G60S, and G51S and G54S were 0.0121, 0.0172, and 0.0199 ft/ft, respectively (Ramboll, 2021b).

[5] The average head gradients measured between G50S and G64S, G50S and G60S, and G51S and G54S were 0.0121, 0.0172, and 0.0199 ft/ft, respectively (Ramboll, 2021b).

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the adjacent DCCP. The CSM was developed using available hydrogeological data (Natural Resource Technology, 2017; Ramboll, 2021e), including information on groundwater flow and surface water characteristics.

Near the BAB, shallow groundwater flows through the uppermost aquifer in a southward direction toward a surface water channel, located about 50 ft to the south, that leads to the DCCP (Ramboll, 2021a). The primary horizontal migration pathway is within the sand layers of the uppermost aquifer. Groundwater flows horizontally rather than vertically through the uppermost aquifer because: (i) vertical hydraulic conductivities within the uppermost aquifer are several orders of magnitude lower than horizontal hydraulic conductivities, and (ii) the underlying shale bedrock acts as an aquitard preventing downward migration (AECOM, 2016; Ramboll, 2021a). Groundwater within the uppermost aquifer near the BAB flows into the DCCP. No other potential groundwater transport pathways exist. At its discharge location, groundwater mixes with surface water in the DCCP. Because the DCCP serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the DCCP is unlikely.

Near the GMF, shallow groundwater flows horizontally through the uppermost aquifer from northwest to southeast toward the DCCP (Natural Resource Technology, 2017; Ramboll, 2021b,e). The preferential flow of groundwater is horizontal rather than vertical because the underlying till and shale bedrock restrict groundwater flow (Natural Resource Technology, 2017). Groundwater within the uppermost aquifer near the GMF flows into the DCCP. No other potential groundwater transport pathways exist. At its discharge location, groundwater mixes with surface water in the DCCP. Because the DCCP serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the DCCP is unlikely.

2.3 Groundwater Monitoring

The analyses presented in this report relied upon the data from the wells used to monitor the BAB and GMF. A total of ten wells were used to monitor the BAB (Table 2.1); of these, six wells are screened in the uppermost aquifer (UA), one well is screened in the bedrock unit (BR), and three wells are screened in a sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow (Ramboll, 2021a). A total of 31 wells were used to monitor the GMF (Table 2.2); of these, 15 wells are screened in the uppermost aquifer (UA), 1 well is screened in the BR, 13 wells are screened in a sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow; and the location of 2 wells is unspecified (Ramboll, 2021b).

The analyses presented in this report relied on all available data from the specified wells collected between 2015 and 2021, which is the period subsequent to the promulgation of the Federal CCR Rule (US EPA, 2015). Groundwater samples were analyzed for a suite of constituents specified in Illinois CCR Rule Part 845.600 (IEPA, 2021a). A summary of the groundwater data used in this risk evaluation is presented in Table 2.3 (for the BAB) and Table 2.4 (for the GMF).

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Table 2.1 Groundwater Monitoring Wells Related to the BAB

Well	Date Constructed	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Well Depth from Ground Surface (ft bgs)	Hydrogeologic Unit[a]
BA01	12/16/2015	33.06	37.73	38.20	UA
BA01C	02/08/2021	35.81	45.26	45.90	BR
BA01L	02/05/2021	11.90	21.37	22.15	UA-PMP
BA02	12/30/2015	23.63	28.43	28.80	UA
BA02L	02/04/2021	6.98	11.66	12.09	UA-PMP
BA03	12/29/2015	16.11	25.57	26.20	UA
BA03L	02/02/2021	5.25	9.94	10.29	UA-PMP
BA04	12/29/2015	24.58	29.38	29.80	UA
BA05	07/28/2016	36.48	46.08	46.60	UA
BA06	08/03/2016	32.32	41.93	42.40	UA

Notes:
BAB = Bottom Ash Basin; bgs = Below Ground Surface.
(a) BR = bedrock unit; UA = uppermost aquifer; UA-PMP = sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow.

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Table 2.2 Groundwater Monitoring Wells Related to the GMF

Well Number	Date Constructed	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Well Depth (ft bgs)	Hydrogeologic Unit[a]
G02S	09/29/2003	23.00	28.00	28.00	UA
G50S	03/13/2007	–	33.98	34.30	UA
G51L	01/28/2008	12.04	16.83	17.21	UA-PMP
G51S	01/28/2008	24.01	28.79	29.16	UA
G52L	01/22/2008	29.21	33.80	34.17	UA-PMP
G52S	01/22/2008	39.15	43.93	44.20	UA
G53L	02/05/2009	16.97	26.32	26.79	UA-PMP
G53S	02/05/2009	30.64	35.13	35.56	UA
G54C	02/05/2021	91.59	101.50	102.00	BR
G54L	02/12/2009	27.32	36.75	37.22	UA-PMP
G54S	02/12/2009	43.50	47.97	48.41	UA
G55L	02/19/2009	36.12	36.60	36.60	UA-PMP
G55S	02/19/2009	41.04	45.49	45.96	UA
G56L	02/16/2009	13.77	22.11	22.89	UA-PMP
G56S	02/16/2009	33.17	37.66	38.29	UA
G57L	01/30/2009	16.17	25.62	26.00	UA-PMP
G57S	01/30/2009	29.65	34.18	34.62	UA
G58L	01/26/2009	20.69	30.10	30.56	UA-PMP
G58S	01/26/2009	31.32	35.80	36.43	UA
G59L	01/23/2009	22.91	32.33	33.03	UA-PMP
G59S	01/23/2009	37.38	41.88	42.49	UA
G60L	01/17/2008	20.12	24.91	25.28	UA-PMP
G60S	01/16/2008	31.12	35.91	36.29	UA
G61S	01/21/2009	30.19	34.63	35.26	UA
G62L	01/22/2009	20.31	29.66	30.12	UA-PMP
G63L	02/02/2009	18.47	27.89	28.36	UA-PMP
G63S	02/02/2009	34.52	39.01	39.47	UA
G64L	01/22/2009	18.12	27.48	27.95	UA-PMP
G64S	01/22/2009	34.50	38.99	39.48	UA
P60	03/15/2017	29.55	34.14	34.60	–
R61L	03/14/2017	18.54	28.17	28.70	–

Notes:
bgs = Below Ground Surface; GMF = Gypsum Management Facility.
(a) – = data not available; BR = bedrock; UA = uppermost aquifer; UA-PMP = sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow.

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Figure 2.1 Groundwater Monitoring Well Locations – BAB. BAB = Bottom Ash Basin. Source: Ramboll US Corp. (2021a).

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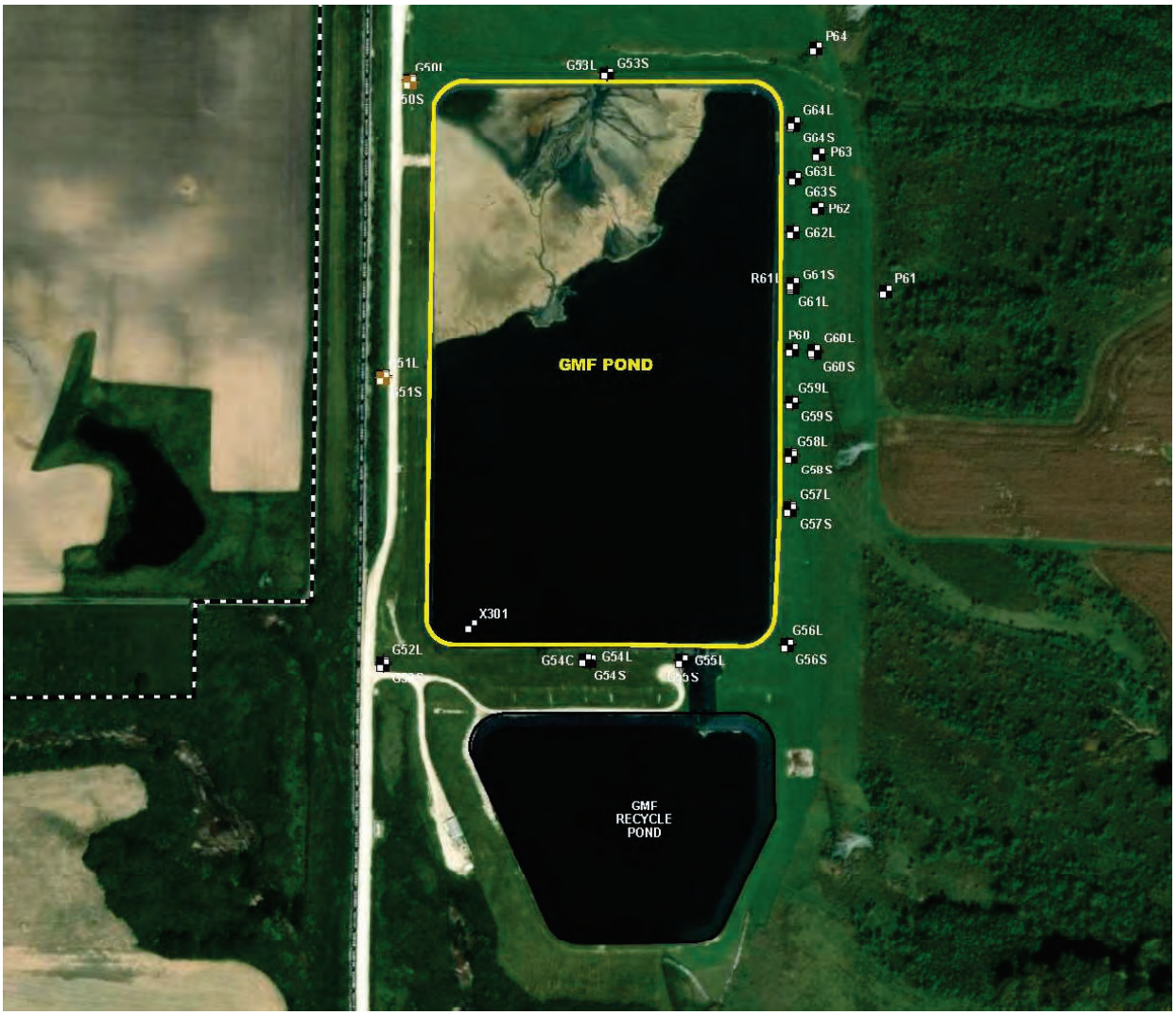

Figure 2.2 Groundwater Monitoring Well Locations – GMF. GMF = Gypsum Management Facility. Adapted from: Ramboll US Corp. (2021b).

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Table 2.3 Groundwater Data Summary – BAB, 2015-2021

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detect	Maximum Detect	Maximum Detection Limit
Total Metals (mg/L)					
Antimony	0	80	–	–	0.003
Arsenic	61	80	0.001	0.024	0.001
Barium	80	80	0.046	0.48	0.001
Beryllium	4	80	0.0015	0.0068	0.001
Boron	128	128	0.017	7.8	0.015
Cadmium	0	80	–	–	0.001
Chromium	17	80	0.0044	0.073	0.004
Cobalt	29	80	0.002	0.037	0.002
Lead	34	80	0.0011	0.042	0.001
Lithium	10	80	0.011	0.068	0.02
Mercury	3	80	0.0002	0.0012	0.0002
Molybdenum	77	80	0.001	0.015	0.001
Selenium	12	80	0.0011	0.015	0.001
Thallium	1	80	0.001	0.001	0.001
Dissolved Metals (mg/L)					
Arsenic	1	2	0.0045	0.0045	0.001
Radionuclides (pCi/L)					
Radium-226+228	76	76	0.0508	9.64	0.944
Other (mg/L, unless otherwise specified)					
Chloride	127	128	2	700	250
Fluoride	71	128	0.25	0.692	0.25
pH (SU)	136	136	6.2	7.7	–
Sulfate	128	128	1.3	890	250
Total Dissolved Solids	128	128	200	2,300	26

Note:
– = Not Applicable; BAB = Bottom Ash Basin; SU = Standard Unit.

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Table 2.4 Groundwater Data Summary – GMF, 2015-2021

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detect	Maximum Detect	Maximum Detection Limit
Total Metals (mg/L)					
Antimony	2	82	0.0037	0.0064	0.003
Arsenic	118	182	0.001	0.051	0.001
Barium	82	82	0.014	0.47	0.001
Beryllium	2	82	0.0013	0.0027	0.001
Boron	217	237	0.01	1.9	0.01
Cadmium	1	83	0.0016	0.0016	0.001
Chromium	7	82	0.0052	0.015	0.004
Cobalt	11	82	0.0021	0.0052	0.002
Lead	79	182	0.0011	0.041	0.001
Lithium	4	82	0.01	0.018	0.02
Mercury	4	82	0.00021	0.0004	0.0002
Molybdenum	42	82	0.001	0.041	0.001
Selenium	4	82	0.0013	0.0031	0.001
Thallium	3	82	0.001	0.0033	0.001
Dissolved Metals (mg/L)					
Antimony	4	665	0.0034	0.012	0.003
Arsenic	209	672	0.001	0.035	0.002
Barium	665	665	0.0076	0.47	0.001
Beryllium	0	18	–	–	0.001
Boron	561	666	0.011	3	0.02
Cadmium	7	666	0.0012	0.0085	0.002
Chromium	20	665	0.0043	0.041	0.004
Cobalt	63	642	0.0021	0.028	0.002
Lead	20	666	0.0011	0.19	0.002
Lithium	0	5	–	–	0.01
Mercury	2	665	0.00024	0.00026	0.0002
Selenium	19	107	0.0011	0.25	0.001
Radionuclides (pCi/L)					
Radium-226+228	83	83	0	5.38	5
Other (mg/L, unless otherwise specified)[a]					
Chloride	228	230	1.1	75	50
Fluoride	86	139	0.25	0.465	0.25
pH (SU)	299	299	6.1	7.5	–
Sulfate	231	232	1.2	540	250
Total Dissolved Solids	134	134	280	900	26

Notes:
– = Not Applicable; GMF = Gypsum Management Facility; SU = Standard Unit
(a) Results for analytes in the "other" group are based on unfiltered samples.

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3 Risk Evaluation

3.1 Risk Evaluation Process

A risk evaluation was conducted to determine whether constituents present in groundwater underlying and downgradient of the GMF and BAB have the potential to pose adverse health effects to human and ecological receptors. The risk evaluation is consistent with the principles of risk assessment established by US EPA and has considered evaluation criteria detailed in Illinois guidance documents (*e.g.*, IEPA, 2013a, 2019).

The general risk evaluation approach is summarized in Figure 3.1 and discussed below.

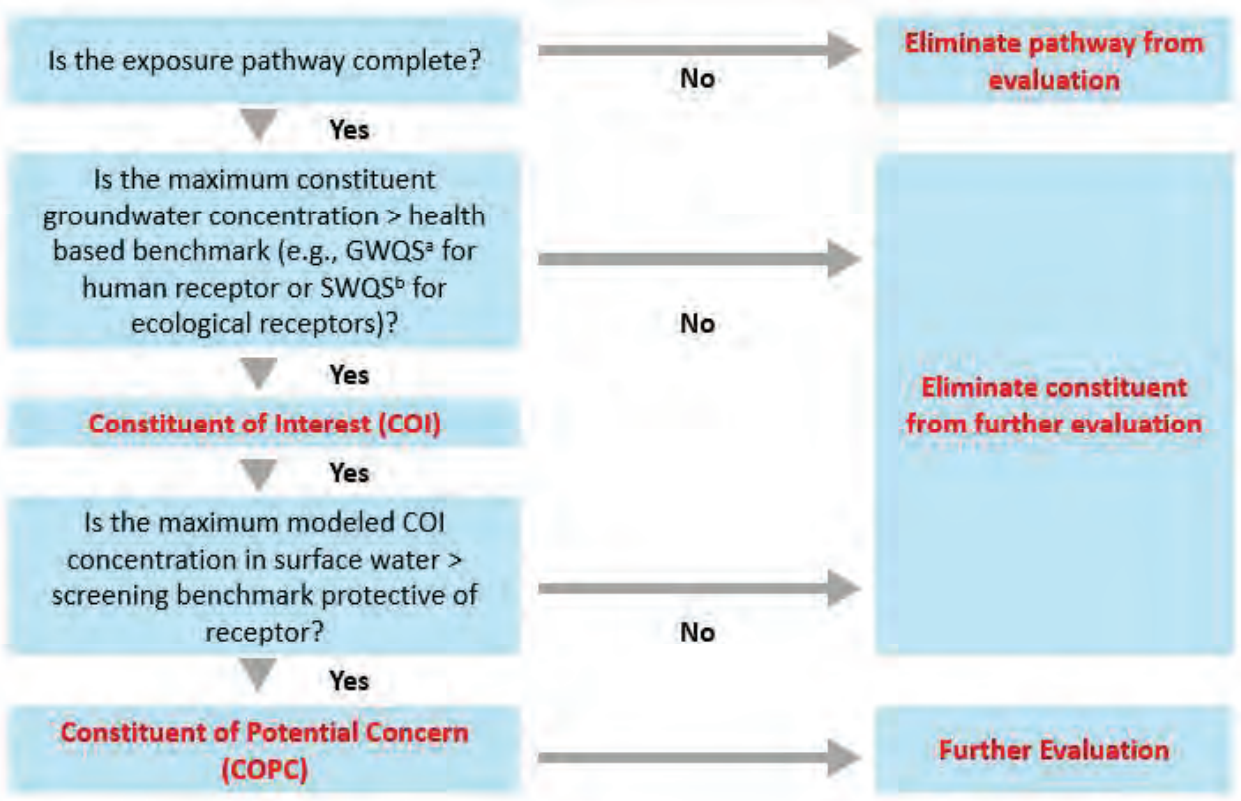

Figure 3.1 Overview of Risk Evaluation Methodology. CCR = Coal Combustion Residuals; COI = Constituent of Interest; IEPA = Illinois Environmental Protection Agency; GWQS = Groundwater Quality Standard; SWQS = Surface Water Quality Standard; US EPA = United States Environmental Protection Agency. (a) The Illinois CCR Rule Part 845.600 GWPS are used to identify human health COIs if human health exposure pathways are complete. (b) IEPA SWQS protective of chronic exposures are used to identify ecological COIs. In the absence of a SWQS, US EPA Region IV ecological screening values are used.

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The first step in the risk evaluation was to develop the CEMs and identify complete exposure pathways. All potential receptors and exposure pathways based on groundwater use and surface water use in the vicinity of the Site were considered. Exposure pathways that are incomplete were excluded from the evaluation. As described in Section 3.2, none of the human exposure pathways were considered complete; therefore, risks to human health were not evaluated further.

The risk assessment evaluated ecological risks in the DCCP. Ecological COIs were identified as constituents with maximum concentrations in groundwater in excess of a surface water quality standard (SWQS) for ecological receptors. Based on the CSM (Section 3.2.2), groundwater underlying the BAB and GMF flows east into the DCCP. Therefore, any potential CCR-related constituents in groundwater would flow toward and discharge into the DCCP.

Surface water and sediment samples have not been collected from the DCCP. Therefore, Gradient modeled the potential migration of COIs from groundwater to surface water and sediment to evaluate potential risks to ecological receptors (see Section 3.3.3). Gradient modeled the COI concentrations in surface water and sediment separately for BAB and GMF, based on the groundwater data from the wells associated with those two CCR management units. The modeled COI concentrations in surface water and sediment were compared to conservative, generic risk-based screening benchmarks for ecological receptors. These generic screening benchmarks rely on default assumptions with limited consideration of Site-specific characteristics. Ecological benchmarks are medium-specific values designed to be protective of all potential ecological receptors exposed to surface water. Ecological screening benchmarks are inherently conservative because they are intended to screen out chemicals that are of no concern with a high level of confidence. Therefore, a modeled COI concentration exceeding a screening benchmark does not indicate an unacceptable risk, but does indicate that further risk evaluation is warranted. COIs with maximum concentrations exceeding a conservative screening benchmark are identified as COPCs requiring further evaluation.

As described in more detail below, this evaluation relied on the screening assessment to demonstrate that constituents present in groundwater underlying the BAB and GMF do not pose an unacceptable ecological risk. That is, after the screening step, no COPCs were identified and further assessment was not warranted.

3.2 Human Conceptual Exposure Model

A CEM provides an overview of the receptors and exposure pathways requiring risk evaluation. The CEM describes the source of the contamination, the mechanism that may lead to a release of contamination, the environmental media to which a receptor may be exposed, the route of exposure (exposure pathway), and the types of receptors that may be exposed to these environmental media.

The human CEM for the Site depicts the relationships between the off-Site environmental media potentially impacted by constituents in groundwater and human receptors that could be exposed to these media. Figure 3.2 presents a human CEM for the Site. It considers a human receptor who could be exposed to COIs hypothetically released from the BAB and the GMF into groundwater, surface water, sediment, and fish. The following human receptors and exposure pathways were considered for inclusion in the Site-specific CEM.

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- Residents – exposure to groundwater/surface water as drinking water
- Residents – exposure to groundwater/surface water used for irrigation
- Recreators in the DCCP to the east of the Site
  - Boaters – exposure to surface water and sediment while boating
  - Swimmers – exposure to surface water and sediment while swimming
  - Anglers – exposure to surface water and sediment *via* consumption of locally caught fish

3.2.1 Exposure from Recreational Activities in Surface Water

As shown in Figure 3.2, all of the exposure pathways related to recreational activities in surface water were considered incomplete, and thus were not evaluated in this risk assessment. Groundwater beneath the BAB and GMF flows into the DCCP. The DCCP is owned by IPRG, and access to it is restricted, thus the DCCP is not used for any recreational activities, including boating, swimming, or fishing.

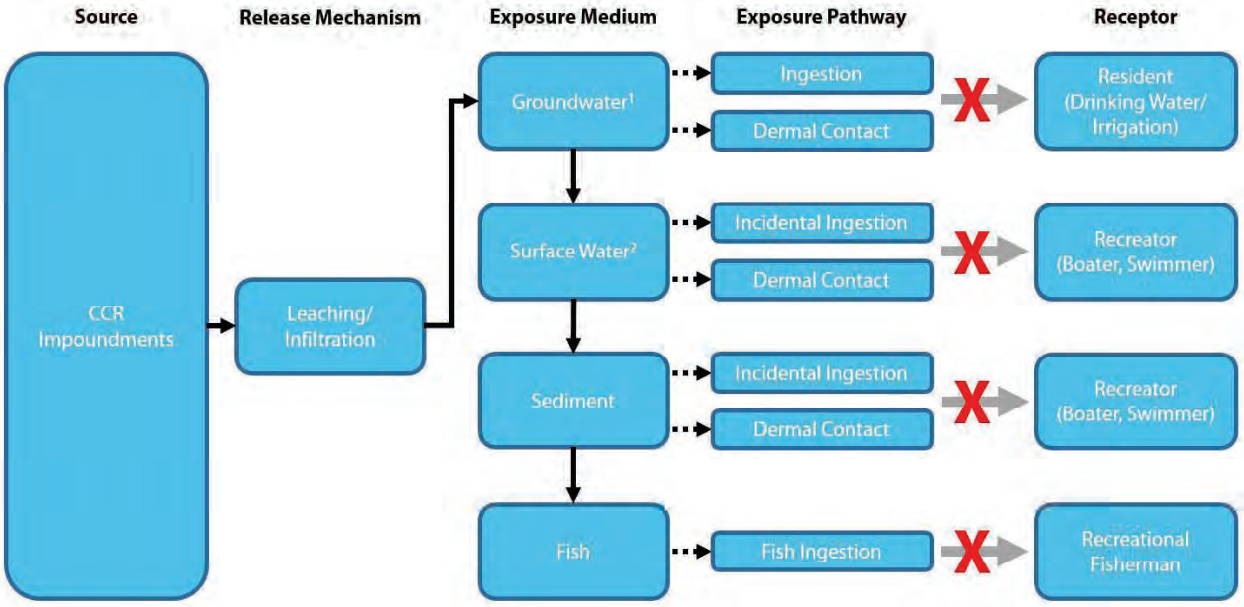

Figure 3.2 Human Conceptual Exposure Model. CCR = Coal Combustion Residual. Dashed line/Red X = Incomplete or insignificant exposure pathway. (1) Groundwater in the vicinity of the Site is not used as a drinking water or irrigation source. (2) Surface water is not used as a drinking water source.

3.2.2 Exposure from Groundwater or Surface Water as a Drinking Water/Irrigation Source

The following sections explain why the residential drinking water and irrigation pathways are incomplete.

3.2.2.1 BAB

Groundwater as a source of drinking water and/or irrigation water is not a complete exposure pathway for potential CCR-related constituents that originated from the BAB. Specifically, shallow groundwater from

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the uppermost aquifer in the vicinity of the BAB is not used as a source of drinking water, and no public groundwater systems are downgradient of the DCPP. Further, the downward migration of groundwater from the uppermost aquifer is largely restricted due to the presence of a thick, shale bedrock unit (Ramboll, 2021a; AECOM, 2016). A summary of the evidence supporting the conclusion that residential uses of the shallow groundwater and DCCP water adjacent to the BAB as sources of drinking water are incomplete exposure pathways is presented below.

- **No potential groundwater receptors are in the vicinity of the BAB**. To identify drinking water receptors within a 1,000 m radius of the BAB, a potable water well survey was completed in 2021 utilizing the following federal and state databases (as cited in Ramboll, 2021a): United States Geological Survey (USGS) National Groundwater Monitoring Network (NGWMN) (USGS, 2021); Illinois State Geological Survey (ISGS) Illinois Water and Related Wells (ILWATER) Map (ISGS, 2020); US EPA Safe Drinking Water Information System (SDWIS) (US EPA, 2021); and IEPA Illinois Drinking Water Watch (DWW) (IEPA, 2021b).
  - No potable public supply wells or intakes were identified within a 1,000 m radial distance from the BAB (Ramboll, 2021a).
  - In a prior investigation, only one water supply well was detected one mile north-northwest of Ash Pond 2, but that well is not located downgradient of the BAB (AECOM, 2016).
- **There is no potential off-Site migration of constituents in groundwater to nearby wells because all shallow groundwater discharges into the DCCP.** The DCCP is the discharge point for groundwater from the uppermost aquifer. Groundwater hydraulic head measurements in the uppermost aquifer indicate that groundwater flows southward toward a channel that is connected to the DCCP (Ramboll, 2021a). Because the DCCP serves as the regional groundwater discharge location in the area, constituents present in groundwater are not likely to migrate underneath or beyond the DCCP.
- **The DCCP adjacent to the Site is not used as a public water supply.** The DCCP is owned and maintained by IPRG. IPRG restricts the use of the pond as a source of drinking water or for recreation. Therefore, the human exposure pathway *via* surface water ingestion in the DCCP was not evaluated further.
- **The uppermost aquifer has a limited hydraulic connection to the underlying bedrock unit.** The bedrock acts as an aquitard with mean hydraulic conductivity values ranging between 2×10^{-6} and 9×10^{-6} cm /sec (AECOM, 2016; Ramboll, 2021a) and bedrock packer tests within the top 100 ft yielded virtually no water (AECOM, 2016). Based on these results, it was concluded that the shale bedrock is a significant barrier to groundwater migration.

3.2.2.2 GMF

Groundwater as a source of drinking water and/or irrigation water is not a complete exposure pathway for CCR-related constituents originating from the GMF. Specifically, shallow groundwater from the uppermost aquifer in the vicinity of the GMF is not used as a source of drinking water, and no public groundwater systems are downgradient of Duck Creek. Additionally, the downward migration of groundwater from the uppermost water-bearing unit is largely restricted due to the presence of underlying low-permeability till and shale bedrock. A summary of the evidence supporting the conclusion that residential uses of the shallow groundwater and DCCP water adjacent to the GMF as sources of drinking water are incomplete exposure pathways is presented below.

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- **No potential groundwater receptors are in the vicinity of the GMF.** To identify drinking water receptors within a 1,000 m radius of the GMF, a potable water well survey was completed in 2021 utilizing the following federal and state databases (Ramboll, 2021b): USGS NGWMN (USGS, 2021); ISGS ILWATER Map (ISGS, 2020); US EPA SDWIS (US EPA, 2021); and IEPA Illinois DWW (IEPA, 2021b).
  - One private well was identified within a 1,000 m radial distance from the GMF (Ramboll, 2021b). However, the well is located southwest of the GMF, while the groundwater flow within the uppermost aquifer is toward the southeast (Ramboll, 2021b); therefore, this well is not considered to be downgradient of the GMF (Ramboll, 2021b).
- **There is no off-Site groundwater migration to any off-Site wells because all shallow groundwater flows into the DCCP.** The DCCP is the discharge point for groundwater from the uppermost aquifer. Groundwater hydraulic head measurements in a total of 7 wells[6] screened within the uppermost aquifer at the GMF indicate that groundwater flows toward the DCCP (Ramboll, 2021b,e). Because the DCCP serves as the regional groundwater discharge location, shallow groundwater near the GMF is not likely to migrate underneath or beyond the DCCP.
- **The DCCP adjacent to the Site is not used as a public water supply.** The DCCP is owned and maintained by IPRG. IPRG restricts the use of the pond as a source of drinking water and/or for recreation. Therefore, the human exposure pathway *via* surface water ingestion adjacent to the GMF was not evaluated further.
- **The GMF has a limited hydraulic connection to deep groundwater.** Three laboratory permeability tests on the lower confining till unit underlying the uppermost aquifer yielded a low mean hydraulic conductivity value of 1.9×10^{-7} cm/sec (Natural Resource Technology, 2017). In addition, the underlying shale bedrock acts as a low-permeability aquitard that restricts vertical intrusion of shallow groundwater. These results indicate that the till and shale bedrock are a significant barrier to groundwater migration.

3.3 Ecological Conceptual Exposure Model

The ecological CEM for the Site depicts the relationships between off-Site environmental media (surface water and sediment) potentially impacted by COIs in groundwater and ecological receptors that may be exposed to these media. The ecological risk evaluation considered both direct toxicity as well as secondary toxicity *via* bioaccumulation. Figure 3.3 presents the ecological CEM for the Site. The following ecological receptor groups and exposure pathways were considered.

- **Ecological Receptors Exposed to Surface Water:**
  - Aquatic plants, amphibians, reptiles, and fish.
- **Ecological Receptors Exposed to Sediment:**
  - Benthic invertebrates (*e.g.*, insects, crayfish, mussels).

[6] Three CCR Rule background monitoring wells (G02S, G50S, and G51S), four CCR Rule downgradient monitoring wells (G54S, G57S, G60S, and G64S) (Ramboll, 2021e).

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- **Ecological Receptors Exposed to Bioaccumulative COIs:**
  - Higher trophic-level wildlife (avian and mammalian) *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of prey (*e.g.*, plants, invertebrates, small mammals, fish).

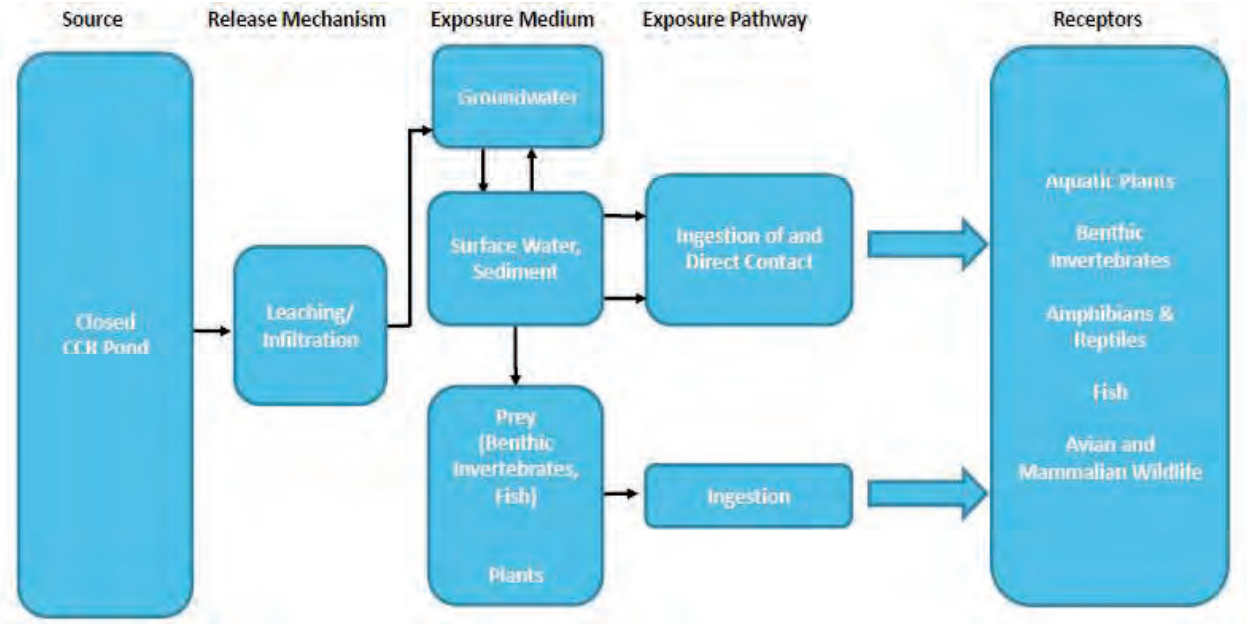

Figure 3.3 Ecological Conceptual Exposure Model. CCR = Coal Combustion Residual.

3.4 Identification of Ecological Constituents of Interest

Risks were evaluated for ecological COIs. A constituent was considered a COI if the maximum detected constituent concentration in groundwater exceeded a benchmark protective of ecological receptors. According to US EPA Risk Assessment Guidance (US EPA, 1989), this screening step is designed to reduce the number of constituents carried through the risk evaluation that are anticipated to have a minimal contribution to the overall risk. Identified COIs are the constituents that are most likely to pose a risk concern in DCCP surface water and sediment. As described above, there were no complete human health exposure pathways. Therefore, COIs were identified to support an ecological risk evaluation only.

3.4.1 Ecological Constituents of Interest

The Illinois GWPSs, as defined in IEPA's guidance, were developed to protect human health, but not necessarily ecological receptors. While ecological receptors are not exposed to groundwater, groundwater can potentially migrate into the adjacent surface water and impact ecological receptors. Therefore, the maximum concentrations of analytes detected in groundwater were compared to ecological surface water benchmarks protective of aquatic life to identify ecological COIs.

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The surface water screening benchmarks for freshwater organisms were obtained from the following hierarchy of sources:

- IEPA (2019) SWQSs. IEPA SWQSs are health-protective benchmarks for aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). The SWQSs for several metals are hardness-dependent (in this case cadmium and lead). Screening benchmarks for these constituents were calculated assuming US EPA's (2019) default hardness of 100 mg/L because hardness data are not available for the DCCP.
- NRWQC – Aquatic Life Criteria Table (US EPA, 2019).
- US EPA Region IV (2018) surface water Ecological Screening Values (ESVs) for hazardous waste sites.

For radium, benchmarks from the United States Department of Energy (US DOE) guidance document "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019) were used. US DOE presents benchmarks for radium-226 and radium-228 separately (4 and 3 pCi/L, respectively) (US DOE, 2019). Given that radium concentrations are expressed as total radium (radium-226+228, *i.e.*, the sum of radium-226 and radium-228), Gradient used the lower of the two benchmarks (3 pCi/L for radium-228) to evaluate total radium concentrations. The IEPA (2019, Section 302.207) general Surface Water Quality Standard for radium notes that the annual average combined concentration of radium-226+228 must not exceed 3.75 pCi/L; however, this value is not necessarily based on protection of ecological receptors, therefore the benchmark of 3 pCi/L from US DOE (2019) was used.

Gradient used the maximum detected concentrations from groundwater samples collected from the wells associated with the BAB and GMF, without considering spatial or temporal representativeness for ecological receptor exposures. The use of the maximum constituent concentrations in this evaluation is designed to conservatively identify COIs that warrant further investigation.

Boron, cobalt, lead, mercury, radium-226+228, and chloride were identified as COIs for ecological receptors in the BAB (Table 3.1). Cadmium and cobalt were identified as COIs for ecological receptors in the GMF (Table 3.2).

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Table 3.1 Ecological Constituents of Interest – BAB

Analyte[a]	Maximum Detected Concentration	Ecological Benchmark[b]	Basis	Ecological COI[c]
Dissolved Metals (mg/L)				
Arsenic	0.0045	0.19	US EPA Region IV ESV	No
Total Metals (mg/L)				
Arsenic	0.024	0.19	IEPA SWQC	No
Barium	0.48	5	IEPA SWQC	No
Beryllium	0.0068	0.064	US EPA Region IV ESV	No
Boron	7.8	7.6	IEPA SWQC	Yes
Chromium	0.073	0.21	IEPA SWQC	No
Cobalt	0.037	0.019	US EPA Region IV ESV	Yes
Lead	0.042	0.02	IEPA SWQC	Yes
Lithium	0.068	0.44	US EPA Region IV ESV	No
Mercury	0.0012	0.0011	IEPA SWQC	Yes
Molybdenum	0.015	7.2	US EPA Region IV ESV	No
Selenium	0.015	1	IEPA SWQC	No
Thallium	0.001	0.006	US EPA Region IV ESV	No
Radionuclides (pCi/L)				
Radium-226+228	9.64	3	US DOE	Yes
Other (mg/L unless otherwise specified)				
Chloride	700	500	IEPA SWQC	Yes
Fluoride	0.692	4	US EPA Region IV ESV	No
pH (SU)	7.7	6.5-9	US EPA NRWQC	No
Sulfate	890	NA	NA	No
Total Dissolved Solids	2,300	NA	NA	No

Notes:

BAB = Bottom Ash Basin; COI = Constituent of Interest; DL = Detection Limit; ESV = Ecological Screening Value; IEPA = Illinois Environmental Protection Agency; NA = Not Applicable; NRWQC = National Recommended Water Quality Criteria; SU = Standard Units; SWQC = Surface Water Quality Criteria; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.

(a) The list of constituents includes those with IL Part 845.600 Groundwater Protection Standards (IEPA, 2021a).

(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQS (IEPA, 2019), US EPA Region IV "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018), US EPA NRWQC (2021), and US DOE's guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).

(c) COIs are constituents for which the maximum concentration exceeds the surface water criterion.

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Table 3.2 Ecological Constituents of Interest – GMF

Analyte[a]	Maximum Detected Concentration	Ecological Benchmark[b]	Basis	Ecological COI[c]
Dissolved Metals (mg/L)				
Antimony	0.012	0.19	US EPA Region IV ESV	No
Arsenic	0.035	0.19	IEPA SWQC	No
Barium	0.47	5.00	IEPA SWQC	No
Boron	3	7.60	IEPA SWQC	No
Cadmium	0.0085	0.001	IEPA SWQC	Yes
Chromium	0.041	0.18	IEPA SWQC	No
Cobalt	0.028	0.02	US EPA Region IV ESV	Yes
Lead	0.19	0.02	IEPA SWQC	No
Mercury	0.00026	0.001	IEPA SWQC	No
Selenium	0.25	1.00	IEPA SWQC	No
Total Metals (mg/L)				
Antimony	0.0064	0.19	US EPA Region IV ESV	No
Arsenic	0.051	0.19	IEPA SWQC	No
Barium	0.47	5.00	IEPA SWQC	No
Beryllium	0.0027	0.06	US EPA Region IV ESV	No
Boron	1.9	7.60	IEPA SWQC	No
Cadmium	0.0016	0.001	IEPA SWQC	No
Chromium	0.015	0.21	IEPA SWQC	No
Cobalt	0.0052	0.02	US EPA Region IV ESV	No
Lead	0.041	0.02	IEPA SWQC	No
Lithium	0.018	0.44	US EPA Region IV ESV	No
Mercury	0.0004	0.001	IEPA SWQC	No
Molybdenum	0.041	7.20	US EPA Region IV ESV	No
Selenium	0.0031	1.00	IEPA SWQC	No
Thallium	0.0033	0.01	US EPA Region IV ESV	No
Radionuclides (pCi/L)				
Radium-226+228	5.38	3	US DOE	No[d]
Other (mg/L, unless otherwise specified)[e]				
Chloride	75	500	IEPA SWQC	No
Fluoride	0.465	4.0	IEPA SWQC	No
pH (SU)	7.5	5-9	US EPA NRWQC	No
Sulfate	540	NA	NA	No
Total Dissolved Solids	900	NA	NA	No

Notes:
COI = Constituent of Interest; DL = Detection Limit; ESV = Ecological Screening Value; GMF = Gypsum Management Facility; IEPA = Illinois Environmental Protection Agency; NA = Not Applicable; NRWQC = National Recommended Water Quality Criteria; SWQC = Surface Water Quality Criteria; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) The list of constituents includes those with IL Part 845.600 groundwater protection standards (IEPA, 2021a).
(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQS (IEPA, 2019), US EPA Region IV "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018), US EPA NRWQC (2021), and US DOE's guidance document "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).
(c) COIs are constituents for which the maximum concentration exceeds the surface water criterion.
(d) Of the 83 groundwater samples analyzed for radium-226+228, only 1 sample was detected above the ecological benchmark. Given that the maximum result is considered an outlier at the 1% and 5% significance levels, radium-226+228 was not considered an ecological COI.
(e) Results for analytes in the "other" group are based on unfiltered samples.

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3.4.2 Surface Water and Sediment Modeling for the GMF and BAB

Surface water and sediment sampling has not been conducted in the DCCP. Many of the COIs are expected to be present in surface water or sediment from natural or non-Site-related anthropogenic sources. It would be difficult to attribute concentrations of these COIs to a particular source given the dynamic nature of the DCCP (as it flows south and discharges to Duck Creek, which drains into the Illinois River) and the multitude of potential sources. Gradient modeled concentrations in DCCP surface water and sediment as a result of groundwater discharge to the DCCP for all constituents that exceeded ecological benchmarks in groundwater. Surface water and sediment concentrations were modeled based on the maximum detected concentrations in groundwater[7] (from 2015 to 2021, regardless of well location).

For this evaluation, we adapted a simplified and conservative form of US EPA's indirect exposure assessment methodology (US EPA, 1998) that was used in US EPA's coal combustion waste risk assessment (US EPA, 2014). The original model is a mass balance calculation based on surface water and groundwater mixing and the concept that the dissolved and sorbed concentrations can be related through an equilibrium partitioning coefficient (K_d). The model assumes a well-mixed groundwater-surface water location, with partitioning among total suspended solids, dissolved water column, sediment porewater, and solid sediments.

Sorption to soil and sediment is highly dependent on the surrounding geochemical conditions. To be conservative, we ignored the natural attenuation capacity of soil and sediment and estimated the surface water concentration based only on the physical mixing of groundwater and surface water (*i.e.*, dilution) at the point of discharge of groundwater to the surface water.

The aquifer and surface water properties used to estimate the volume of groundwater flowing into the DCCP and surface water concentrations from the BAB and GMF are presented in Tables 3.3 and 3.5, respectively. The COI concentrations in sediment were modeled using the COI-specific sediment-to-water partition coefficients and the sediment properties presented in Tables 3.4 and 3.6 for the BAB and GMF, respectively. In the absence of Site-specific information for the DCCP, we used default assumptions (*e.g.*, depth of the upper benthic layer and bed sediment porosity) to model sediment concentrations. A description of the surface water and sediment modeling and the detailed results are presented in Appendix A.

The modeled surface water and sediment concentrations are discussed in Section 3.4. As described earlier, the modeled concentrations reflect conservative contributions from groundwater discharge.

[7] The maximum concentrations were taken, regardless of "total" or "dissolved" concentrations.

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Table 3.3 Groundwater and Surface Water Properties Used in Modeling – BAB

Parameter	Unit	Value	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent-specific	Maximum detected dissolved or total concentration in groundwater.
Cross Section Area	m^2	260	Estimated by multiplying the maximum thickness of the permeable sand unit (7 ft or ~2.1 m) within the uppermost aquifer (Ramboll, 2021a) by the length of the BAB (400 ft or ~122 m).
Hydraulic Gradient	m/m	0.01	Average of field-measured hydraulic gradients reported in Ramboll (2021a).
Hydraulic Conductivity	cm/s	6.33×10^{-4}	Average of field-measured hydraulic conductivity values reported in Ramboll (2021a).
Surface Water			
Surface Water Flow Rate	L/yr	2.5×10^{10}	The rate of surface water discharge from the DCCP to Duck Creek *via* NPDES outfalls 1 and 2 (NPDES Permit No. IL0055620) (IEPA, 2013b).
TSS	mg/L	6	6 mg/L is the representative average river concentration (Hanson Professional Services Inc., 2019).
Depth of the Water Column	m	1.5	Conservative estimate of 5 ft or ~1.5 m near the edge of the DCCP (Bist LLC, 2021). Model results were not sensitive to an increase in the water column depth.
Suspended Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
BAB = Bottom Ash Basin; COI = Constituent of Interest; DCCP = Duck Creek Cooling Pond; NPDES = National Pollutant Discharge Elimination System; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

Table 3.4 Sediment Properties Used in Modeling – BAB

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014).
Depth of Water Body	m	1.55	Sum of depth of the water column and depth of the upper benthic layer.
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014).
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014).
TSS Mass Per Unit Area	kg/m^2	0.009	Depth of the water column × TSS × conversion factors (10^{-6} kg/mg and 1,000 L/m^3).
Sediment Mass Per Unit Area	kg/m^2	30	Depth of the upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g, 10^6 cm^3/m^3).
Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
BAB = Bottom Ash Basin; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

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Table 3.5 Groundwater and Surface Water Properties Used in Modeling – GMF

Parameter	Unit	Values	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent-specific	Maximum detected dissolved or total concentration in groundwater.
Cross Section Area	m^2	2,488	Estimated by multiplying the maximum thickness of the "shallow sand unit" of the uppermost aquifer (18 ft or 5.5 m) (Ramboll, 2021b) and the diagonal (NE-SW) length of the GMF (~453.5 m).
Hydraulic Gradient	m/m	0.02	Average hydraulic gradient within the uppermost aquifer (Ramboll, 2021b).
Hydraulic Conductivity	cm/s	3.58×10^{-4}	As reported by Ramboll for the uppermost aquifer (Ramboll, 2021b).
Surface Water			
Surface Water Flow Rate	L/yr	2.5×10^{10}	The rate of surface water discharge from the DCCP to Duck Creek *via* NPDES outfalls 1 and 2 (NPDES Permit No. IL0055620) (IEPA, 2013b).
TSS	mg/L	6	6 mg/L is the representative average river concentration (Hanson Professional Services Inc., 2019).
Depth of the Water Column	m	1.5	Conservative estimate of 5 ft or ~1.5 m near the edge of the DCCP (Bist LLC, 2021). Model results were not sensitive to an increase in the depth of the water column.
Suspended Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
COI = Constituent of Interest; GMF = Gypsum Management Facility; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

Table 3.6 Sediment Properties Used in Modeling – GMF

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014).
Depth of Water Body	m	1.55	Sum of depth of water column and depth of upper benthic layer.
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014).
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014).
TSS Mass Per Unit Area	kg/m^2	0.009	Depth of water column × TSS × conversion factors (10^{-6} kg/mg and 1,000 L/m^3).
Sediment Mass Per Unit Area	kg/m^2	30	Depth of upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g, 10^6 cm^3/m^3).
Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
GMF = Gypsum Management Facility; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

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3.5 Ecological Risk Evaluation

Based on the ecological CEM (Figure 3.3), ecological receptors could be exposed to surface water, sediment, and dietary items (*i.e.*, prey and plants) potentially impacted by identified COIs (boron, cobalt, lead, and mercury in the BAB; cadmium and cobalt in the GMF).

3.5.1 Ecological Receptors Exposed to Surface Water

Screening Exposures: The ecological evaluation considered aquatic communities in the DCCP potentially impacted by identified ecological COIs. In the absence of surface water data, the maximum of the total and dissolved COI concentrations detected in groundwater was used to model surface water concentrations. Modeled surface water concentrations were compared to risk-based ecological screening benchmarks.

Screening Benchmarks: Surface water screening benchmarks protective of aquatic life were obtained from the following hierarchy of sources:

- IEPA SWQS (IEPA, 2019), regulatory standards that are intended to protect aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). For lead, the surface water benchmark is hardness-dependent and calculated using a default hardness of 100 mg/L. While IEPA's general water quality standard for chloride of 500 mg/L (IEPA, 2019) is not specified to be protective of ecological receptors, it was used because it is on the same order of magnitude as US EPA's NRWQC for chloride (230 and 860 mg/L for chronic and acute exposures, respectively), which is protective of aquatic life (US EPA, 2021).
- US EPA Region IV (2018) surface water ESVs for hazardous waste sites.
- For radium, US DOE presents benchmarks for radium-226 and radium-228 separately (4 and 3 pCi/L, respectively). Given that radium concentrations are expressed as total radium (the sum of radium-226 and radium-228), Gradient used the lower of the two US DOE benchmarks (3 pCi/L for radium-228) to evaluate the total radium concentrations. In addition, this benchmark is protective of bioaccumulative effects in higher trophic-level wildlife discussed further in Section 3.4.3.

Risk Evaluation: The maximum modeled COI concentrations in surface water were compared to the above hierarchy of benchmarks protective of aquatic life (Table 3.7). All modeled surface water concentrations were below their respective benchmarks. Thus, none of the COIs evaluated are expected to pose an unacceptable risk to aquatic life in the DCCP.

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Table 3.7 Risk Evaluation for Ecological Receptors Exposed to Surface Water

COI[a]	Maximum Surface Water Concentration, Modeled	Ecological Freshwater Benchmark	Basis	COPC
BAB				
Boron (mg/L)	1.7×10^{-4}	7.6	IEPA (2019)	No
Cobalt (mg/L)	7.9×10^{-7}	0.019	US EPA Region IV (2018)	No
Lead[b] (mg/L)	8.9×10^{-7}	0.016	IEPA (2019)	No
Mercury (mg/L)	2.5×10^{-8}	0.8	US EPA Region IV (2018)	No
Chloride (mg/L)	1.5×10^{-2}	500	IEPA (2019)	No
Radium-226+228 (pCi/L)	2.1×10^{-4}	3	US DOE (2019)	No
GMF				
Cadmium[b] (mg/L)	2.0×10^{-6}	0.0009	IEPA (2019)	No
Cobalt (mg/L)	6.4×10^{-6}	0.019	US EPA Region IV (2018)	No

Notes:
BAB = Bottom Ash Basin; COI = Constituent of Interest; COPC = Constituent of Potential Concern; GMF = Gypsum Management Facility; IEPA = Illinois Environmental Protection Agency; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) Modeled COI concentrations reflect the potential maximum COI surface water concentrations from groundwater mixing with surface water.
(b) A default hardness value of 100 mg/L was used to calculate this hardness-dependent benchmark.

3.5.2 Ecological Receptors Exposed to Sediment

Screening Exposures: COIs in impacted groundwater discharging into the DCCP can sorb to sediments *via* chemical partitioning. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations. Therefore, the modeled COI sediment concentrations reflect the potential maximum Site-related sediment concentration from groundwater discharge. Chloride was not modeled in sediment as it does not have a K_d value and is not expected to partition into sediment.

Screening Benchmarks: Sediment screening benchmarks were obtained from US EPA Region IV (2018). The majority of the sediment ESVs are based on threshold effect concentrations (TECs) from MacDonald *et al.* (2000), which provide consensus values that identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed.

For radium, benchmarks from US DOE's guidance document "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019), were used. US DOE (2019) presents benchmarks for radium-226 and radium-228 separately (101 and 876 pCi/kg, respectively). Similar to surface water, given that modeled radium is presented as the combined radium-226+228, the lower of the two benchmarks was used as the benchmark to be protective of ecological receptors for both radium-226 and radium-228. In addition, this benchmark is protective of bioaccumulative effects in the higher trophic-level wildlife discussed further in Section 3.4.3. The benchmarks used in this evaluation are listed in Table 3.8.

Screening Risk Results: The maximum modeled COI sediment concentrations were below their respective sediment screening benchmarks, for both the BAB and GMF (Table 3.8). The modeled sediment concentrations attributed to potential contributions from Site groundwater for all COIs were less than 1.5% of the sediment screening benchmark. Therefore, the modeled sediment concentrations attributed to potential contributions from Site groundwater are not expected to significantly contribute to ecological exposures in the DCCP adjacent to the Site.

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Table 3.8 Risk Evaluation for Ecological Receptors Exposed to Sediment

COI	Modeled Sediment Concentration	ESV[a]	COPC	Percentage of Benchmark
BAB				
Boron (mg/kg)	0.00100	38[b]	No	0.0026%
Cobalt (mg/kg)	0.00072	50	No	0.0014%
Lead (mg/kg)	0.0089	35.8	No	0.025%
Mercury (mg/kg)	0.00092	0.18	No	0.51%
Radium-226+228 (pCi/kg)	1.5	101	No	1.4%
GMF				
Cadmium (mg/kg)	0.0026	0.99	No	0.27%
Cobalt (mg/kg)	0.0059	50	No	0.012%

Notes:
BAB = Bottom Ash Basin; COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; GMF = Gypsum Management Facility; NOEC = No Observed Effect Concentration; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) ESVs were taken from US EPA Region IV (2018) for all metal COIs. The benchmark for radium-226+228 is the lower of the US DOE (2019) benchmarks for Ra-226 and Ra-228.
(b) Boron NOEC of 38 mg/kg was used as a conservative benchmark for boron in the absence of an ESV (ECHA, 2019).

3.5.3 Ecological Receptors Exposed to Bioaccumulative Constituents of Interest

Screening Exposures: COIs with bioaccumulative properties can impact higher trophic-level wildlife exposed to these COIs *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, and fish).

Screening Benchmark: US EPA Region IV (2018) guidance and IEPA (2019) SWQS guidance were used to identify analytes with potential bioaccumulative effects.

Risk Evaluation: Mercury was the only COI[8] identified as having potential bioaccumulative effects. The modeled mercury concentration in surface water (1.3×10^{-8} mg/L) is well below the US EPA Region IV (2018) ecological benchmark for wildlife (0.0013 mg/L) that is protective of bioaccumulative effects. Therefore, mercury is not considered to pose an ecological risk *via* bioaccumulation.

Radium is not described in US EPA Region IV guidance, but it has been identified as bioaccumulative by other entities (*e.g.*, ATSDR, 1990). However, the benchmark used to screen radium concentrations in surface water and sediment already considers bioaccumulative exposures. Given that the modeled concentrations are below benchmarks which account for bioaccumulative exposures, radium-226+228 is not expected to pose a risk concern to ecological receptors based on its bioaccumulative properties.

3.6 Uncertainties and Conservatisms

A number of uncertainties and their potential impacts on the risk evaluation are discussed below. Wherever possible, conservative assumptions were used in an effort to minimize uncertainties and overestimate rather than underestimate risks.

[8] US EPA Region IV (2018) identifies only mercury (including methyl mercury) and selenium as having potential bioaccumulative effects. IEPA (2019) identifies mercury as the only metal with bioaccumulative properties.

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Exposure Estimates:

- The risk evaluation included the Illinois Part 845.600 (IEPA, 2021a) constituents detected in groundwater samples collected from wells downgradient of the BAB and GMF. However, it is possible that none of the detected constituents are related specifically to these ash ponds.
- The ecological risk characterization was based on the maximum modeled COI concentrations, rather than on average concentrations. Thus, the variability in exposure concentrations was not considered. Assuming continuous exposure to the maximum concentration overestimates ecological exposures, given that receptors are mobile and concentrations change over time. For example, US EPA guidance states that risks should be estimated using average exposure concentrations as represented by the 95% upper confidence limit on the mean (US EPA, 1992). Given that exposure estimates based on the maximum concentrations did not exceed risk benchmarks, we have greater confidence that there is no risk concern.
- Only analytes detected in groundwater were used to identify COIs and model COI concentrations in surface water and sediment. For the constituents that were not detected in groundwater, the detection limits were below the Illinois Part 845.600 GWPS (IEPA, 2021a) and thus do not require further evaluation.
- COI concentrations in surface water were modeled using the maximum detected total or dissolved COI concentrations in groundwater. Surface water concentrations for the BAB were modeled using the maximum detected total groundwater COI concentrations, and maximum detected dissolved groundwater COI concentrations for the GMF. Modeling surface water concentrations using total metal concentrations for BAB COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.
- The COIs identified in this evaluation also occur naturally in the environment. Contributions to exposure from natural or other non-BAB/GMF related sources were not considered in the evaluation of modeled concentrations; only exposure contributions potentially attributable to Site groundwater mixing with surface water were evaluated. While not quantified, exposures from potential BAB/GMF-related groundwater contributions are likely to represent only a small fraction of the overall human and ecological exposure to COIs that also have natural or non-BAB/GMF-related sources.

Toxicity Benchmarks:

- Screening level ecological benchmarks were compiled from IEPA and US EPA guidance and designed to be protective of the majority of site conditions, leaving the option for site-specific refinement. In some cases, these benchmarks may not be representative of the Site-specific conditions or receptors found at the Site, or may not accurately reflect concentration-response relationships encountered at the Site. For example, the ecological benchmark for cadmium is hardness-dependent and US EPA's default hardness of 100 mg/L was used due to a lack of hardness data for the DCCP. Regardless of the hardness, the maximum modeled cadmium concentration is orders of magnitude below the SWQS.
- In addition, for the ecological evaluation, we conservatively assumed all constituents to be 100% bioavailable. Modeled COI concentrations in surface water are considered total COI concentrations. US EPA recommends using dissolved metals as a measure of exposure to ecological receptors because it represents the bioavailable fraction of metal in water (US EPA,

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1993). Therefore, the modeled surface water COI concentrations may be an overestimation of exposure concentrations to ecological receptors.

- For radium, groundwater concentrations were calculated as the sum of radium-226 and radium-228. US DOE (2019) presents surface water and sediment benchmarks protective of ecological receptors for radium-226 and radium-228 separately. Gradient relied on the lower of the two benchmarks to evaluate risks for radium-226+228. By comparing the total radium-226+228 concentration to the most stringent benchmark, it is assuming that all of the total radium concentrations has the toxicity of the more toxic isotope, which is an overestimation of risk. Despite the overestimation, the modeled exposure estimates are at least an order of magnitude lower than the conservative benchmark.

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4 Summary and Conclusions

A screening-level risk evaluation was performed for Site-related constituents in groundwater at the DCPP in Canton, Illinois. The CSM developed for the Site indicates that groundwater beneath the GMF and BAB flows into the DCCP and may potentially impact surface water and sediment.

CEMs were developed for human and ecological receptors. There are no complete exposure pathways for humans, because the DCCP is part of the Site and does not have any recreational uses. Based on the local hydrogeology, residential exposure to groundwater used for drinking water or irrigation is not a complete pathway and was not evaluated. The complete exposure pathways for ecological receptors include aquatic life (including aquatic and marsh plants, amphibians, reptiles, and fish) exposed to surface water; benthic invertebrates exposed to sediment; and avian and mammalian wildlife exposed to bioaccumulative COIs in surface water, sediment, and dietary items.

Groundwater data collected between 2015 and 2021 were used to estimate exposures. Gradient used the maximum detected concentrations from groundwater samples collected from the wells associated with the BAB and GMF, without considering spatial or temporal representativeness for ecological receptor exposures. The use of the maximum constituent concentrations in this evaluation is designed to conservatively identify COIs that warrant further investigation. For constituents identified as COIs for ecological receptors, surface water and sediment concentrations in the DCCP were modeled using the maximum detected groundwater concentration.

Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. Surface water and sediment exposure estimates were screened against benchmarks protective of ecological receptors for this risk evaluation. The risk evaluation showed that none of the modeled COIs in surface water exceeded protective screening benchmarks. Ecological receptors exposed to sediment include benthic invertebrates. The modeled sediment COIs did not exceed the conservative screening benchmarks, therefore, none of the COIs evaluated in sediment are expected to pose an unacceptable risk to ecological receptors. Ecological receptors were also evaluated for exposure to bioaccumulative COIs. This evaluation considered higher-trophic-level wildlife with direct exposure to surface water and sediment and secondary exposure through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, fish). Based on the modeled concentration, mercury is not considered to pose an ecological risk *via* bioaccumulation. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. The risk evaluation was based on the maximum detected COI concentration; however, US EPA guidance states that risks should be based on a representative average concentration such as the 95% upper confidence limit on the mean; thus, using the maximum concentration tends to overestimate exposure. Although the COIs identified in this evaluation also occur naturally in the environment, the contributions to exposure from natural background sources and nearby industry were not considered; thus, CCR-related exposures were likely overestimated. Exposure estimates assumed 100% metal bioavailability, which likely results in overestimates of exposure and risks. Exposure estimates were based on inputs to evaluate the "reasonable maximum exposure"; thus, most individuals will have lower exposures than those estimated in this risk assessment.

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Finally, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions when the GMF or BAB are closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and consequently potential exposures to CCR-related constituents in the environment will also decline.

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References

AECOM. 2016. "Closure and Post-Closure Care Plan for Ash Ponds Nos. 1 and 2 at Illinois Power Resources Generating, LLC, Duck Creek Power Station, 17751 North Cilco Road, Canton, IL 61520." Report to Illinois Power Resources Generating, LLC, Canton, IL. March.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. "Toxicological Profile for Radium." December.

Bist LLC. 2021. "Bathymetry figures for the Bottom Ash Basin and GMF Pond, Duck Creek Power Station, Canton, Illinois." Accessed at http://fishing-app.gpsnauticalcharts.com/i-boating-fishing-web-app/fishing-marine-charts-navigation.html.

Hanson Professional Services Inc. 2019. "Antidegradation Assessment for Management of Waters from Closure and Post-Closure Care of Ash Ponds, Vermilion Site, Dynegy Midwest Generation, LLC, NPDES Permit No. IL0004057." Report to Dynegy Midwest Generation, LLC, Collinsville, IL. June 1.

Illinois Environmental Protection Agency (IEPA). 2013a. "Title 35: Environmental Protection, Subtitle F: Public Water Supplies, Chapter I: Pollution Control Board, Part 620: Ground Water Quality." Accessed at https://www.ilga.gov/commission/jcar/admincode/035/035006200D04200R.html.

Illinois Environmental Protection Agency (IEPA). 2013b. "Public Notice/Fact Sheet [re: Draft reissued NPDES Permit No. IL0055620, Duck Creek Power Plant, 17751 North CILCO Road, Canton, Illinois 61520 (Fulton County)]." Bureau of Water, Division of Water Pollution Control, Permit Section. Submitted to Ameren Energy Resources Co., LLC, St. Louis, MO. August 15.

Illinois Environmental Protection Agency (IEPA). 2019. "Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, Part 302: Water Quality Standards." Accessed at https://www.epa.gov/sites/production/files/2019-11/documents/ilwqs-title35-part302.pdf.

Illinois Environmental Protection Agency (IEPA). 2021a. "Standards for the disposal of coal combustion residuals in surface impoundments." Accessed at https://www.ilga.gov/commission/jcar/admincode/035/03500845sections.html.

Illinois Environmental Protection Agency (IEPA). 2021b. "Public Water Supply Systems Search (SDWIS Version 3.02)." Accessed at http://water.epa.state.il.us/dww/index.jsp.

Illinois State Geological Survey (ISGS). 2020. "Illinois Water Well (ILWATER) Interactive Map." December 31. Accessed at https://prairie-research.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87.

MacDonald, DD; Ingersoll, CG; Berger, TA. 2000. "Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems." *Arch. Environ. Contam. Toxicol.* 39:20-31. doi: 10.1007/s002440010075.

Electronic Filing: Received, Clerk's Office 06/20/2024

Natural Resource Technology. 2017. "Hydrogeologic Monitoring Plan, Duck Creek GMF Pond - CCR Unit ID 203, Duck Creek Landfill - CCR Unit ID 204, Duck Creek Power Station, Canton, Illinois." Report to Illinois Power Resources Generating, LLC. October 17.

Ramboll. 2021a. "Hydrogeologic Site Characterization Report, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021b. "Hydrogeologic Site Characterization Report, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021c. "Groundwater Monitoring Plan, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021d. "Groundwater Monitoring Plan, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021e. "40 C.F.R. 257.95(g)(3)(ii): Alternative Source Demonstration, Duck Creek Gypsum Management, Facility Pond." Report to Illinois Power Resources Generating, LLC.

US Dept. of Energy (US DOE). 2019. "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota." DOE-STD-1153-2019. Accessed at https://www.standards.doe.gov/standards-documents/1100/1153-astd-2019/@@images/file.

US EPA. 1989. "Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part A) (Interim final)." Office of Emergency and Remedial Response, NTIS PB90-155581, EPA-540/1-89-002, December.

US EPA. 1992. "Risk Assessment Guidance for Superfund: Supplemental Guidance to RAGS: Calculating the Concentration Term." Office of Emergency and Remedial Response, OSWER Directive 9285.7-08I, NTIS PB92-963373, May.

US EPA. 1993. Memorandum to US EPA Directors and Regions re: Office of Water policy and technical guidance on interpretation and implementation of aquatic life metals criteria. Office of Water, EPA-822-F93-009, October 1.

US EPA. 1998. "Methodology for assessing health risks associated with multiple pathways of exposure to combustor emissions." National Center for Environmental Assessment (NCEA), EPA 600/R-98/137, December. http://www.epa.gov/nceawww1/combust.htm.

US EPA. 2014. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery, December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

US EPA. 2015. "Hazardous and solid waste management system; Disposal of coal combustion residuals from electric utilities (Final rule)." *Fed. Reg.* 80(74):21302-21501, 40 CFR 257, 40 CFR 261, April 17.

US EPA. 2019. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

Electronic Filing: Received, Clerk's Office 06/20/2024

US EPA. 2021. "Safe Drinking Water Information System (SDWIS) Search." Accessed on September 28, 2021 at https://www.epa.gov/enviro/sdwis-search.

US EPA. 2021. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." September 16. Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

US EPA Region IV. 2018. "Region 4 Ecological Risk Assessment Supplemental Guidance (March 2018 Update)." Superfund Division, Scientific Support Section, March.

US Geological Survey (USGS). 2021. "National Ground-Water Monitoring Network (NGWMN)." Accessed at https://cida.usgs.gov/ngwmn/index.jsp.

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Appendix A

Surface Water and Sediment Modeling

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Abbreviations

BAB	Bottom Ash Basin
CCR	Coal Combustion Residual
COI	Constituent of Interest
DCCP	Duck Creek Cooling Pond
GMF	Gypsum Management Facility
MGD	Million Gallons Per Day
NPDES	National Pollutant Discharge Elimination System
US EPA	United States Environmental Protection Agency

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Gradient modeled concentrations in the Duck Creek Cooling Pond (DCCP) surface water and sediment based on available groundwater data. First, we estimated the flow rate of constituents of interest (COIs) potentially discharged to the DCCP *via* groundwater. Then, we adapted United States Environmental Protection Agency's (US EPA's) indirect exposure assessment methodology (US EPA, 1998) in order to model surface water and sediment water concentrations in the DCCP.

Model Overview

The groundwater flow into the DCCP is represented by a one-dimensional steady-state model. In this model, the groundwater migrates horizontally in the uppermost aquifer in the direction of the DCCP. For the Bottom Ash Basin (BAB), the groundwater flow entering the DCCP is the flow going through a cross-sectional area that has a length equal to the length of the DCCP adjacent to the BAB with potential coal combustion residual (CCR)-related impacts and a height equal to the saturated thickness of the permeable sand unit within the uppermost aquifer (Table 3.3). For the Gypsum Management Facility (GMF), the groundwater flow entering the DCCP is the flow going through a cross-sectional area that has a length equal to the length of the DCCP adjacent to the GMF with potential CCR-related impacts and a height equal to the saturated thickness of the "Shallow Sand Unit" of the uppermost aquifer (Table 3.5). It was assumed that all the groundwater flowing through the uppermost aquifer discharges to the DCCP.

The groundwater flow into the DCCP mixes with the surface water in the DCCP. The COIs potentially entering the DCCP *via* groundwater can dissolve into the water column, sorb to suspended sediments, or sorb to benthic sediments. Using US EPA's indirect exposure assessment methodology (US EPA, 1998), the model evaluates the surface water and sediment concentrations at a location downstream of the groundwater discharge, assuming a well-mixed water column.

Groundwater Discharge Rate

Gradient used conservative assumptions to evaluate the potential groundwater discharge rate of the COIs. We conservatively assumed that the groundwater concentrations were uniformly equal to the maximum detected concentration for each individual COI. We ignored adsorption by subsurface soil and assumed that all the groundwater flowing through the uppermost aquifer was discharged into the DCCP.

For each groundwater unit, the groundwater flow rate into the river was derived using Darcy's Law:

$$Q = KiA$$

where:

Q = Groundwater flow rate (m^3/s)
K = Hydraulic conductivity (m/s)
i = Hydraulic gradient (m/m)
A = Cross-sectional area (m^2)

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For each COI, the mass discharge rate into the DCCP was then calculated by:

$$m_c = C_c \times Q \times CF$$

where:

m_c = Mass discharge rate of the COI (mg/year)
C_c = Maximum groundwater concentration of the COI (mg/L)
Q = Groundwater flow rate (m^3/s)
CF = Conversion factors needed for unit conversion: 1,000 L/m^3; 31,557,600 s/year

The values of the aquifer parameters used for these calculations are provided in Table A.1 for the BAB and Table A.2 for the GMF. The calculated mass discharge rates were then used as inputs for the surface water and sediment partitioning model.

Surface Water and Sediment Concentration

Groundwater discharged into the DCCP gets diluted in the surface water. Constituents transported by groundwater into the surface water migrate into the water column and the bed sediments. The surface water model we used to estimate the surface water and sediment concentrations is a steady-state model described in US EPA's indirect exposure assessment methodology (US EPA, 1998) and also used in US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014). This model describes the partitioning of constituents between surface water, suspended sediments, and benthic sediments based on equilibrium partition coefficients. It estimates the concentrations of constituents in surface water, suspended sediments, and benthic sediments at steady-state equilibrium at a theoretical location downstream of the discharge point after complete mixing of the water column. In our analysis, we used the partitioning coefficients given in Table J-1 of the US EPA CCR Risk Assessment for all COIs (US EPA, 2014) except radium (Sheppard, 2009). These coefficients are presented in Table A.3.

To be conservative, we assume that the constituents are not affected by dissipation or degradation once they enter the water body. The total water body concentration of the COI is calculated using the following equation from US EPA (1998):

$$C_{wtot} = \frac{m_c}{V_f \times f_{water}}$$

where:

C_{wtot} = Total water body concentration of the constituent (mg/L)
V_f = Water body annual flow (L/year)
f_{water} = Fraction of COI in the water column (unitless)
m_c = Mass discharge rate of the COI (mg/year)

For the DCCP flow rate, we used a discharge rate of about 18 million gallons per day (MGD), based on the estimated DCCP surface water discharge rates to Duck Creek *via* outfall 001 (0.038 MGD) and outfall 002 (18 MGD), as indicated in National Pollutant Discharge Elimination System (NPDES) Permit No. IL0055620 (IEPA, 2013b).

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The fraction of COIs in the water column was calculated for each COI using the sediment/water and suspended solids/water partition coefficients (US EPA, 2014, Table J-1). The fraction of COIs in the water column is calculated using the following equation from US EPA (2014):

$$f_{water} = \frac{(1 + [K_{dsw} \times TSS \times 0.000001]) \times \frac{d_w}{d_z}}{\left([1 + (K_{dsw} \times TSS \times 0.000001)] \times \frac{d_w}{d_z}\right) + ([bsp + K_{dbs} \times bsc] \times \frac{d_b}{d_z})}$$

where:

f_{water}	=	fraction of COI in the water column
K_{dsw}	=	Suspended sediment-water partition coefficient (mL/g)
K_{dbs}	=	Sediment-water partition coefficient (mL/g)
TSS	=	Total suspended solids in the surface water body (mg/L), set equal to the representative average concentration of 6 mg/L (Hanson Professional Services Inc., 2019)
0.000001	=	Units conversion factor
d_w	=	Depth of the water column (m)
d_b	=	Depth of the upper benthic layer (m), set equal to 0.03 m (US EPA, 2014)
$d_z = d_w + d_b$	=	Depth of the water body (m)
bsp	=	Bed sediment porosity (unitless), set equal to 0.6 (US EPA, 2014)
bsc	=	Bed sediment particle concentration (g/cm^3), set equal to 1.0 g/cm^3 (US EPA, 2014)

The fraction of COIs dissolved in the water column (f_d) is calculated as (US EPA 2014):

$$f_d = \frac{1}{1 + K_{dsw} \times TSS \times 0.000001}$$

The values of the fraction of COIs in the water column and other calculated parameters are presented in Table A.4 for the BAB and in Table A.5 for the GMF. Other water body parameters are presented in Table A.6, which apply to both the BAB and GMF.

The total water column concentration (C_{wcTot}) of the COIs, comprising both the dissolved and suspended sediment phases, is then calculated using the following equation from US EPA (2014):

$$C_{wcTot} = C_{wtot} \times f_{water} \times \frac{d_z}{d_w}$$

Finally, the dissolved water column concentration (C_{dw}) for the COIs is calculated using the following equation from US EPA (2014):

$$C_{dw} = f_d \times C_{wcTot}$$

The dissolved water column concentration is then used to calculate the concentration of COIs sorbed to suspended solids in the water column (US EPA, 1998):

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$$C_{sw} = C_{dw} \times K_{dsw}$$

where:

C_{sw} = Concentration sorbed to suspended solids (mg/kg)
C_{dw} = Concentration dissolved in the water column (mg/L)
K_{dsw} = Suspended solids/water partition coefficient (mL/g)

In the same way, using the total water body concentration and the fraction of COIs in the benthic sediments, the model derives the total concentration in benthic sediments (US EPA 2014, Table J-1-12):

$$C_{bstot} = f_{benth} \times C_{wtot} \times \frac{d_z}{d_b}$$

where:

C_{bstot} = Total concentration in bed sediment (mg/L or g/m^3)
C_{wtot} = Total water body concentration of the constituent (mg/L)
f_{benth} = Fraction of contaminant in benthic sediments (unitless)
d_b = Depth of the upper benthic layer (m)
$d_z = d_w + d_b$ = Depth of the water body (m)

This value can be used to calculate dry weight sediment concentration as follows:

$$C_{sed-dw} = \frac{C_{bstot}}{bsc}$$

where:

C_{sed-dw} = Dry weight sediment concentration (mg/kg)
C_{bstot} = Total sediment concentration (mg/L)
bsc = Bed sediment bulk density (used the default value of 1 g/cm^3 from US EPA, 2014)

The total sediment concentration is composed of the concentration dissolved in the bed sediment pore water (equal to the concentration dissolved in the water column) and the concentration sorbed to benthic sediments (US EPA, 1998).

The concentration sorbed to benthic sediments is calculated using the following equation from US EPA (1998):

$$C_{sb} = C_{dbs} \times K_{dbs}$$

where:

C_{sb} = Concentration sorbed to bottom sediments (mg/kg)
C_{dbs} = Concentration dissolved in the sediment pore water (mg/L)
K_{dbs} = Sediments/water partition coefficient (mL/kg)

For each COI, the modeled total water column concentration, the modeled dry weight sediment concentration, and the modeled concentration sorbed to sediment are presented in Table A.7 for the BAB and in Table A.8 for the GMF.

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References

Hanson Professional Services Inc. 2019. "Antidegradation Assessment for Management of Waters from Closure and Post-Closure Care of Ash Ponds, Vermilion Site, Dynegy Midwest Generation, LLC, NPDES Permit No. IL0004057." Report to Dynegy Midwest Generation, LLC, Collinsville, IL. June 1.

Ramboll. 2021. "Hydrogeologic Site Characterization Report, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Sheppard, S; Long, J; Sanipelli, B; Sohlenius, G. 2009. "Solid/liquid partition coefficients (Kd) for selected soils and sediments at Forsmark and Laxemar-Simpevarp." Report to Swedish Nuclear Fuel and Waste Management Co. SKB Rapport R-09-27, March.

US EPA. 1998. "Methodology for assessing health risks associated with multiple pathways of exposure to combustor emissions." National Center for Environmental Assessment (NCEA), EPA 600/R-98/137, December. http://www.epa.gov/nceawww1/combust.htm.

US EPA. 2014. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery, December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

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Tables

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Table A.1 Parameters Used to Estimate Groundwater Discharge to Surface Water - BAB

GW Unit	Parameter	Full Name	Value	Unit
Uppermost Aquifer	A	Cross-Sectional Area	260	m^2
Uppermost Aquifer	i	Hydraulic Gradient	0.01	m/m
Uppermost Aquifer	K	Hydraulic Conductivity	0.00063	cm/s

Notes:
BAB = Bottom Ash Basin; GW = Groundwater.
Source: Hydraulic gradient and hydraulic conductivity values from Ramboll (2021).

Table A.2 Parameters Used to Estimate Groundwater Discharge to Surface Water - GMF

GW Unit	Parameter	Full Name	Value	Unit
Uppermost Aquifer	A	Cross-Sectional Area	2,488	m^2
Uppermost Aquifer	i	Hydraulic Gradient	0.02	m/m
Uppermost Aquifer	K	Hydraulic Conductivity	0.00036	cm/s

Notes:
GMF = Gypsum Management Facility; GW = Groundwater.
Source: Hydraulic gradient and hydraulic conductivity values from Ramboll (2021).

Table A.3 Partition Coefficients

Constituent	Sediment-Water, Mean, K_{dbs}		Suspended Sediment-Water, Mean, K_{dsw}	
	Value (log_{10}) (mL/g)	Value (mL/g)	Value (log_{10}) (mL/g)	Value (mL/g)
Antimony	3.6	3.98E+03	4.8	6.31E+04
Arsenic	2.4	2.51E+02	3.9	7.94E+03
Beryllium	2.8	6.31E+02	4.2	1.58E+04
Boron	0.8	6.31E+00	3.9	7.94E+03
Cadmium	3.3	2.00E+03	4.9	7.94E+04
Cobalt	3.1	1.26E+03	4.8	6.31E+04
Lead	4.6	3.98E+04	5.7	5.01E+05
Mercury	4.9	7.94E+04	5.3	2.00E+05
Radium-226 + 228	3.9	7.40E+03	3.9	7.40E+03
Selenium	0.6	3.98E+00	3.8	6.31E+03
Thallium	1.3	2.00E+01	4.1	1.26E+04

Notes:
Lithium was not modeled because it lacks a Kd value in US EPA (2014).
Sources: US EPA (2014); Sheppard (2009).

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Table A.4 Calculated Parameters for the BAB

Constituent	Fraction of Constituent in the Water Column f_{water}	Fraction of Constituent in the Benthic Sediments $f_{benthic}$	Fraction of Constituent Dissolved in the Water Column $f_{dissolved}$
Arsenic	0.1741	0.8259	0.9545
Beryllium	0.0808	0.9192	0.9132
Boron	0.8848	0.1152	0.9545
Cobalt	0.0525	0.9475	0.7254
Lead	0.0051	0.9949	0.2496
Mercury	0.0014	0.9986	0.4551
Radium 226 + 228	0.0071	0.9929	0.9575

Note:
BAB = Bottom Ash Basin.

Table A.5 Calculated Parameters for the GMF

Constituent	Fraction of Constituent in the Water Column f_{water}	Fraction of Constituent in the Benthic Sediments $f_{benthic}$	Fraction of Constituent Dissolved in the Water Column $f_{dissolved}$
Antimony	0.0172	0.9828	0.7254
Arsenic	0.1741	0.8259	0.9545
Boron	0.8848	0.1152	0.9545
Cadmium	0.0361	0.9639	0.6772
Cobalt	0.0525	0.9475	0.7254
Lead	0.0051	0.9949	0.2496
Selenium (IV)	0.9199	0.0801	0.9635
Thallium	0.7261	0.2739	0.9298

Note:
GMF = Gypsum Management Facility.

Table A.6 Surface Water Parameters

Parameter	Full Name	Value	Unit
TSS	Total Suspended Solids	6	mg/L
V_{fx}	Surface Water Flow Rate	2.5E+10	L/yr
db	Depth of Upper Benthic Layer (default: 0.03)	0.03	m
dw	Depth of Water Column	1.52	m
dz	Depth of Water Body	1.55	m
bsc	Bed Sediment Bulk Density (default: 1.0)	1	g/cm^3
bsp	Bed Sediment Porosity (default: 0.6)	0.6	-
M_{TSS}	TSS Mass per Unit Area	0.009	kg/m^2
M_S	Sediment Mass per Unit Area	30	kg/m^2

Note:
Sources of default values: US EPA (1998, 2014).

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Table A.7 Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations for the BAB

Constituent	Groundwater Concentration (mg/L)	Mass Discharge Rate to Surface Water (mg/year)	Total Water Column Concentration (mg/L)	Concentration Sorbed to Bottom Sediments (mg/kg)
Arsenic	2.40E-02	1.25E+04	5.10E-07	1.22E-04
Beryllium	6.80E-03	3.53E+03	1.44E-07	8.32E-05
Boron	7.80E+00	4.05E+06	1.66E-04	9.98E-04
Chloride	7.00E+02	3.64E+08	1.49E-02	Not Applicable
Cobalt	3.70E-02	1.92E+04	7.86E-07	7.18E-04
Lead	4.20E-02	2.18E+04	8.92E-07	8.86E-03
Lithium	6.80E-02	3.53E+04	1.44E-06	Not Applicable
Mercury	1.20E-03	6.23E+02	2.55E-08	9.22E-04
Constituent	**Groundwater Concentration (pCi/L)**	**Mass Discharge Rate to Surface Water (pCi/year)**	**Total Water Column Concentration (pCi/L)**	**Concentration Sorbed to Bottom Sediments (pCi/kg)**
Radium-226 + 228	9.64E+00	5.01E+06	2.05E-04	1.45E+00

Notes:
BAB = Bottom Ash Basin; K_d = Equilibrium Partitioning Coefficient.
Chloride and lithium were not modeled due to lack of K_d value in US EPA (2014).

Table A.8 Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations for the GMF

Constituent	Groundwater Concentration (mg/L)	Mass Discharge Rate to Surface Water (mg/year)	Total Water Column Concentration (mg/L)	Concentration Sorbed to Bottom Sediments (mg/kg)
Antimony	1.20E-02	6.75E+04	2.76E-06	7.97E-03
Arsenic	5.10E-02	2.87E+05	1.17E-05	2.81E-03
Boron	3.00E+00	1.69E+07	6.90E-04	4.15E-03
Cadmium	8.50E-03	4.78E+04	1.95E-06	2.64E-03
Cobalt	2.80E-02	1.57E+05	6.44E-06	5.88E-03
Lead	1.90E-01	1.07E+06	4.37E-05	4.34E-01
Selenium (VI)	2.50E-01	1.41E+06	5.75E-05	2.20E-04
Thallium	3.30E-03	1.86E+04	7.59E-07	1.41E-05

Notes:
GMF = Gypsum Management Facility.
Source: US EPA (2014).

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Appendix B

Supporting Information

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Supporting Information for Closure Alternatives Analysis – Gypsum Management Facility at Duck Creek Power Plant

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GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE January 25, 2022 **Reference No.** 21454861-13-R-1

TO Illinois Power Resources Generating, LLC

FROM Golder Associates USA Inc.

SUPPORTING INFORMATION FOR CLOSURE ALTERNATIVES ANALYSIS – GYPSUM MANAGEMENT FACILITY POND AT DUCK CREEK POWER PLANT

Golder Associates USA Inc. (Golder), a Member of WSP, has prepared this technical memorandum for Illinois Power Resources Generating, LLC (IPRG) to support the Closure Alternatives Analysis for the Gypsum Management Facility (GMF) Pond at Duck Creek Power Plant (DCPP). The GMF Pond was used for containment of gypsum produced at DCPP and has not received gypsum since the power plant was retired in 2019. The Closure Alternatives Analysis is being completed in accordance with Illinois Administrative Code Title 35, Part 845, Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (Part 845), by Gradient. With this technical memorandum, Golder summarizes the design basis and references used in developing the closure concepts evaluated by the Closure Alternatives Analysis.

1.0 GMF POND HISTORY

1.1 Existing Liner System Information

Golder reviewed several documents related to the design, construction, and operation of the GMF Pond. Notable documents included the History of Construction (AECOM 2016), the Gypsum Stack Acceptance Report (Hanson 2009a), and the Initial Facility Report Volumes 1–4 (Hanson 2009b). Based on review of these documents, a dual composite liner system with a leak detection layer was installed for the GMF Pond consisting of (from top to bottom):

- primary composite liner
  - Solmax 460T-1000 60-mil textured high-density polyethylene (HDPE) geomembrane
  - 1-foot cushion dirt layer (2 feet in select areas on the sideslopes)
- leak detection layer
  - SKAPS GT-142 4-oz/yd^2 geotextile separator
  - 1-foot granular drainage layer
  - SKAPS GE-110 10-oz/yd^2 geotextile cushion
- secondary composite liner
  - Solmax 460T-4013 60-mil textured HDPE geomembrane

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- CETCO Bentomat SDN reinforced geosynthetic clay liner (GCL)
- 3-foot compacted clay layer placed in 8-inch lifts, compacted to at least 95% of the standard Proctor maximum dry density at a moisture content between the standard Proctor optimum moisture content (OMC) and 5% wet of the OMC

According to the Acceptance Report (Hanson 2009a), the liner system was subjected to a rigorous construction quality assurance (CQA) program.

The GMF Pond was constructed by excavating the natural ground a minimum of 5.4 feet to reach foundation grades. During preparation of the foundation grades, unsuitable sand materials were removed from several areas and stockpiled separately. These areas were then backfilled with suitable material previously stockpiled or locally available. Backfilled areas were compacted to at least 95% of the standard Proctor maximum dry density at a moisture content within 2% of the OMC. Eight Shelby tube samples collected from the foundation grade berms were used for hydraulic conductivity testing, with results ranging from 2.2×10^{-8} centimeters per second (cm/s) to 1.0×10^{-7} cm/s.

After certification of the foundation grades, the 3-foot compacted clay layer was constructed in 8-inch lifts. Eighteen Shelby tube samples were collected during construction. Hydraulic conductivity results from tests on the Shelby tube samples ranged from 8.6×10^{-9} cm/s to 9.8×10^{-7} cm/s, significantly less than the construction specification of 1.0×10^{-4} cm/s. The compacted clay layer was proof rolled prior to installation of the overlying GCL.

After placement of the compacted clay layer, geosynthetic components of the secondary liner system were installed. Certified properties for the geosynthetic materials are provided in the Geosynthetics Quality Assurance Report (Feezor 2009).

A leak detection layer with leachate collection and recovery system (LD/LCRS) was installed above the lower geomembrane. The LD/LCRS included a 10-oz/yd^2 geotextile overlain by a 1-foot granular drainage layer with 6-inch- and 12-inch-diameter HDPE piping embedded. Laboratory hydraulic conductivity test results for the granular drainage layer soil ranged from 1.5×10^{-2} to 5.7×10^{-2} cm/s. Test reports from hydraulic conductivity and particle-size distribution testing are provided in the Acceptance Report (Hanson 2009a). The piping within the LD/LCRS directs leachate to two sumps at the toe of the south berm of the GMF Pond, with risers to facilitate removal of leachate. A 4-oz/yd^2 geotextile was installed above the 1-foot granular drainage layer. Certified properties for the geosynthetic materials are provided in the Geosynthetics Quality Assurance Report (Feezor 2009).

A 1-foot cushion soil layer compacted to at least 90% of the standard Proctor maximum dry density was placed above the 4-oz/yd^2 geotextile. According to the Acceptance Report (Hanson 2009a), the layer was constructed of general fill transported from a stockpile or borrow to the work area by truck and graded with a dozer to a depth of approximately 1 foot. The local stockpiles generally consisted of fine-grained soils, predominantly low-plasticity silts and clays (classified as CL and ML under the United Soil Classification System [USCS]). The cushion layer was then overlain by a 60-mil HDPE geomembrane constructed with the same installation specifications as the lower geomembrane. Certified properties for the upper geomembrane are provided in the Geosynthetics Quality Assurance Report (Feezor 2009).

In addition to the dual composite liner system, the GMF Pond has a ring drain system above the primary liner system that was used to recover and recycle water used for hydraulic conveyance of gypsum to the GMF Pond. The ring drain system consists of a rectangular array of 6-inch-diameter perforated HDPE pipe installed above the

upper geomembrane around the perimeter of the GMF Pond floor. The pipe is surrounded by coarse aggregate and wrapped in a geotextile. The ring drain pipe network directs water to five sumps (one each along the toes of the north, east, and west embankments and two along the toe of the south embankment).

1.2 Operational History

The GMF Pond was constructed between 2007 and 2009 and was put into operation in 2009. The GMF Pond was used to store gypsum and to clarify gypsum transport water for reuse in the wet scrubber system until DCPP was retired in December 2019. Gypsum was hydraulically conveyed to the GMF Pond at approximately 20% solids (Hanson 2009b). It was deposited from the north end of the GMF Pond and in the northwest corner, which formed a delta or beach of built-up gypsum in these locations during the operational life. The gypsum would build up to the water level and then expand laterally (rather than vertically) due to the relatively weak nature of the subaqueous gypsum. During the operational life, the beach expanded so that roughly one-third of the GMF Pond footprint had gypsum built up to the typical water level. The water level was (and still is) controlled by an overflow channel at the southeast corner of the GMF Pond. The overflow elevation was adjustable and could be as low as El. 614 feet or as high as approximately El. 616 feet. Water decanted (or was siphoned early in the life of the GMF Pond) from the GMF Pond into the Recycle Pond, which is located immediately south of the GMF Pond. A set of pumps situated on the west side of the Recycle Pond was used to transfer the decanted water back to the wet scrubber system for reuse. The Operation and Maintenance Manual for the GMF Pond provides additional information and is included in the History of Construction (AECOM 2016).

It is Golder's understanding that the pumps for the LD/LCRS are controlled by the hydraulic head in the 1-foot granular drainage layer (i.e., they only operate when there has been enough infiltration into the LD/LCRS to build up the hydraulic head to a trigger level) and that the pumps have rarely needed to operate. This anecdotal information suggests that the primary composite liner is intact and provides an effective barrier to infiltration from the GMF Pond and that the secondary composite liner is intact and provides an effective barrier to lateral infiltration.

1.3 Type and Volume of Materials

Based on Golder's comparison (using Autodesk Civil 3D) of the existing conditions (December 2020 survey by IngenAE) and the approximate top-of-liner-system grades developed from the as-built top of cushion layer (Hanson 2009a), approximately 400,000 cubic yards (cy) of gypsum are present in the GMF Pond. The GMF Pond footprint is approximately 31 acres, with approximately 60,800 cy of cushion dirt, 55,500 cy of granular drainage material, and 166,500 cy of compacted clay used in construction of the GMF Pond.

The wet scrubber system used for flue gas desulfurization at DCPP produced synthetic gypsum (calcium sulfate). The synthetic gypsum is generally of the same chemical structure as natural gypsum. Because the material was sluiced, the particle-size distribution of the gypsum in the GMF Pond is expected to be variable, becoming finer with increased distance from the deposition locations. Based on geotechnical testing Golder conducted on a composite of three samples of gypsum collected near the north end of the GMF Pond, the material is non-plastic with more than 97% by weight passing the No. 200 sieve (ML under the USCS) and a specific gravity of 2.66. Slurry consolidation testing conducted by Golder on a reconstituted sample of gypsum from the GMF Pond indicated a range of hydraulic conductivities from 6×10^{-5} cm/s to 1×10^{-4} cm/s under typical confining stresses in the GMF Pond.

1.4 Water Levels

At the time of the December 2020 survey by IngenAE, the water level in the GMF Pond was at El. 613.9 (North American Vertical Datum of 1988). Although the water level would be expected to respond to wet or dry climate conditions, this water level is likely typical for the GMF Pond. Based on this water level, approximately 95% of the gypsum in the GMF Pond is below the water level. Based on Golder's site observations, gypsum below the water level can be considered saturated. The gypsum above the water level forms a plateau at the north end of the GMF Pond with the highest point at approximately El. 616 feet. Based on Golder's site observations, gypsum above the water level is moist, but not saturated, and is capable of supporting foot traffic, but likely not equipment traffic without dewatering.

2.0 CLOSURE CONCEPT INFORMATION

To provide necessary information for the Closure Alternatives Analysis, Golder developed a closure concept that would involve closure with CCR remaining in place and a closure concept that would involve closure by removal of CCR. These closure concepts are described in this section.

2.1 Closure in Place

2.1.1 Final Cover System Materials

For closure with CCR in place, Part 845 requires installation of a final cover system over the CCR. Based on a demonstration to be submitted to the Illinois Environmental Protection Agency for approval pursuant to Section 845.750(c)(2), an alternative final cover system is incorporated into the closure-in-place concept. The final cover system consists of (from top to bottom):

- 2-foot final protective layer—locally available soils compacted to between 80% and 95% of the standard Proctor maximum dry density for establishment of vegetation and protection of the underlying geomembrane. Material is likely to be primarily low-plasticity silt or clay based on review of site geotechnical information (e.g., Hanson 2009b).
- Geocomposite.
- 40-mil LLDPE geomembrane.

To the extent possible, the gypsum would be graded to achieve final cover subgrade, and the final cover system would be constructed directly on the gypsum surface in most areas. Compacted fill, composed of locally available soils, would be placed only as needed to achieve final cover subgrade. The compacted fill is anticipated to be compacted to a minimum of 95% of the standard Proctor maximum dry density to provide a firm subgrade.

2.1.2 Closure Construction Plan

Conceptual final cover system grades and details are shown in Exhibit 1. The closure-in-place concept was developed to reduce the waste footprint at closure, while also recognizing the complications associated with handling and stacking wet gypsum materials. The proposed closure-in-place option would have final cover slopes of 4% to accommodate moderate settlement, with a berm constructed at the south end of the consolidated footprint to enhance stability. The location of the berm has been selected to accommodate the estimated volume

of gypsum to be contained within the consolidated footprint based on the grading plan presented. The general sequencing plan for the closure-in-place option is as follows:

- Pump out ponded water from the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400,000 cy of gypsum. Pumping out the ponded water will enable gravity drainage of the gypsum to begin, but there will be a significant amount of saturated material that will need to be relocated.
- Once the ponded water has been removed from the GMF Pond, shallow gypsum zones in the consolidated footprint will be dewatered as needed to enable equipment trafficking. Gypsum south of the consolidated footprint will be dewatered as needed to enable relocation. Free liquids in the gypsum will be eliminated by removing liquid wastes or solidifying gypsum remaining in place.
- Gypsum will be removed from the berm footprint and relocated into the consolidated footprint. The berm will be constructed in an east-west orientation at the south end of the consolidated footprint. The upstream face of the berm will be lined with a composite liner system consisting of a 60-mil HDPE geomembrane overlying a compacted clay layer, which will tie into the existing dual composite liner system.
- The remaining gypsum south of the berm will be collected and deposited north of the berm.
- Geosynthetic components of the existing dual composite liner system south of the berm will be removed and hauled away for disposal. Soil materials that must be removed to expose the geosynthetic layers will be stockpiled on site.

Ponded water removal from the GMF Pond will be a significant effort. Removal of the ponded water at the GMF Pond may take three to six months, depending on pumping rates, operating hours, and weather conditions. Once the ponded water is removed, Golder anticipates that the removal of liquid waste will take 12 to 18 months. The final cover system could be installed during the following construction season.

2.1.3 Stormwater Management

Stormwater runoff from the GMF Pond closure area will be managed by sheet flow off the cover system. Runoff will be routed into existing drainage channels northeast and southeast of the GMF Pond. A new channel will be excavated along the northern perimeter of the consolidated footprint to route water into the existing drainage channel northeast of the GMF Pond. To prevent impoundment of water in the south end of the current GMF Pond footprint, existing earthen embankments will be removed in the southeast corner of the GMF Pond and in the Recycle Pond to allow stormwater to passively flow into the existing drainage southeast of the GMF Pond. No new stormwater management ponds or other features would be needed for closure.

2.2 Closure by Removal

Under the closure-by-removal option, the gypsum in the GMF Pond will be dewatered and all gypsum will be hauled by truck from the GMF Pond to the existing permitted on-site landfill located approximately 1 mile north of the GMF Pond. Alternatively, the gypsum may be disposed of at an off-site landfill approximately 33 miles away. Additionally, the dual composite liner system described in Section 1.1 will be removed as required under 845.740(a) and disposed. Subsoil beneath the liner system will be excavated to a depth of up to 1 foot and disposed. Additional details on the closure-by-removal option are shown in Exhibit 2.

2.2.1 Material Removal Phasing

To completely remove the gypsum material from the GMF Pond, the gypsum will need to be dewatered. As described in Section 2.1.2, removal of ponded water from the GMF Pond is expected to take several months. After removal of the ponded water, the gypsum will still be unsuitable for supporting heavy construction traffic over much of the footprint. Careful planning will be required to safely remove the wet gypsum from the GMF Pond. The gypsum removal will likely be accomplished in phases, relying on a series of trenches to facilitate dewatering of the material. The trenches will shorten drainage routes to facilitate gravity dewatering of gypsum in the vicinity of each trench and will direct the water to sumps from which the water can be pumped. Exact dewatering means and methods would be determined by the gypsum removal contractor. The dewatering and closure-by-removal concept evaluated in the Closure Alternatives Analysis follows:

- Pump out ponded water from the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400,000 cy of gypsum. Pumping out the ponded water will enable gravity drainage of the gypsum to begin, but there will be a significant amount of saturated material that will need to be relocated.
- Excavate a series of trenches from north to south in the gypsum. Conceptually, the trenches may be on the order of 5 feet deep at regular spacing (potentially every 50 feet) and graded to allow water to drain to the south. Sumps in the trenches along the south end of the gypsum deposit will be used to collect water, which will be pumped from the GMF Pond to the Recycle Pond. The trenches will remain open until the top layer of gypsum across the GMF Pond is sufficiently dewatered to enable removal and transport without producing free water when disturbed. This process will repeat until all gypsum has been removed from the GMF Pond. Each layer may take several weeks or months to dewater and remove. Active dewatering or multiple handling of the gypsum may be an option to expedite the closure construction. The ring drain system may also be used to facilitate dewatering of the gypsum.
- Once all gypsum has been removed from the GMF Pond, the existing dual composite liner system described in Section 1.1 will be removed as required under 845.740(a). The earthen and geosynthetic materials will be disposed in a permitted landfill.
- A tentative schedule for the closure-by-removal process is:
  - three to six months to pump ponded water out of the GMF Pond
  - between one and two construction seasons to dewater and remove saturated gypsum
  - one or two construction seasons to remove the existing liner system and establish final reclamation grades, depending on on-site or off-site disposal

2.2.2 Surface Reconstruction

Once the GMF Pond is completely dewatered and all gypsum has been removed, the site will be reconfigured to allow passive surface water flow. Earthen embankments in the southeast corner of the GMF Pond and in the Recycle Pond will be removed to allow surface water to flow into an existing drainage channel southeast of the GMF Pond.

2.2.3 Stormwater Management

Surface water will shed to the south across the footprint and will be directed to an existing drainage southeast of the GMF Pond. To prevent impoundment of water in the south end of the footprint, existing earthen embankments will be removed in the southeast corner of the GMF Pond and in the Recycle Pond to allow stormwater to passively flow into the existing drainage southeast of the GMF Pond. No new stormwater management ponds or other features would be needed for closure.

3.0 ADDITIONAL INFORMATION

Gradient provided a request for additional information to support the Closure Alternatives Analysis. The additional information compiled by Golder in response to the request is provided in Tables 1 through 4. Table 1 provides narrative responses for information requests based largely on Part 845 requirements for the Closure Alternatives Analysis. Table 2 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-in-place approach. Table 3 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in a permitted on-site landfill, which would require an approximate 2-acre expansion to the existing on-site landfill. Table 4 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in an off-site landfill.

In accordance with Part 845, the cost estimates meet the criteria for a Class 4 estimate under the AACE classification standard (feasibility-level, -30% to +50% expected accuracy range). Cost estimates are presented in 2022 United States dollars. cost estimates for many of the cost components, whereby a labor and heavy equipment spread was assigned to the activity. That is, the number and classification (e.g., operator, laborer) of personnel carrying out the activity and the number and type of heavy equipment pieces (e.g., dozer, loader, haul truck) was estimated based on our experience with similar construction operations. This information, combined with an estimate of production rate (e.g., number of cubic yards placed per day), yields a unit cost for the operation (e.g., cost per cubic yard placed). Golder developed production rates based on equipment capabilities (e.g., haul truck capacity, estimated load and unload times, estimates of average speed) and checked them against experience from similar projects. The hourly heavy equipment rates used in the cost estimates were from an internal database of heavy equipment ownership and operating costs by type and size (capacity) of equipment. The internal database reflects the estimated cost associated with owned heavy equipment in the central United States. The hourly labor rates used in the cost estimates were from an internal database of typical labor rates from similar projects in the north-central United States. Unit prices for some cost components (e.g., furnishing and installation of geosynthetics, seeding and mulching) were estimated based on typical unit prices from similar recent projects. Material quantities correspond with the closure approaches shown in Exhibits 1 and 2 and were developed primarily in Autodesk Civil3D. At a conceptual level of cost estimating, project costs other than direct construction costs (e.g., mobilization and demobilization, miscellaneous construction items not captured elsewhere) were estimated as a proportion of the direct construction cost. Experience on similar projects was used as the basis for the proportions applied.

4.0 REFERENCES

AECOM. 2016. History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Duck Creek Power Station. October. Available online: https://www.luminant.com/ccr/?wpdf_download_file=L25hcy9jb250ZW50L2xpdmUvbHVtaW5hbnQzL2RvY3VtZW50cy9jY3IvSWxsaW5vaXMvRHVjay1DcmVlay8yMDE2L0hpc3Rvcnkgb2YgQ29uc3RydWN0aW9uLnBkZg%3D%3D).

Feezor (Feezor Engineering, Inc.). 2009. Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station. July.

Hanson (Hanson Professional Services Inc.). 2009a. Acceptance Report, Gypsum Stack, Gypsum Management Facility, AERG Duck Creek Power Generating Station. December.

Hanson. 2009b. Initial Facility Report, Gypsum Stack, Gypsum Management Facility, Duck Creek Generating Station. February.

Exhibits: Tables
- Table 1: Information Summary
- Table 2: Closure Estimates – Closure in Place
- Table 3: Closure Estimates – Closure by Removal with On-Site Disposal
- Table 4: Closure Estimates – Closure by Removal with Off-Site Disposal

Exhibits 1 and 2
- Exhibit 1: Closure-in-Place Figures
- Exhibit 2: Closure-by-Removal Figures

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Tables

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Table 1: Information Summary

Background/Current Site Conditions	
Surface area of impoundment	30.8 acres
Volume of CCR in impoundment	400,000 cy
Published or draft engineering evaluations undertaken at the site to date	
Conceptual site models	Refer to the Groundwater Modeling Report.
Regional well (receptor) survey information	Refer to the Groundwater Modeling Report.
History of construction report	See [1].
Dike stability report	Observations and stability factors of safety described by AECOM [2] and [3] were adequate.
Hydraulic evaluation of basins (evaluation of possibility of overtopping and/or emergency spillway releases during flood conditions)	Hydraulic and hydrologic analyses performed by AECOM [4] found that the geomembrane-lined spillway can adequately manage flow during peak discharge from the 1,000-year storm event without overtopping of the embankments. This also means that the spillway is adequate to carry sustained flows.
Surface impoundment hazard assessment/hazard category determination	A hazard potential classification assessment performed by Stantec [5] found the GMF Pond to have significant hazard potential. 40 CFR 257.53 defines a significant hazard potential CCR surface impoundment as a diked surface impoundment for which failure or misoperation would result in no probable loss of human life but could cause economic loss, environmental damage, disruption of lifeline facilities, and/or impact other concerns.
Habitat survey	During site development, it was confirmed that the site did not contain wild or scenic rivers (per the National Park Service), the facility did not restrict the flow of a 100-year flood, the site did not qualify for listing on the National Register of Historic Places (per the Illinois Historic Preservation Agency), the site did not pose a threat to a dedicated nature preserve persuant to the Illinois Natural Areas Preservation Act (per the Illinois Nature Preserves Commission), and there were no records of the presence of endangered/threatened species or natural areas in the vicinity of the facility [6].
Wetlands survey	In March and May of 2007, field surveys were conducted to determine and delineate the existence of any potential wetland areas in accordance with the 1987 Corps of Engineers Wetland Delineation Manual. It was determined that six unnamed tributaries, a linear ditch wetland, and two headwater drainages were within the facility boundary. No defined hydrologic connection to Duck Creek was identified, so these were determined to be isolated waters and wetlands and not regulated under the Clean Water Act [6].

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Table 1: Information Summary

Closure Design and Implementation	
Copy of draft of closure report, if available	Provided.
Engineering spreadsheet containing breakdown of labor, equipment/vehicle, and material requirements for each closure alternative, if available (expected on-site and off-site vehicle and equipment mileages, labor hours, etc.)	See Tables 2 through 4.
Overview of planned activities under each closure alternative	Closure in place: Under this scenario, gypsum will be contained in the northern portion of the GMF Pond, which will necessitate relocation of gypsum currently in the southern portion of the GMF Pond to this final containment area, followed by final cover installation. The general sequence is: -Ponded water will be pumped out of the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400000 cy of gypsum. Pumping out the ponded water will allow gravity drainage of the gypsum to begin. -Gypsum within the final containment area will be dewatered using trenches and sumps and possibly the existing ring drain system. -Once the ponded water has been removed from the GMF Pond, a berm will be constructed across the GMF Pond in an east-west orientation at the south end of the final containment area. Gypsum in the berm footprint will need to be removed before the berm is constructed. The upstream face of the berm will be lined with a composite liner system, which will tie into the existing dual liner system. -The remaining gypsum south of the berm will be collected and deposited north of the berm. -Geosynthetic components of the existing dual composite liner system south of the berm will be removed and disposed in the closure footprint. Soil materials between these components will be removed and stockpiled south of the GMF Pond. -Compacted fill will be used as needed to achieve subgrade and a final cover system consisting of the following components (from top to bottom) will be constructed over the final containment area: -2-foot-thick final protective layer composed of locally available soils -Geocomposite -40-mil LLDPE geomembrane -A channel will be excavated, including removal of sections of the perimeter embankment around the Recycle Pond, to allow surface water flow into an existing drainage channel southeast of the GMF Pond.

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Table 1: Information Summary

Closure Design and Implementation	
Overview of planned activities under each closure alternative	Closure by removal: Under this scenario, the gypsum in the GMF Pond will be dewatered and hauled by truck from the GMF Pond to the existing permitted on-site landfill, which will require a 2-acre expansion, or to a permitted off-site landfill. Additionally, the existing dual composite liner system will be removed as required under Part 845.740(a). The general sequence is: -Ponded water will be pumped out of the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400000 cy of gypsum. Pumping out the ponded water will allow gravity drainage of the gypsum to begin. -A series of trenches will be excavated from north to south in the gypsum. The trenches will likely be on the order of 5 feet deep at regular spacing (such as every 50 feet) and graded to allow water to drain to the south. Sumps will be excavated in the trenches along the south end of the gypsum deposit to collect water, which will be pumped from the GMF Pond to the Recycle Pond. The trenches will remain open until the surrounding gypsum is sufficiently dewatered to enable removal and transport without producing free water. This process will repeat until all gypsum has been removed from the GMF Pond. Each layer may take several weeks or months to dewater and remove. The ring drain system may also be used to facilitate dewatering of the gypsum. -Once all gypsum has been removed from the GMF Pond, the existing dual composite liner system will be removed and the subsoil will be overexcavated up to an additional 1 foot. The geosynthetic materials and soils will be disposed in the on-site landfill or in an off-site landfill. -A channel will be excavated, including removal of sections of the perimeter embankment around the Recycle Pond, to allow surface water flow into an existing drainage channel southeast of the GMF Pond.
Expected duration of major construction activities under each closure activity	Closure in place: Approximately three years. Removal of ponded water from the GMF Pond may take 3 to 6 months, depending on pumping rates, operating hours, and weather conditions. Once the ponded water is removed, it is anticipated that the removal of liquid waste will take 12 to 18 months. It is anticipated that final cover construction and establishment of final grades efforts could be completed during the following construction season.
	Closure by removal: Approximately three years for on-site disposal and four years for off-site disposal. Removal of ponded water from the GMF Pond may take 3 to 6 months, depending on pumping rates, operating hours, and weather conditions. Expansion of the existing landfill can take place during this time. It is anticipated that dewatering and removal of the gypsum will take one or two construction seasons for on-site disposal or two full years for off-site disposal. It is anticipated that removal of the dual composite liner system and establishment of final grades will require an additional construction season for on-site disposal or 18 months for off-site disposal.

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Table 1: Information Summary

Closure Design and Implementation	
If an on-site landfill will be constructed on the site under a given closure alternative, please include the years required to construct and later close the on-site landfill	Closure in place: Not applicable. The existing permitted on-site landfill has sufficient capacity to accept waste generated from closure in place without expansion of the existing landfill or construction of a new on-site landfill.
	Closure by removal: If disposal will be on site, the landfill expansion could be completed in a single construction season. Landfill closure could be completed in a single construction season following closure of the GMF Pond.
If an on-Site landfill must first be constructed on the Site, please estimate the anticipated delay in the commencement of excavation activities while the landfill is being sited, designed, and constructed. Will dewatering/unwatering of the ponds begin immediately, or after the landfill is constructed?	Closure in place: Not applicable.
	Closure by removal: The landfill has already been sited and permitted, including the expansion area. Final design and construction of the expansion could be completed while removal of ponded water and gypsum dewatering are occurring at the GMF Pond.
Proposed location of the on-site landfill if on-site disposal is being considered for CBR scenario	The existing on-site landfill is approximately 1 mile north of the GMF Pond via site roads.
Surface area of the on-site landfill, if a new landfill must be constructed at the site	If a landfill expansion is required (on-site disposal), the additional surface area is estimated as 2 acres.
Name and location of proposed off-site landfill	If an off-site landfill were to be used, the Peoria City-County Landfill is the nearest suitable facility (33 miles away). An alternate off-site landfill is the Envirofill of IL Landfill.
Location of borrow area, if a borrow area will be established (for either the impoundment or construction/closure of an on-Site landfill). If location is unknown, please estimate a likely distance to the borrow area.	The anticipated on-site borrow source location is approximately 0.4 miles north of the GMF via site roads and approximately 0.7 miles south of the on-site landfill by site roads.
Estimated volume of soil to be hauled from the borrow area under each closure alternative	Closure in place: The amount of borrow material required is estimated as 73,800 cubic yards.
	Closure by removal: If a landfill expansion is not required, no borrow material will be needed. If a landfill expansion is required (on-site disposal), the maximum amount of borrow material required is estimated as 18,000 cubic yards.
Difficulty associated with implementation of each closure alternative (e.g., do any alternatives pose particular engineering/implementation challenges?)	Closure in place: Dewatering and relocation of gypsum will require considerable effort and time. Establishing the surface water drainage channel through the Gypsum Recycle Pond perimeter berm will be challenging because of the excavation depths involved.
	Closure by removal: Dewatering of the gypsum prior to removal will require considerable effort and time. Establishing the surface water drainage channel through the Gypsum Recycle Pond perimeter berm will be challenging because of the excavation depths involved.
Availability of necessary equipment and specialists for each closure alternative	Good availability of equipment and services is anticipated for all closure alternatives.
Available capacity and location of needed treatment, storage, and disposal services for each closure alternative	The distance to the nearest off-site landfill (approximately 33 miles) presents a significant challenge for the option that involves off-site disposal.
Estimated cost of each closure alternative	Closure in place: $6.2 million.
	Closure by removal: $8.9 million (on-site disposal); $82.4 million (off-site disposal).

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Table 1: Information Summary

Post-Closure Plan/Long-Term Management Plan	
Planned duration of post-closure care activities	Closure in place: The owner or operator of the CCR surface impoundment must conduct post-closure care for 30 years. The owner or operator must continue to conduct post-closure care beyond the 30-year post-closure care period until groundwater monitoring data shows the concentrations are (a) below groundwater protection standards given in Section 845.600 of Part 845 or (b) not increasing for those constiuents over background using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
	Closure by removal: An owner or operator of a CCR surface impoundment that elects to close a CCR surface impoundment by removing CCR as provided in Section 845.740 must continue groundwater monitoring for three years after the completion of closure or until concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
Expected frequency of groundwater and surface water monitoring during post-closure period	Closure in place: Quarterly for 5 years and semi-annually thereafter.
	Closure by removal: Quarterly.
Expected frequency of inspections post closure	Monthly for the first year and annually thereafter [6].
Summary of planned maintenance activities post-closure	Closure in place: Groundwater monitoring will be conducted. Site inspections will be conducted on a quarterly basis for a minimum of 5 years after closure. An annual site inspection will be performed until settlement has ceased and there are no eroded or scoured areas or until the end of the 30-year post-closure care period. Over these 30 years, repair and maintenance, including soil filling and reseeding, will be performed if ponding is observed, cracks greater than 1 inch wide or gullies 6 inches or deeper have formed, vegetative or vector problems arise, or leachate seeps are present. Areas susceptible to erosion will be recontoured and reseeded. Eroded and scoured drainage channels will be repaired and the liner material replaced if necessary. Vegetation will be mowed annually. Areas of failed or eroded vegetation in excess of 100 square feet will be revegetated. Minor repairs to ensure the integrity and proper function of fencing, surface water drainage features, monitoring points, and groundwater monitoring wells may be required. Leachate will be pumped from the leachate collection sumps into storage tanks or tanker trucks and transported to a wastewater treatment plant for treatment and disposal [6].
	Closure by removal: Groundwater monitoring will be conducted.
Summary of planned post-closure care activities at the on-site landfill, if a new on-site landfill is going to be constructed	Not applicable.

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Table 1: Information Summary

Corrective Measures Assessment	
Corrective measures being considered post-closure	None anticipated.
Overview of planned activities for each corrective measure	None anticipated.

References

1) AECOM. (2016). History of Construction, USEPA Final CCR Rule, 40 CFR 257.73(c), Duck Creek Power Station, Canton, Illinois. Available online: https://www.luminant.com/ccr.

2) AECOM (2016). CCR Rule Report: Initial Structural Stability Assessment for GMF Pond at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

3) AECOM (2016). CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

4) AECOM (2016). CCR Rule Report: Initial Inflow Design Flood Control System Plan for GMF Pond at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

5) Stantec. (2016). Initial Hazard Potential Classification Assessment, EPA Final CCR Rule, GMF Pond, Duck Creek Power Station, Fulton County, Illinois. Available online: https://www.luminant.com/ccr.

6) Hanson (Hanson Professional Services, Inc.) 2009. Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station.

Electronic Filing: Received, Clerk's Office 06/20/2024

Table 2: Closure Estimates - Closure In Place

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 488,170	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 75,000	$ 75,000	1 surveyor	Pickup truck	
Borrow Area Preparation and Reclamation	LS	1	$ 50,000	$ 50,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Ponded Water Removal	LS	1	$ 128,000	$ 128,000	1 superintendent (part-time), 1 laborer (part-time)	Pickup truck (part-time), diesel pump, generator	
Pipe Removal/Abandonment	LS	1	$ 15,000	$ 15,000	2 equipment operators, 2 laborers	Excavator, haul truck	
Embankment Fill/Compacted Clay - Berm	CY	25,700	$ 4.50	$ 115,650	7 equipment operators	Excavator, dozer, compactor, water truck, 3 haul trucks	889 (0.4 miles one way)
Geomembrane - Berm	SF	58,600	$ 0.85	$ 49,810	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance technician	Pickup truck, telehandler	
Gypsum Dewatering	LS	1	$ 1,700,000	$ 1,700,000	1 superintendent, 1 laborer, 1 operator (part-time)	Excavator, diesel pumps	
Gypsum Relocation	CY	85,000	$ 8.20	$ 697,000	9 equipment operators	2 excavators, dozer, 2 loaders, 4 haul trucks, diesel pump	2,778 (0.2 miles one way)
Geosynthetics Removal and Disposal	AC	17	$ 4,000	$ 68,000	4 equipment operators, 2 laborers	Loader, 3 haul trucks	100 (0.2 miles one way)
Cushion Soil Removal and Stockpiling	CY	29,100	$ 2.90	$ 84,390	5 equipment operators	Excavator, dozer, 3 haul trucks, diesel pump	1,007 (0.2 miles one way)
Drainage Soil Removal and Stockpiling	CY	26,600	$ 2.90	$ 77,140	5 equipment operators	Excavator, dozer, 3 haul trucks, diesel pump	920 (0.2 miles one way)
Geomembrane - Final Cover	SF	679,600	$ 0.75	$ 509,700	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance	Pickup truck, telehandler	
Geocomposite- Final Cover	SF	679,600	$ 0.75	$ 509,700			
Protective Soil Layer	CY	50,400	$ 3.90	$ 196,560	8 equipment operators	2 excavators, dozer, water truck, 4 haul trucks	1,744 (0.4 miles one way)
Fertilize, Seed, and Mulch	AC	35	$ 5,000	$ 175,000	2 equipment operators	Seed drill or hydroseeder	
Stormwater Channel Excavation	CY	81,000	$ 4.70	$ 380,700	3 equipment operators	Excavator, 2 haul trucks, diesel pump	2,803 (0.4 miles one way)
Erosion Controls	LS	1	$ 50,000	$ 50,000	2 laborers		
Construction Quality Assurance	LS	1	$ 300,000	$ 300,000	1 to 2 technicians	1 to 2 pickup trucks	
Miscellaneous Construction	LS	1	10%	$ 536,980	Miscellaneous	Miscellaneous	
			Total	**$ 6,206,800**			

Notes:
Miscellaneous Construction includes other work not captured in the items shown.
Soil components were assumed to be taken from the stockpile north of the GMF (0.4-mile haul).
Disposal was assumed to occur in the on-site landfill (1.2-mile haul).
Stockpiling was assumed to occur south of the closure footprint (0.2-mile haul).
Soil excavated for the stormwater channel was assumed to be stockpiled 0.4 miles from the excavation.

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Table 3: Closure Estimates - Closure by Removal with On-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 727,240	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 50,000	$ 50,000	1 surveyor	Pickup truck	
Ponded Water Removal	LS	1	$ 128,000	$ 128,000	1 superintendent (part-time), 1 laborer (part-time)	Pickup truck (part-time), diesel pump	
Pipe Removal/Abandonment	LS	1	$ 25,000	$ 25,000	2 equipment operators, 2 laborers	Excavator, haul truck	
Gypsum Dewatering	LS	1	$ 1,700,000	$ 1,700,000	1 superintendent, 1 laborer, 1 operator (part-time)	Excavator, diesel pumps	
Gypsum Loading and Disposal	CY	400,000	$ 7.00	$ 2,800,000	11 equipment operators	2 excavators, dozer, 2 loaders, 6 haul trucks, diesel pump	13,072 (1.2 miles one way)
Geosynthetics Removal and Disposal	AC	31	$ 8,000	$ 248,000	4 equipment operators, 2 laborers	Loader, 3 haul trucks	119 (1.2 miles one way)
Cushion Soil Removal and Disposal	CY	60,800	$ 4.00	$ 243,200	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	2,104 (1.2 miles one way)
Drainage Soil Removal and Disposal	CY	55,500	$ 4.00	$ 222,000	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	1,920 (1.2 miles one way)
Compacted Clay Removal and Disposal	CY	166,500	$ 4.00	$ 666,000	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	5,761 (1.2 miles one way)
Subsoil Overexcavation and Disposal	CY	50,000	$ 4.00	$ 200,000	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	1,731 (1.2 miles one way)
Fertilize, Seed, & Mulch	AC	36	$ 5,000	$ 180,000	2 equipment operators	Seed drill or hydroseeder	
Stormwater Channel Excavation	CY	86,000	$ 4.70	$ 404,200	3 equipment operators	Excavator, 2 haul trucks, diesel pump	2,976 (0.4 miles one way)
Erosion Controls	LS	1	$ 75,000	$ 75,000	2 laborers		
Subgrade Preparation - Landfill Expansion	AC	2	$ 10,000	$ 20,000	2 equipment operators, laborer	Dozer, loader	
Compacted Clay - Landfill Expansion	CY	9,700	$ 4.50	$ 43,650	7 equipment operators	Excavator, dozer, compactor, water truck, 3 haul trucks	336 (0.7 miles one way)
Geomembrane - Landfill Expansion	SF	87,100	$ 0.85	$ 74,035	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance technician	Pickup truck, telehandler	
Geosynthetic Clay Liner - Landfill Expansion	SF	87,100	$ 0.95	$ 82,745		Pickup truck, telehandler	
Geotextile - Landfill Expansion	SF	174,200	$ 0.15	$ 26,130		Pickup truck, telehandler	
Drainage Soil - Landfill Expansion	CY	3,200	$ 17.00	$ 54,400	2 equipment operators	Dozer, loader	
Leachate Collection System - Landfill Expansion	LS	1	$ 30,000	$ 30,000	5 laborers		
Construction Quality Assurance	LS	1	$ 75,000	$ 75,000	1 to 2 technicians	1 to 2 pickup trucks	
Miscellaneous Construction	LS	1	10%	$ 799,960	Miscellaneous	Miscellaneous	
			Total	**$ 8,874,560**			

Notes:

Miscellaneous Construction includes other work not captured in the items shown.

Disposal was assumed to occur in the on-site landfill (1.2-mile haul).

Soil excavated for the stormwater channel was assumed to be stockpiled 0.4 miles from the excavation.

Soil components for landfill expansion except drainage soil (imported) were assumed to be taken from the stockpile north of the GMF (0.7-mile haul).

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Table 4: Closure Estimates - Closure by Removal with Off-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 6,806,150	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 25,000	$ 25,000	1 surveyor	Pickup truck	
Ponded Water Removal	LS	1	$ 128,000	$ 128,000	1 superintendent (part-time), 1 laborer (part-time)	Pickup truck (part-time), diesel pump	
Pipe Removal/Abandonment	LS	1	$ 25,000	$ 25,000	2 equipment operators, 2 laborers	Excavator, haul truck	
Gypsum Dewatering	LS	1	$ 1,700,000	$ 1,700,000	1 superintendent, 1 laborer, 1 operator (part-time)	Excavator, diesel pumps	
Gypsum Removal	CY	400,000	$ 3.40	$ 1,360,000	5 equipment operators	2 excavators, dozer, 2 loaders, diesel pump	
Gypsum Disposal	CY	400,000	$ 79	$31,600,000	8 equipment operators	8 on-highway trucks	26,846 (32.6 miles one way)
Geosynthetics Removal	AC	31	$ 6,000	$ 186,000	Equipment operator, 2 laborers	Loader	
Geosynthetics Hauling and Disposal	AC	31	$ 5,000	$ 155,000	3 equipment operators	3 on-highway trucks	245 (32.6 miles one way)
Cushion Soil Removal	CY	60,800	$ 2.90	$ 176,320	2 equipment operators	2 excavators, diesel pump	
Cushion Soil Hauling and Disposal	CY	60,800	$ 94	$ 5,715,200	8 equipment operators	8 on-highway trucks	4,343 (32.6 miles one way)
Drainage Soil Removal	CY	55,500	$ 2.90	$ 160,950	2 equipment operators	2 excavators, diesel pump	
Drainage Soil Hauling and Disposal	CY	55,500	$ 94	$ 5,217,000	8 equipment operators	8 on-highway trucks	3,964 (32.6 miles one way)
Compacted Clay Removal	CY	166,500	$ 2.90	$ 482,850	2 equipment operators	2 excavators, diesel pump	
Compacted Clay Hauling and Disposal	CY	166,500	$ 94	$15,651,000	8 equipment operators	8 on-highway trucks	11,893 (32.6 miles one way)
Subsoil Overexcavation	CY	50,000	$ 2.90	$ 145,000	2 equipment operators	2 excavators, diesel pump	
Subsoil Hauling and Disposal	CY	50,000	$ 94	$ 4,700,000	8 equipment operators	8 on-highway trucks	3,571 (32.6 miles one way)
Fertilize, Seed, & Mulch	AC	36	$ 5,000	$ 180,000	2 equipment operators	Seed drill or hydroseeder	
Stormwater Channel Excavation	CY	86,000	$ 4.70	$ 404,200	3 equipment operators	Excavator, 2 haul trucks, diesel pump	2,976 (0.4 miles one way)
Erosion Controls	LS	1	$ 50,000	$ 50,000	2 laborers		
Miscellaneous Construction	LS	1	10%	$ 7,486,770	Miscellaneous	Miscellaneous	
			Total	**$ 82,354,440**			

Notes:

Miscellaneous Construction includes other work not captured in the items shown.

Disposal was assumed to occur in an off-site landfill (32.6-mile haul).

Soil excavated for the stormwater channel was assumed to be stockpiled 0.4 miles from the excavation.

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EXHIBIT 1

Closure-in-Place Figures

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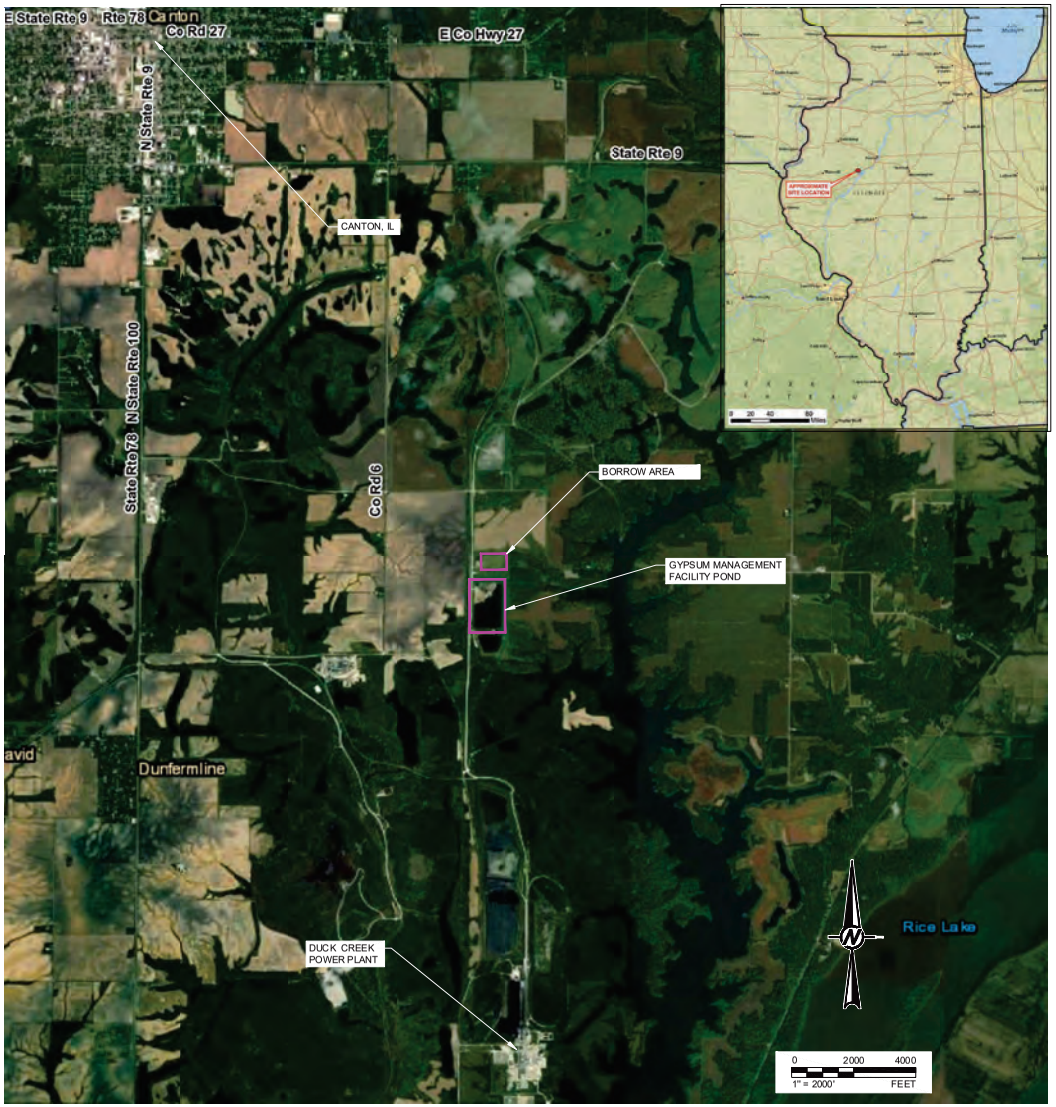

ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI USA 63021

PERMIT APPLICATION DRAWING LIST		
NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	GYPSUM REGRADING AND CONTAINMENT PLAN	A
4	FINAL COVER AND STORMWATER PLAN	A
5	SECTIONS	A
6	DETAILS (1 OF 2)	A
7	DETAILS (2 OF 2)	A

NOTE(S)

1. AERIAL IMAGERY FROM ESRI-PROVIDED BASEMAP SERVICE. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.
2. INSET MAP BOUNDARIES FROM ESRI-PROVIDED FEATURE SERVICE. USA STATE BOUNDARIES. 2021
3. INSET MAP BACKGROUND FROM ESRI-PROVIDED BASEMAP SERVICE. NATIONAL GEOGRAPHIC BASEMAP. 2021.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

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ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

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UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
TITLE SHEET

PROJECT NO. 21454861 | REV. A | 1 of 7 | DRAWING 1

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R002918

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LEGEND

- 600 — EXISTING GROUND ELEVATION CONTOURS (NOTE 1)
- EXISTING ROAD
- LIMIT OF GMF POND LINER SYSTEM (NOTE 2)
- WATER LEVEL LINE (NOTE 3)
- EXISTING PIPING (NOTE 3)

NOTES

1. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
2. LIMIT OF LINER SYSTEM ESTIMATED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES, DATED 03/05/2009.
3. WATER LEVEL LINE AND EXISTING PIPING FROM INGENAE SURVEY RECORD DRAWING DATED 3/19/2021.
4. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020.

0 120 240
1" = 120' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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PROJECT
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TITLE
EXISTING CONDITIONS

PROJECT NO. 21454861 | REV. A | 2 of 7 | DRAWING 2

R002919

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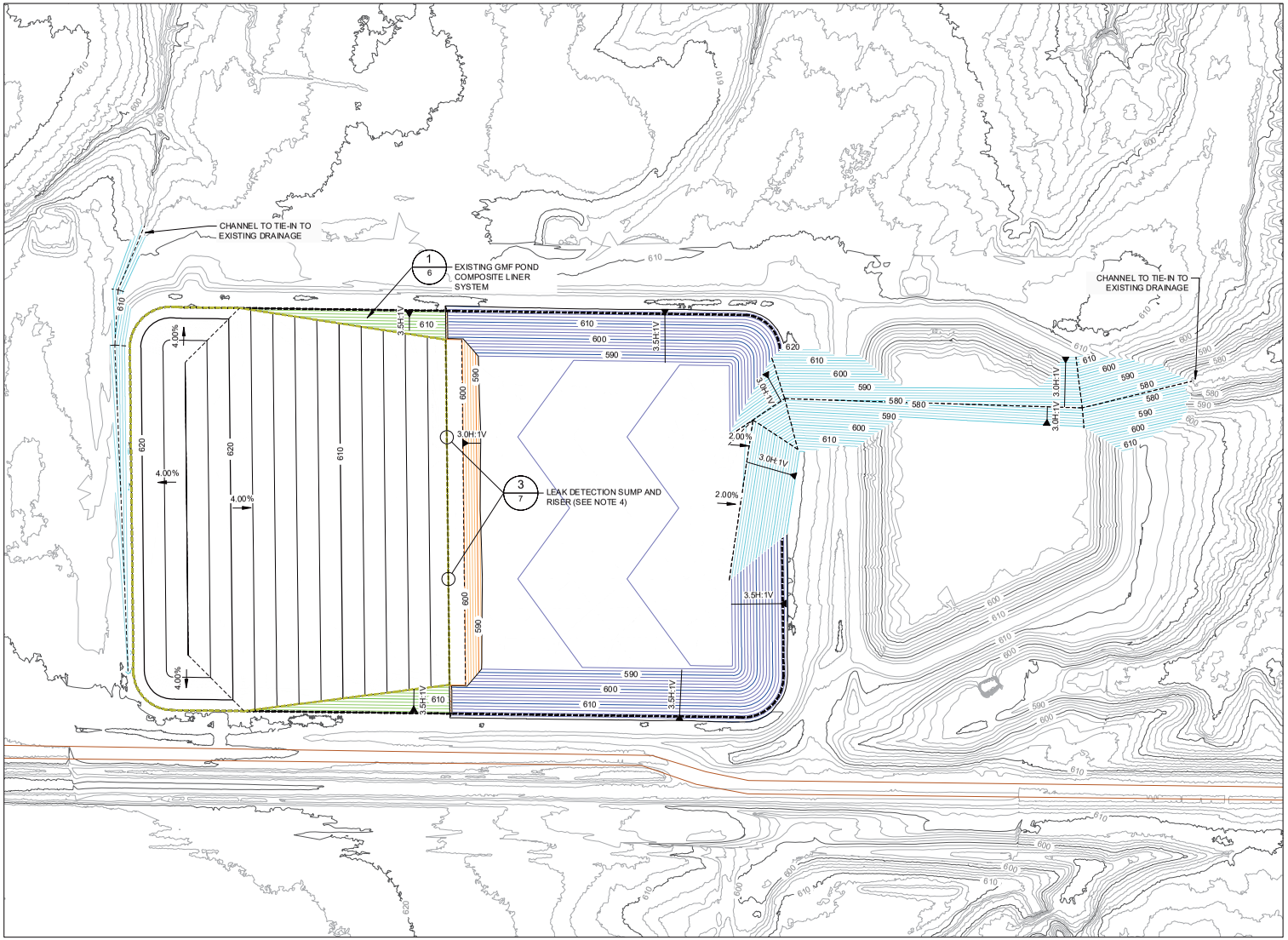

LEGEND

- 600 — TOP OF RELOCATED GYPSUM
- 600 — TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- 600 — TOP OF EXISTING CLAY LINER (SEE NOTE 1)
- 600 — DRAINAGE CHANNEL GRADES
- 600 — EARTHEN BERM GRADES
- 600 — EXISTING GROUND CONTOURS (SEE NOTE 2)
- EXISTING ROAD
- LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)
- LIMIT OF WASTE

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.
4. THE EXISTING LEAK DETECTION SYSTEM WILL BE ADAPTED TO THE CLOSURE FOOTPRINT. EXISTING LEACHATE COLLECTION PIPING WILL BE TERMINATED IN NEW SUMPS (TWO LOCATIONS WITH NEW RISERS FOR CONTINUED LEAK DETECTION CAPABILITY.

0 120 240
1" = 120' FEET

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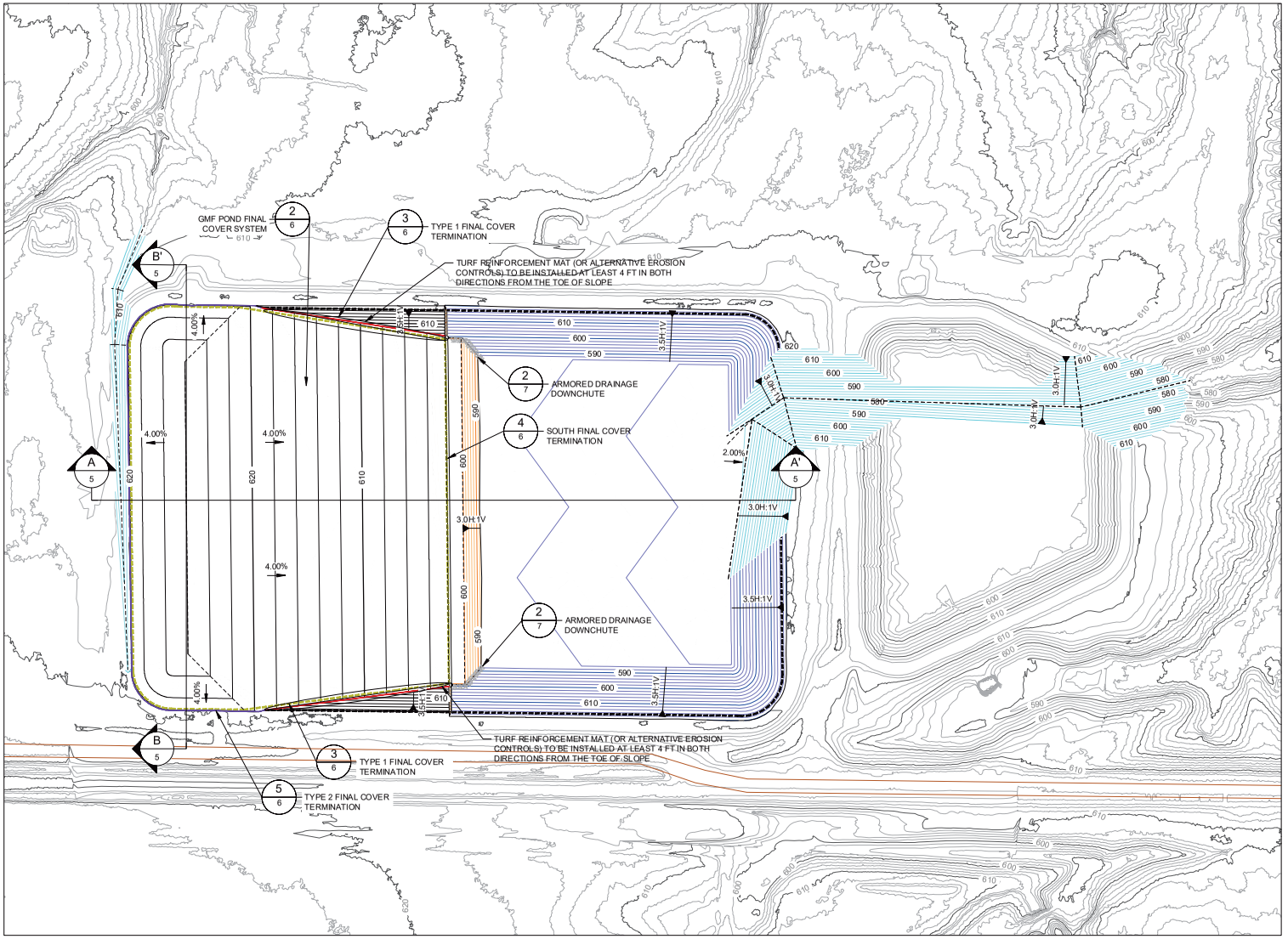
PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
GYPSUM REGRADING AND CONTAINMENT PLAN

PROJECT NO. 21454861 | REV. A | 3 of 7 | DRAWING 3

R002920



LEGEND

- 600 — TOP OF FINAL COVER SYSTEM
- 600 — TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- 600 — TOP OF EXISTING CLAY LINER (SEE NOTE 1)
- 600 — EARTHEN BERM GRADES
- 600 — EXISTING GROUND CONTOURS (SEE NOTE 2)
- EXISTING ROAD
- LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)
- LIMIT OF WASTE AT CLOSURE
- TYPE 1 FINAL COVER TERMINATION
- TYPE 2 FINAL COVER TERMINATION

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.

0 120 240
1" = 120' FEET

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PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
FINAL COVER AND STORMWATER PLAN

PROJECT NO.	REV.	4 of 7	DRAWING
21454861	A		4

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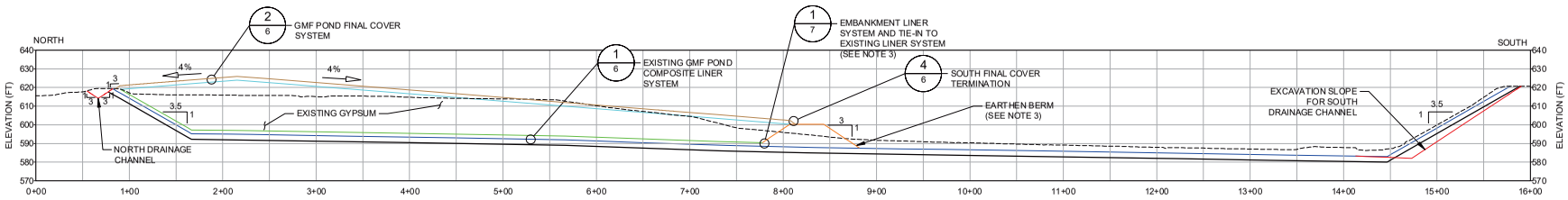

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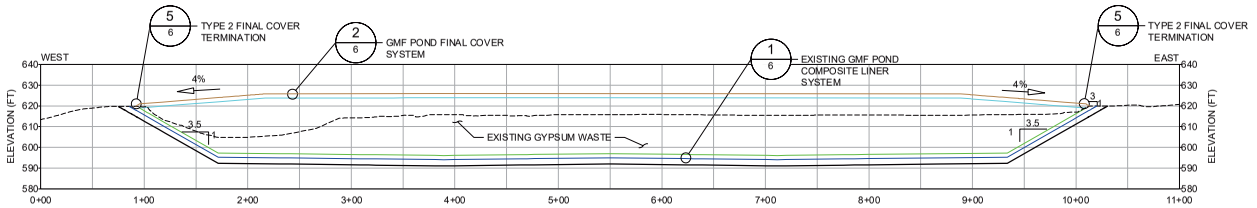

SCALE 1" = 60' VERT. SCALE X2 — B/5 SECTION B-B'

0 60 120 1" = 60' FEET

LEGEND

- TOP OF FINAL COVER SYSTEM
- TOP OF RELOCATED GYPSUM
- TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- TOP OF EXISTING CLAY LINER (SEE NOTE 1)
- BOTTOM OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- EXISTING GROUND CONTOURS (SEE NOTE 2)
- EARTHEN BERM (SEE NOTE 3)
- DRAINAGE CHANNEL GRADING

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES SHOWN WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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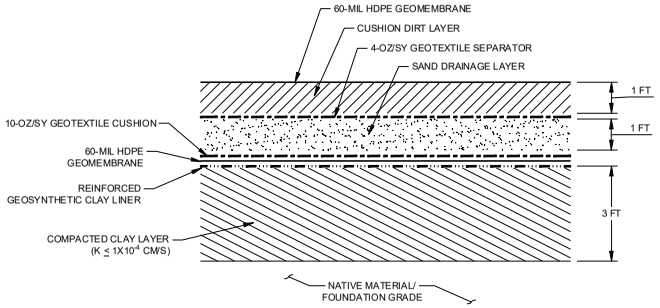
PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
SECTIONS

PROJECT NO. 21454861 | REV. A | 5 of 7 | DRAWING 5

R002922



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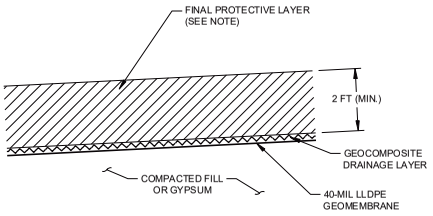

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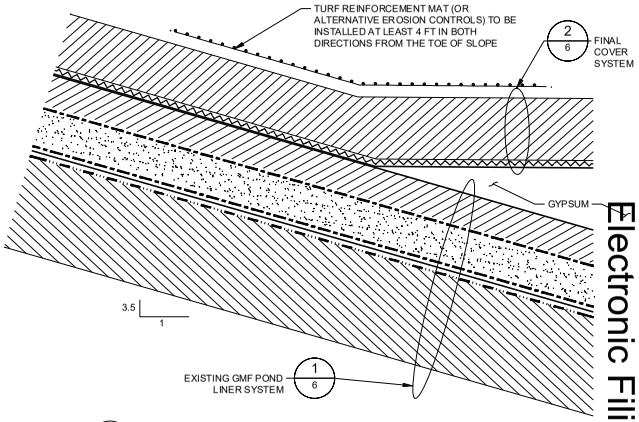

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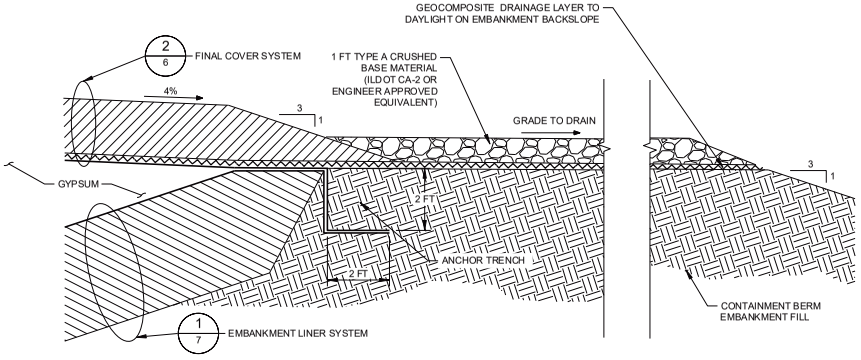
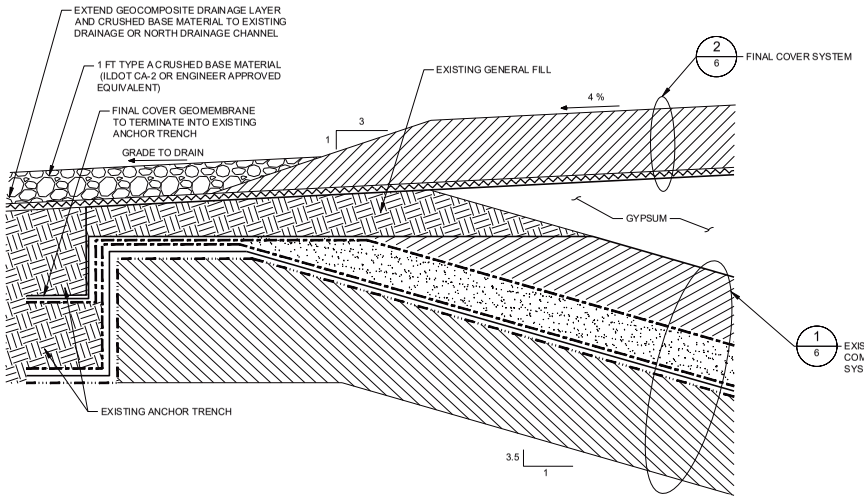


SCALE N.T.S. 4/6 SOUTH FINAL COVER TERMINATION



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PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
DETAILS (1 OF 2)

PROJECT NO.	REV.	6 of 7	DRAWING
21454861	A		6

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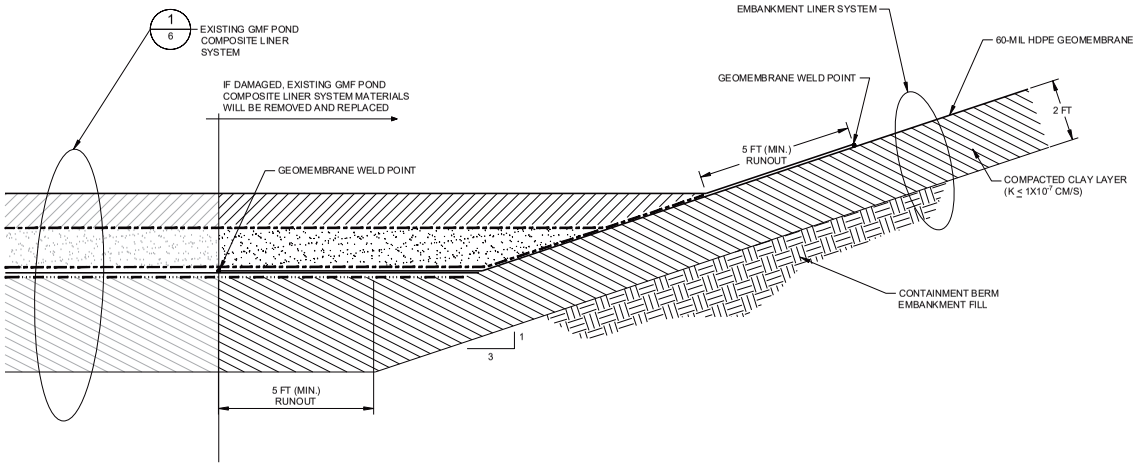
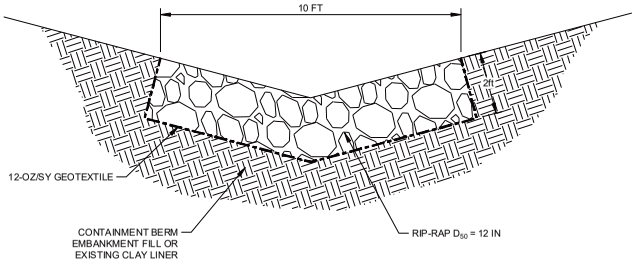


SCALE N.T.S. 1/7 EMBANKMENT LINER SYSTEM AND TIE-IN TO EXISTING COMPOSITE LINER SYSTEM



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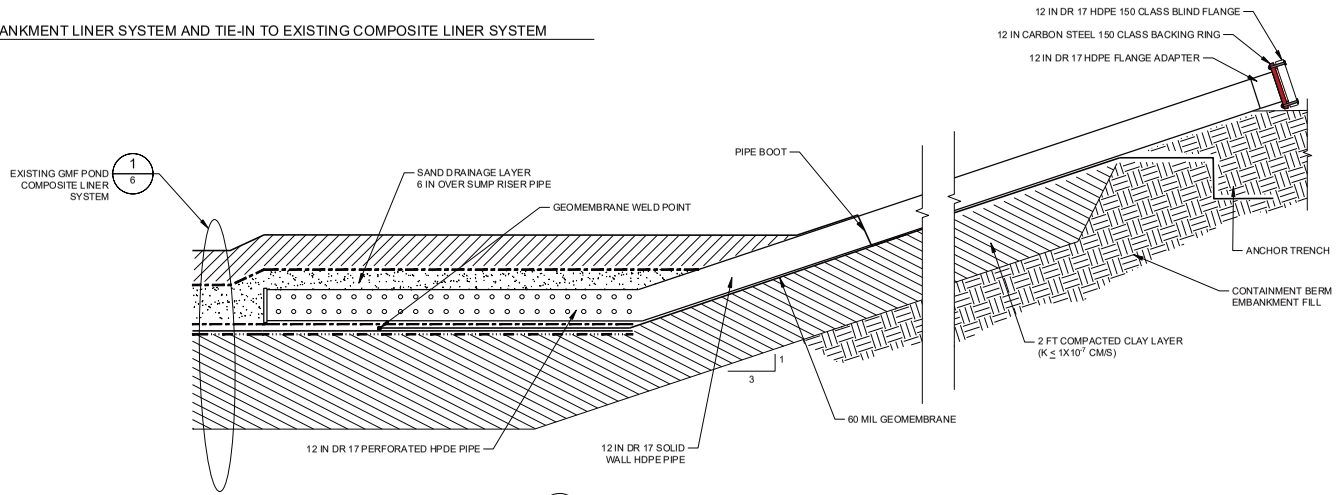

SCALE N.T.S. 3/7 LEAK DETECTION SYSTEM SUMP AND RISER

NOTE

EXISTING 6 INCH LEACHATE COLLECTION PIPE NOT SHOWN IN DETAIL. LEACHATE COLLECTION PIPE WILL TERMINATE AND BE CAPPED AT THE TOE OF THE CONTAINMENT BERM

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PROJECT
GYPSUM MANAGEMENT FACILITY POND
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TITLE
DETAILS (2 OF 2)

PROJECT NO.	REV.	7 of 7	DRAWING
21454861	A		7

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EXHIBIT 2

Closure-by-Removal Figures

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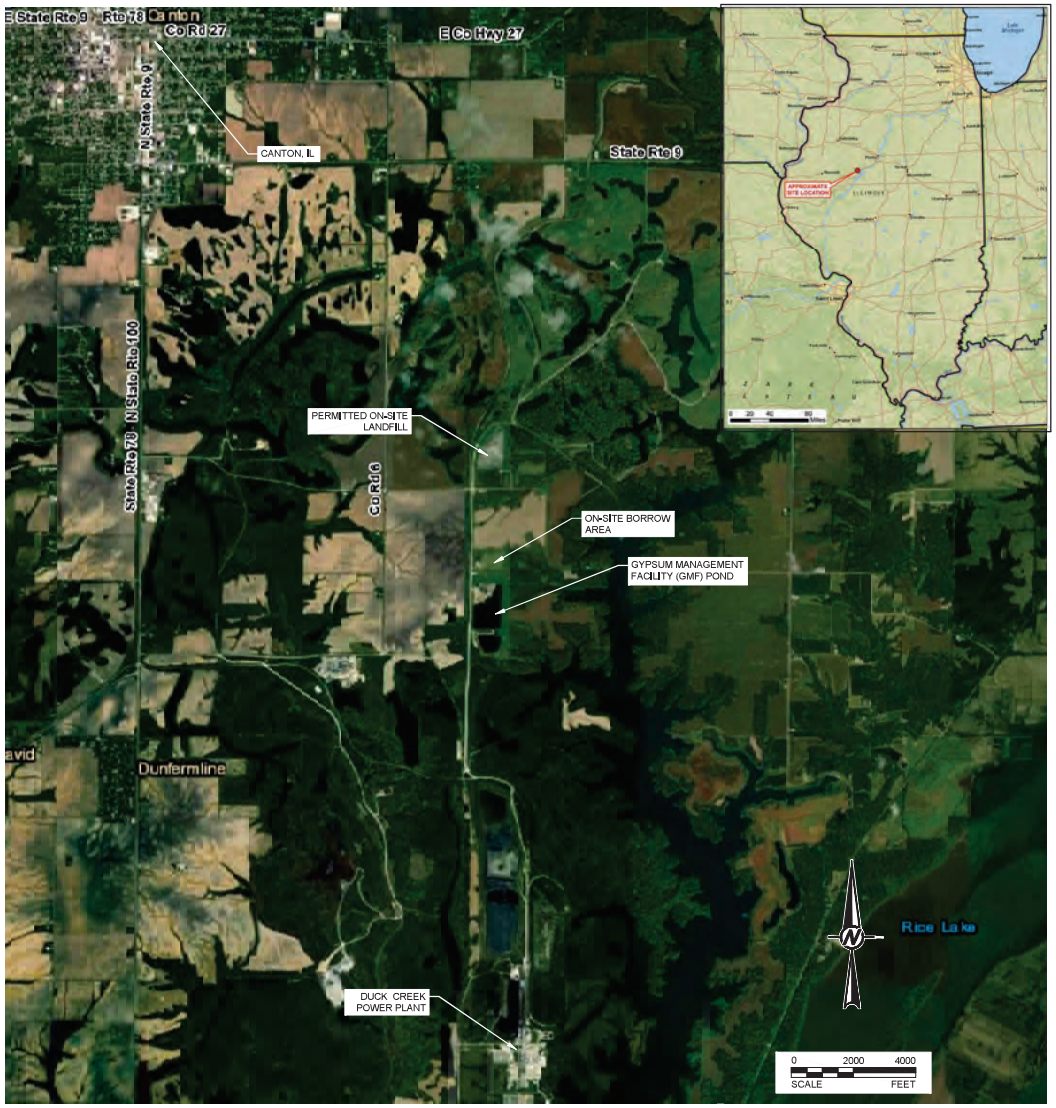

ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
GYPSUM MANAGEMENT FACILITY POND
CLOSURE-BY-REMOVAL

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI USA 63021

DRAWING LIST		
NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	EXCAVATION PLAN	A
4	SECTIONS	A
5	DETAILS	A

NOTE(S)
1. AERIAL IMAGERY FROM ESRI-PROVIDED BASEMAP SERVICE. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.
2. INSET MAP BOUNDARIES FROM ESRI-PROVIDED FEATURE SERVICE, USA STATE BOUNDARIES, 2021
   INSET MAP BACKGROUND FROM ESRI-PROVIDED BASEMAP SERVICE. NATIONAL GEOGRAPHIC BASEMAP, 2021.

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PROJECT
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TITLE
TITLE SHEET

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		1

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LEGEND

- 600 — EXISTING GROUND ELEVATION CONTOURS (NOTE 1)
- EXISTING ROAD
- LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 2)
- WATER LEVEL LINE (NOTE 3)
- EXISTING PIPING (NOTE 3)
- EXISTING LCRS PIPING (SEE NOTE 4)
- EXISTING PWRS RING DRAIN SYSTEM (NOTE 4)

NOTES

1. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
2. LIMIT OF LINER SYSTEM ESTIMATED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES, DATED 03/05/2009.
3. WATER LEVEL LINE AND EXISTING PIPING FROM INGENAE SURVEY RECORD DRAWING DATED 3/19/2021.
4. LEACHATE COLLECTION AND REMOVAL SYSTEM (LCRS) PIPING AND PROCESS WATER RECOVERY SYSTEM (PWRS) RING DRAIN INFRASTRUCTURE LOCATIONS ARE ESTIMATED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES, DATED 03/05/2009. LCRS PIPING AND PWRS RING DRAIN MATERIALS WILL BE REMOVED AND DISPOSED.
5. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020.

0 120 240
SCALE FEET

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TITLE
EXISTING CONDITIONS

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		2

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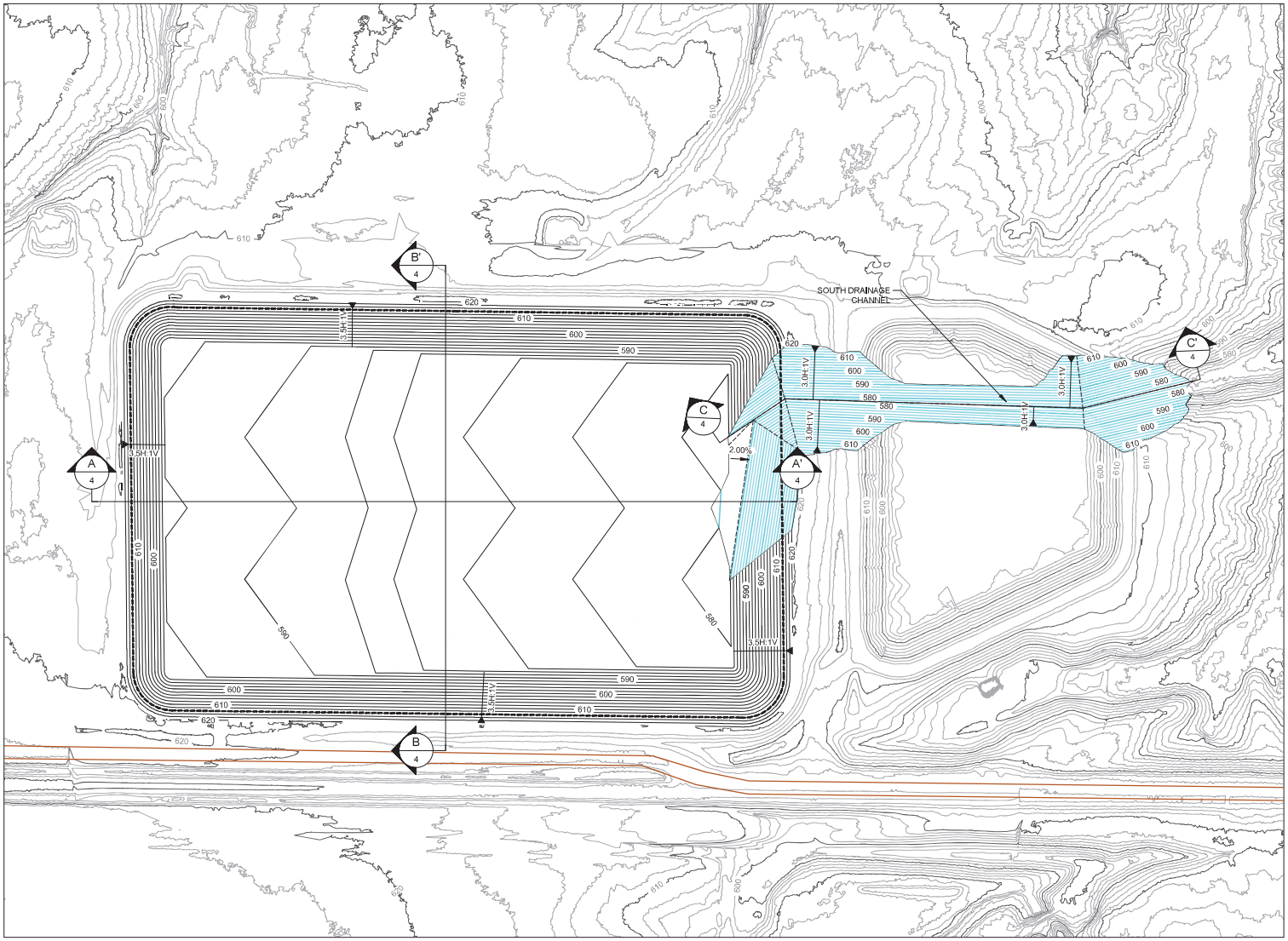

LEGEND

- 600 — BOTTOM OF EXISTING GMF POND COMPOSITE LINER SYSTEM (NOTE 1)
- 600 — EXISTING GROUND ELEVATION CONTOURS (NOTE 2)
- 600 — DRAINAGE CHANNEL GRADES
- EXISTING ROAD
- LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM SHOWN WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES. SOUTH DRAINAGE CHANNEL DESIGNED BY GOLDER.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE BY REMOVAL INCLUDES REMOVAL OF PONDED WATER, REMOVAL OF GYPSUM, AND REMOVAL OF THE EXISTING GMF POND LINER SYSTEM. GYPSUM REMOVED FROM THE GMF POND WILL BE DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL.

0 120 240
SCALE FEET

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TITLE
EXCAVATION PLAN

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		3

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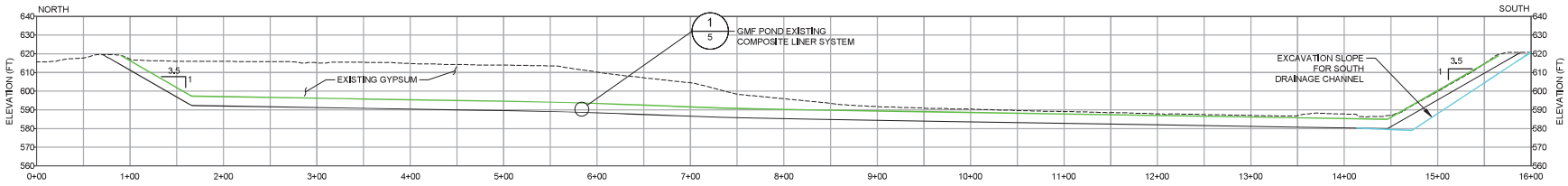

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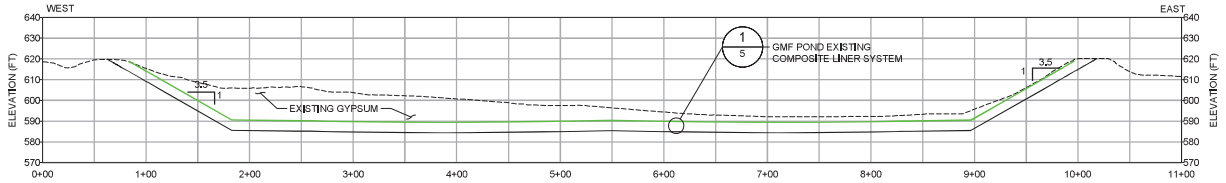
SCALE FEET



SCALE AS SHOWN
VERT. SCALE X2
B 4 SECTION B-B'
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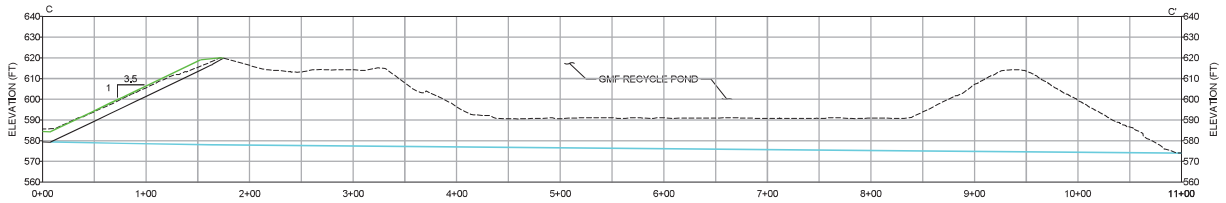

SCALE AS SHOWN
VERT. SCALE X2
C 4 SECTION C-C'
0 60 120
SCALE FEET

LEGEND

- TOP OF EXISTING GMF POND COMPOSITE LINER SYSTEM (SEE NOTE 1)
- BOTTOM OF GMF POND EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- DRAINAGE CHANNEL GRADING
- EXISTING GROUND CONTOURS (SEE NOTE 2)

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES SHOWN WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE BY REMOVAL INCLUDES REMOVAL OF PONDED WATER, REMOVAL OF GYPSUM, AND REMOVAL OF THE EXISTING GMF POND LINER SYSTEM. GYPSUM REMOVED FROM THE GMF POND WILL BE DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL.

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TITLE
SECTIONS

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		4

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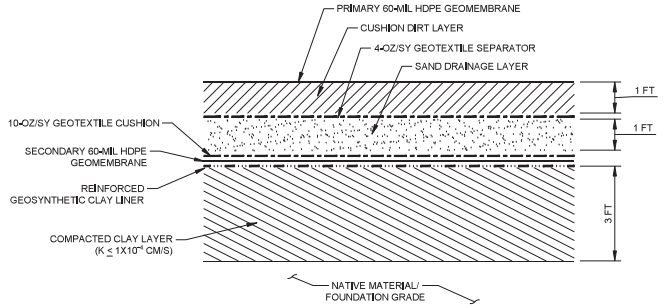

SCALE N.T.S. 1/5 GMF POND EXISTING COMPOSITE LINER SYSTEM

NOTE: ALL COMPONENTS OF THE EXISTING LINER SYSTEM WILL BE REMOVED AND DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL. UP TO AN ADDITIONAL 12 INCHES OF SOIL MAY BE EXCAVATED FROM BENEATH THE EXISTING LINER SYSTEM AND DISPOSED.

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DETAILS

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Supporting Information for Closure Alternatives Analysis – Bottom Ash Basin at Duck Creek Power Plant

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GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE January 25, 2022 **Reference No.** 21454861-12-R-0

TO Illinois Power Resources Generating, LLC

FROM Golder Associates USA Inc.

SUPPORTING INFORMATION FOR CLOSURE ALTERNATIVES ANALYSIS – BOTTOM ASH BASIN AT DUCK CREEK POWER PLANT

Golder Associates USA Inc. (Golder), a Member of WSP, has prepared this technical memorandum for Illinois Power Resources Generating, LLC (IPRG) to support the Closure Alternatives Analysis for the Bottom Ash Basin at Duck Creek Power Plant (DCPP). The Bottom Ash Basin was used to temporarily store and dewater sluiced bottom ash produced at DCPP and has not received bottom ash since the power plant was retired in 2019. The Closure Alternatives Analysis is being completed in accordance with Illinois Administrative Code Title 35, Part 845, Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (Part 845) by Gradient. With this technical memorandum, Golder summarizes the design basis and references used in developing the closure concepts evaluated by the Closure Alternatives Analysis.

1.0 BOTTOM ASH BASIN HISTORY

1.1 Existing Liner System Information

Based on construction drawings by Sargent & Lundy (2007a), the existing liner system for the facility consists of (from top to bottom):

- 8 inches of reinforced concrete
- 1 foot of compacted clay, placed in 6-inch-thick lifts to at least 95% of the standard Proctor maximum dry density
- 60-mil HDPE geomembrane
- minimum 6 inches of prepared subgrade (presumably native soils) compacted to at least 95% of the standard Proctor maximum dry density

According to the Bottom Ash and Low Volume Sump Water Basin and Piping General Work Contract Specifications (Sargent & Lundy 2007b), the liner system was subjected to a rigorous construction quality assurance (CQA) program.

According to the technical specifications for the reinforced concrete layer from Sargent & Lundy (2007b), the concrete appears to have used a conventional mix design (28-day compressive strength of 4,000 pounds per square inch, water-to-cement ratio of 0.5 or less).

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The technical specifications for composite-lined ponds from Sargent & Lundy (2007b) required a hydraulic conductivity of 1 x 10^{-6} centimeters per second (cm/s) or less for the compacted clay.

According to the technical specifications for geomembrane liner from Sargent & Lundy (2007b), the geomembrane was specified to conform to GRI GM 13, which is a common HDPE geomembrane product for waste containment. According to the technical specifications (Sargent & Lundy 2007b), the CQA program for the liner system included destructive and non-destructive testing of geomembrane seams.

Based on borehole logs from the area of the Bottom Ash Basin (Hanson 2006), native soils at the subgrade elevations (roughly El. 568 to 580 feet) generally consist of clayey silt with trace sand (ML under the Unified Soil Classification System). The hydraulic conductivity of these soils at the degree of compaction required by the technical specifications ranged from 6.0 x 10^{-7} to 2.4 x 10^{-5} cm/s, with a geometric mean of 6.1 x 10^{-6} cm/s, in permeability testing reported by Hanson (2006).

1.2 Operational History

The Bottom Ash Basin is an incised CCR surface impoundment with reinforced concrete slopes and floor. It was used to manage sluiced bottom ash at DCPP from the time construction of the Bottom Ash Basin was completed in 2009 until the power plant was retired in December 2019. During operation, bottom ash was hydraulically conveyed (sluiced) from the power plant in 10-inch-diameter basalt-lined piping and deposited at the Bottom Ash Basin in one of the two western cells, known as Primary Pond 1 and Primary Pond 2. Coarse bottom ash particles settled by gravity in the cell where they were deposited, and the sluice water was decanted via 12-inch-diameter corrugated high-density polyethylene (HDPE) piping into the eastern cell, known as the Secondary Pond. Further gravity settling occurred in the Secondary Pond before the clarified water was decanted via 12-inch-diameter corrugated HDPE piping into the Discharge Canal, which flows into Duck Creek Reservoir, with discharge at a permitted outfall in accordance with the site's National Pollutant Elimination System (NPDES) permit. Bottom ash particles accumulated in Primary Pond 1 and Primary Pond 2, requiring periodic cleanout events. During cleanout events, mobile equipment was used to excavate bottom ash out of the cell, stage it on the concrete apron for dewatering as needed, and load it into trucks for beneficial reuse or permanent disposal at the on-site landfill. Primary Pond 1 and Primary Pond 2 could operate alternately, so that bottom ash could be deposited into one cell while the other cell was being cleaned out. When DCPP was retired, nearly all of the remaining bottom ash was removed and disposed, with no appreciable bottom ash remaining at the Bottom Ash Basin.

1.3 Type and Volume of Materials

The Bottom Ash Basin does not contain appreciable amounts of CCR. Precipitation is stored in the Bottom Ash Basin when it occurs.

2.0 CLOSURE CONCEPT INFORMATION

Although appreciable amounts of CCR are not present in the Bottom Ash Basin, two concepts have been developed regarding closure of the facility. The first option for closure of the Bottom Ash Basin is to leave the existing concrete structure and underlying liner system intact, place fill to establish positive surface water drainage, and construct a final cover system compliant with Part 845 (i.e., closure in place). The second option for the closure of the Bottom Ash Basin is to remove and dispose the existing liner system components and place fill to promote positive surface water drainage (i.e., closure by removal). Additional discussion of these concepts is presented in the following sections.

2.1 Closure in Place

Under this scenario, the liner system for the Bottom Ash Basin described in Section 1.1 is to remain in place. Because 845.740(a) requires removal of the liner system for closure by removal, Golder interprets that this concept would be subject to the requirements for closure in place (845.750), including installation of a final cover system, even though no CCR would remain in place. Fill will be brought in to reach subgrade elevations designed to promote positive drainage. The facility will then be closed as described in the following section.

2.1.1 Final Cover System Materials

For closure with CCR in place, Part 845 requires installation of a final cover system over the CCR. Based on a demonstration to be submitted to the Illinois Environmental Protection Agency for approval pursuant to Section 845.750(c)(2), an alternative final cover system is incorporated into the closure-in-place concept. The final cover system consists of (from top to bottom):

- 2-foot final protective layer—locally available soils compacted to between 80% and 95% of the standard Proctor maximum dry density for establishment of vegetation and protection of the geomembrane. Material is likely to be primarily low-plasticity silt based on review of site geotechnical information (Hanson 2006).
- Geocomposite.
- 40-mil linear low-density polyethylene (LLDPE) geomembrane.

Compacted fill, composed of locally available soils, would be placed as needed to achieve final cover subgrade. The compacted fill is anticipated to be compacted to a minimum of 95% of the standard Proctor maximum dry density to provide a firm subgrade.

2.1.2 Cover System Grades

The closure design consists of the final cover system covering the concrete-lined areas. The final cover system is sloped at a 2% grade, and then terminates at the edge of concrete. A 4H:1V slope composed of compacted fill ties the final cover system at the edge of concrete into existing ground. Cover system grades and details are provided in Figures 1 and 2.

2.1.3 Closure Construction Timeline

The closure construction will require approximately 10,750 cubic yards (cy) of import fill to reach subgrade, followed by installation of 87,500 square feet (sf) of geomembrane and geocomposite. Approximately 6,500 cy of soil fill will be installed for the final protective layer. The area is not currently ponding water, and significant dewatering is not anticipated prior to beginning closure construction. Based on these construction quantities, closure is anticipated to be completed in a single construction season, and a phased construction plan is unnecessary.

2.1.4 Stormwater Management

Stormwater runoff from the Bottom Ash Basin closure area will be managed by sheet flow off the cover system into an existing stormwater channel (Sargent & Lundy 2007a). Stormwater in this channel is routed into the existing Discharge Canal south of the Bottom Ash Basin. No new stormwater management ponds or features are planned for closure.

2.2 Closure by Removal

Under this scenario, the concrete, compacted clay, and geomembrane components of the liner system for the Bottom Ash Basin, as described in Section 1.1, will be removed as required under 845.740(a) and disposed of in the existing permitted on-site landfill located approximately 3.7 miles north of the Bottom Ash Basin. Alternatively, the materials may be disposed of at an off-site landfill approximately 33 miles away. Subsoil beneath the liner system will be excavated to a depth of up to 1 foot and disposed. Fill will be brought in to reach subgrade elevations designed to promote positive surface water drainage. The facility will then be closed as described in the following section.

2.2.1 Closure Materials

Because no appreciable amounts of bottom ash remain in the Bottom Ash Basin, once the concrete, compacted clay, geomembrane, and subsoil are removed, closure will consist of grading of the area to promote positive drainage and prevent significant ponding. The closed area will be seeded and mulched to promote long-term vegetation.

Based on a review of the soil materials available on site, the fill to reach closure grades is anticipated to consist of low-plasticity silts (Hanson 2006). To limit the potential for excessive settlement, the fill will be compacted to a minimum of 95% of the standard Proctor maximum dry density.

2.2.2 Closure Grades

Because no engineered final cover is necessary for this concept, the closure grades for the closure by removal option are lower in elevation compared to those shown for the closure in place concept. The final grades are still sloped at a 2% grade, and then terminate at the edge of concrete. A 4H:1V slope composed of compacted fill will be used to tie the final surface at the edge of concrete into existing ground. The plan grades and details for this concept are provided in Figures 3 and 4.

2.2.3 Closure Construction Timeline

The closure construction will require removal of approximately 1,950 cy of concrete, 1,600 cy of compacted clay, 3,200 cy of subsoil, and 1 acre of geomembrane. Approximately 17,500 cy of fill will be required to reach closure grades. No final cover system is needed for this closure scenario. The area is not currently ponding water, and significant dewatering is not anticipated prior to beginning closure construction. Based on these construction quantities, the closure is anticipated to be completed in a single construction season, and a phased construction plan was deemed unnecessary.

2.2.4 Stormwater Management

Stormwater runoff from the Bottom Ash Basin closure area will be managed by sheet flow off the final surface into an existing stormwater channel (Sargent & Lundy 2007a). Stormwater in this channel is routed into the existing Discharge Canal south of the Bottom Ash Basin. No new stormwater management ponds or features are planned for closure.

3.0 ADDITIONAL INFORMATION

Gradient provided a request for additional information to support the Closure Alternatives Analysis. The additional information compiled by Golder in response to the request is provided in Tables 1 through 4. Table 1 provides narrative responses for information requests based largely on Part 845 requirements for the Closure Alternatives Analysis. Table 2 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-in-place approach. Table 3 summarizes conceptual-

level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in the existing permitted on-site landfill, which has ample remaining capacity to accept these materials. Table 4 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in an off-site landfill.

In accordance with Part 845, the cost estimates meet the criteria for a Class 4 estimate under the AACE classification standard (feasibility-level, -30% to +50% expected accuracy range). Cost estimates are presented in 2022 United States dollars. cost estimates for many of the cost components, whereby a labor and heavy equipment spread was assigned to the activity. That is, the number and classification (e.g., operator, laborer) of personnel carrying out the activity and the number and type of heavy equipment pieces (e.g., dozer, loader, haul truck) was estimated based on our experience with similar construction operations. This information, combined with an estimate of production rate (e.g., number of cubic yards placed per day), yields a unit cost for the operation (e.g., cost per cubic yard placed). Golder developed production rates based on equipment capabilities (e.g., haul truck capacity, estimated load and unload times, estimates of average speed) and checked them against experience from similar projects. The hourly heavy equipment rates used in the cost estimates were from an internal database of heavy equipment ownership and operating costs by type and size (capacity) of equipment. The internal database reflects the estimated cost associated with owned heavy equipment in the central United States. The hourly labor rates used in the cost estimates were from an internal database of typical labor rates from similar projects in the north-central United States. Unit prices for some cost components (e.g., furnishing and installation of geosynthetics, seeding, and mulching) were estimated based on typical unit prices from similar recent projects. Material quantities correspond with the closure approaches shown in Exhibits 1 and 2 and were developed primarily in Autodesk Civil3D. At a conceptual level of cost estimating, project costs other than direct construction costs (e.g., mobilization and demobilization, miscellaneous construction items not captured elsewhere) were estimated as a proportion of the direct construction cost. Experience on similar projects was used as the basis for the proportions applied.

4.0 REFERENCES

Hanson (Hanson Professional Services Inc.). 2006. Geotechnical Investigation Results. Bottom Ash Basin. Duck Creek Power Station. February.

Sargent & Lundy. 2007a. Bottom Ash and Low Volume Sump Water Basin and Piping Drawings, Issued for Construction. Duck Creek Power Station. September.

Sargent & Lundy. 2007b. Bottom Ash and Low Volume Sump Water Basin and Piping Construction Specifications. Duck Creek Power Station. September.

Attachments: Attachment 1: Exhibits 1 and 2
- Exhibit 1: Closure-in-Place Figures
- Exhibit 2: Closure-by-Removal Figures

Attachment 2: Tables
- Table 1: Information Summary
- Table 2: Closure Estimates – Closure in Place
- Table 3: Closure Estimates – Closure by Removal with On-Site Disposal
- Table 4: Closure Estimates – Closure by Removal with Off-Site Disposal

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Tables

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Table 1: Information Summary

Background/Current Site Conditions	
Surface area of impoundment	2.2 acres total (includes all three cells and the concrete area around the cells). 0.9 acres maximum wetted area.
Volume of CCR in impoundment	No appreciable amount (CCR has already been removed and disposed).
Published or draft engineering evaluations undertaken at the site to date	
Conceptual site models	None.
Regional well (receptor) survey information	None.
History of construction report	See [1]
Dike stability report	Stability analysis was not completed for the CCR Rule (volume is less than 20 acre-feet and height is less than 20 feet), according to AECOM [2]. Based on site observations, there is no risk associated with dike stability.
Hydraulic evaluation of basins (evaluation of possibility of overtopping and/or emergency spillway releases during flood conditions)	Hydraulic and hydrologic analyses performed by AECOM [3] found that the Bottom Ash Basin adequately manages outflow during the 25-year IDF, as overtopping of the BAB is not expected.
Surface impoundment hazard assessment/hazard category determination	Hazard category determination not completed for the CCR Rule (not required for incised CCR surface impoundments).
Habitat survey	Not available.
Wetlands survey	Not available. Based on visual observation, wetlands do not appear to be present in the area to be disturbed for closure construction.

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Table 1: Information Summary

Closure Design and Implementation	
Copy of draft of closure report, if available	Provided.
Engineering spreadsheet containing breakdown of labor, equipment/vehicle, and material requirements for each closure alternative, if available (expected on-site and off-site vehicle and equipment mileages, labor hours, etc.)	See Tables 2 through 4.
Overview of planned activities under each closure alternative	Closure by removal: Under this scenario, approximately 1950 cy of concrete, 1600 cy of compacted clay, and 1 acre of geomembrane that make up the BAB liner system, along with 3200 cy of overexcavated subsoil, will be removed and disposed in the on-site landfill or in an off-site landfill. Approximately 17500 cy of low-plasticity silts available on site will be used as fill to reach reclamation grades, and it will be compacted to at least 95% of the standard Proctor maximum dry density to prevent excessive settlement. The site will be graded to promote positive drainage and prevent significant ponding (2% grade to the edge of concrete, 4H:1V from edge of concrete to existing ground), and it will be seeded to promote long-term vegetation.
	Closure in place: Under this scenario, the concrete, compacted clay, and geomembrane that make up the BAB liner system will remain in place. Approximately 10750 cy of low-plasticity silt available on site will be used as fill to reach reclamation grades, and it will be compacted to at least 95% of the standard Proctor maximum dry density to prevent excessive settlement. The final cover system will be composed of (from top to bottom): 2 feet of locally available low-plasticity silt, compacted to between 80% and 95% of the standard Proctor maximum dry density; a drainage layer of approximately 87500 sq ft of geocomposite; and approximately 87500 sq ft of 40-mil LLDPE geomembrane. To promote drainage and prevent excessive ponding, the cover system will be sloped at a 2% grade to the edge of concrete, and compacted fill with a 4H:1V slope will extend from the edge of concrete to the existing grades. It will be seeded to promote long-term vegetation.
Expected duration of major construction activities under each closure activity	Closure by removal: 12 weeks.
	Closure in place: 6 weeks.
If an on-site landfill will be constructed on the site under a given closure alternative, please include the years required to construct and later close the on-site landfill	Not applicable. The existing permitted on-site landfill has sufficient capacity to accept waste generated from closure by removal without expansion of the existing landfill or construction of a new on-site landfill.
If an on-site landfill must first be constructed on the site, please estimate the anticipated delay in the commencement of excavation activities while the landfill is being sited, designed, and constructed; indicate whether dewatering/unwatering of the ponds will begin immediately, or after the landfill is constructed	Not applicable.
Proposed location of the on-site landfill if on-site disposal is being considered for CBR scenario	The existing on-site landfill is approximately 3.7 miles north of the Bottom Ash Basin via site roads.

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Table 1: Information Summary

Closure Design and Implementation	
Surface area of the on-site landfill, if a new landfill must be constructed at the site	Not applicable.
Name and location of proposed off-site landfill	If an off-site landfill were to be used, the Peoria City-County Landfill is the nearest suitable facility (33 miles away). An alternate off-site landfill is the Envirofill of IL Landfill.
Location of borrow area, if a borrow area will be established (for either the impoundment or construction/closure of an on-site landfill); if location is unknown, please estimate a likely distance to the borrow area	The anticipated on-site borrow source location is approximately 3.4 miles north of the Bottom Ash Basin via site roads.
Estimated volume of soil to be hauled from the borrow area under each closure alternative	Closure by removal: 18,000 cy.
	Closure in place: 17,000 cy.
Difficulty associated with implementation of each closure alternative (e.g., do any alternatives pose particular engineering/implementation challenges?)	No major challenges are anticipated for any closure alternative.
Availability of necessary equipment and specialists for each closure alternative	Good availability of equipment and services is anticipated for all closure alternatives.
Available capacity and location of needed treatment, storage, and disposal services for each closure alternative	The distance to the nearest off-site landfill (approximately 33 miles) presents a significant challenge for the option that involves off-site disposal.
Estimated cost of each closure alternative	Closure by removal: $480,000 (on-site disposal); $1,360,000 (off-site disposal).
	Closure in place: $500,000.

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Table 1: Information Summary

Post-Closure Plan/Long-Term Management Plan	
Planned duration of post-closure care activities	Closure by removal: An owner or operator of a CCR surface impoundment that elects to close a CCR surface impoundment by removing CCR as provided in Section 845.740 must continue groundwater monitoring for three years after the completion of closure or until concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
	Closure in place: The owner or operator of the CCR surface impoundment must conduct post-closure care for 30 years. The owner or operator must continue to conduct post-closure care beyond the 30-year post-closure care period until groundwater monitoring data shows the concentrations are (a) below groundwater protection standards given in Section 845.600 of Part 845 or (b) not increasing for those constiuents over background using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
Expected frequency of groundwater and surface water monitoring during post-closure period	Closure by removal: Quarterly.
	Closure in place: Quarterly for 5 years and semi-annually thereafter.
Summary of planned maintenance activities post-closure	Closure by removal: Groundwater monitoring will be conducted.
	Closure in place: Groundwater monitoring will be conducted. Site inspections will be conducted on a quarterly basis for a minimum of 5 years after closure. An annual site inspection will be performed until settlement has ceased and there are no eroded or scoured areas or until the end of the 30-year post-closure care period. Over these 30 years, repair and maintenance, including soil filling and reseeding, will be performed if ponding is observed, cracks greater than 1 inch wide or gullies 6 inches or deeper have formed, vegetative or vector problems arise, or leachate seeps are present. Areas susceptible to erosion will be recontoured and reseeded. Eroded and scoured drainage channels will be repaired and the liner material replaced if necessary. Vegetation will be mowed annually. Areas of failed or eroded vegetation in excess of 100 square feet will be revegetated. Minor repairs to ensure the integrity and proper function of fencing, surface water drainage features, monitoring points, and groundwater monitoring wells may be required.
Summary of planned post-closure care activities at the on-site landfill, if a new on-site landfill is going to be constructed	Not applicable.

Corrective Measures Assessment	
Corrective measures being considered post-closure	None anticipated.
Overview of planned activities for each corrective measure	None anticipated.

References

1) Golder (2021). History of Construction for the Bottom Ash Basin, Duck Creek Power Plant.

2) AECOM (2016). CCR Rule Report: Initial Structural Stability Assessment for Bottom Ash Basin at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

3) AECOM (2016). CCR Rule Report: Initial Inflow Design Flood Control System Plan for Bottom Ash Basin at Duck Creek Power Station. Available online:

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Table 2: Closure Estimates - Closure in Place

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 34,950	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 20,000	$ 20,000	1 surveyor		
Borrow Area Preparation and Reclamation	LS	1	$ 15,000	$ 15,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Pipe Removal/Abandonment	LS	1	$ 10,000	$ 10,000	1 equipment operator, 4 laborers	Excavator	
Embankment Fill	CY	10,750	$ 9.30	$ 99,975	8 equipment operators	Excavator, dozer, compactor, water truck, 4 haul trucks	372 (3.4 miles one way)
Geomembrane	SF	87,500	$ 0.75	$ 65,625	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance technician	Telehandler	
Geocomposite	SF	87,500	$ 0.75	$ 65,625			
Final Protective Soil Layer	CY	6,500	$ 8.20	$ 53,300	7 equipment operators	Excavator, dozer, water truck, 4 haul trucks	225 (3.4 miles one way)
Fertilize, Seed, and Mulch	AC	3	$ 5,000	$ 15,000	2 equipment operators	Seed drill or hydroseeder	
Erosion Control	LS	1	$ 5,000	$ 5,000	1 equipment operator, 2 laborers	Excavator	
Construction Quality Assurance	LS	1	$ 75,000	$ 75,000	1 technician		
Miscellaneous Construction	LS	1	10%	$ 38,450	Miscellaneous	Miscellaneous	
			Total	**$ 497,925**			

Notes:

Miscellaneous Costruction includes other work not captured in the items shown.

Soil components were assumed to be taken from the stockpile north of the GMF (3.4-mile haul).

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Table 3: Closure Estimates - Closure by Removal with On-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 37,530	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 10,000	$ 10,000	1 surveyor		
Borrow Area Preparation and Reclamation	LS	1	$ 15,000	$ 15,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Pipe Removal/Abandonment	LS	1	$ 10,000	$ 10,000	1 equipment operator, 4 laborers	Excavator	
Concrete Demolition and Disposal	CY	1,950	$ 57	$ 111,150	5 equipment operators, 4 laborers	2 breakers, dozer, loader, haul truck	67 (3.7 miles one way)
Geomembrane Removal and Disposal	AC	1	$ 8,000	$ 8,000	3 equipment operators, 4 laborers	Dozer, loader, haul truck	4 (3.7 miles one way)
Liner Soil Removal and Disposal	CY	1,600	$ 8.00	$ 12,800	6 equipment operators	Excavator, dozer, 4 haul trucks	55 (3.7 miles one way)
Subsoil Overexcavation and Disposal	CY	3,200	$ 8.00	$ 25,600	6 equipment operators	Excavator, dozer, 4 haul trucks	111 (3.7 miles one way)
Embankment Fill	CY	17,500	$ 9.30	$ 162,750	8 equipment operators	Excavator, dozer, compactor, water truck, 4 haul trucks	606 (3.4 miles one way)
Fertilize, Seed, and Mulch	AC	3	$ 5,000	$ 15,000	2 equipment operators	Seed drill or hydroseeder	
Erosion Control	LS	1	$ 5,000	$ 5,000	1 equipment operator, 2 laborers	Excavator	
Construction Quality Assurance	LS	1	$ 25,000	$ 25,000	1 technician		
Miscellaneous Construction	LS	1	10%	$ 41,280	Miscellaneous	Miscellaneous	
			Total	**$ 479,110**			

Notes:
Miscellaneous Construction includes other work not captured in the items shown.
Soil components were assumed to be taken from the stockpile north of the GMF (3.4-mile haul).
Disposal was assumed to occur in the on-site landfill (3.7-mile haul).

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Table 4: Closure Estimates - Closure by Removal with Off-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 110,440	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 10,000	$ 10,000	1 surveyor		
Borrow Area Preparation and Reclamation	LS	1	$ 15,000	$ 15,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Pipe Removal/Abandonment	LS	1	$ 10,000	$ 10,000	1 equipment operator, 4 laborers	Excavator	
On-Site Concrete Demolition	CY	1,950	$ 182	$ 354,900	4 equipment operators, 4 laborers	2 breakers, dozer, loader	
Off-Site Concrete Hauling and Disposal					Equipment operator	On-highway truck	140 (32.6 miles one way)
On-Site Geomembrane Removal	AC	1	$ 8,500	$ 8,500	2 equipment operators, 4 laborers	Dozer, loader	
Off-Site Geomembrane Hauling and Disposal					Equipment operator	On-highway truck	6 (32.6 miles one way)
On-Site Liner Soil Removal	CY	1,600	$ 109	$ 174,400	2 equipment operators	Excavator, dozer	
Off-Site Liner Soil Hauling and Disposal					4 equipment operators	4 on-highway trucks	114 (32.6 miles one way)
On-Site Subsoil Overexcavation	CY	3,200	$ 109	$ 348,800	2 equipment operators	Excavator, dozer	
Off-Site Subsoil Hauling and Disposal					4 equipment operators	4 on-highway trucks	229 (32.6 miles one way)
Embankment Fill	CY	17,500	$ 9.30	$ 162,750	8 equipment operators	Excavator, dozer, compactor, water truck, 4 haul trucks	606 (3.4 miles one way)
Fertilize, Seed, and Mulch	AC	3	$ 5,000	$ 15,000	2 equipment operators	Seed drill or hydroseeder	
Erosion Control	LS	1	$ 5,000	$ 5,000	1 equipment operator, 2 laborers	Excavator	
Construction Quality Assurance	LS	1	$ 25,000	$ 25,000	1 technician		
Miscellaneous Construction	LS	1	10%	$ 121,480	Miscellaneous	Miscellaneous	
			Total	**$ 1,361,270**			

Notes:
Miscellaneous Construction includes other work not captured in the items shown.
Soil components were assumed to be taken from the stockpile north of the GMF (3.4-mile haul).
Disposal was assumed to occur in an off-site landfill (32.6-mile haul).

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EXHIBIT 1

Closure-in-Place Figures

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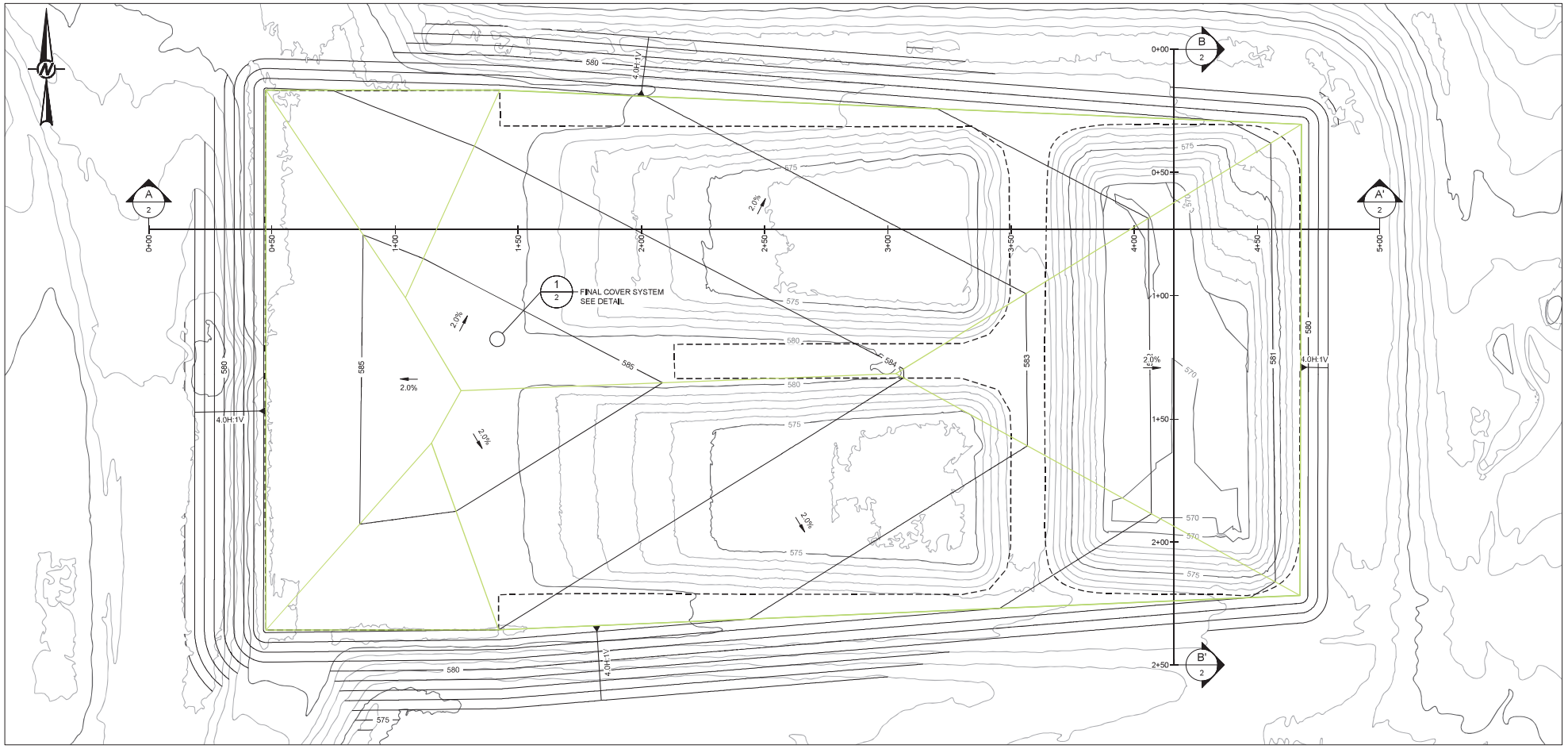

LEGEND

- 600 — PROPOSED CLOSURE GRADES
- 600 — EXISTING GROUND CONTOURS (SEE NOTE 1)
- EDGE OF CONCRETE (SEE NOTE 3)
- GRADING BREAKLINE

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020 AND TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE LOCATED DURING THIS SURVEY.
2. ELEVATIONS ARE IN NAVD 88.
3. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021.

0 20 40
SCALE FEET

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-05
DESIGNED	JEO
PREPARED	KAC
REVIEWED	JJS
APPROVED	JEO

PROJECT
BOTTOM ASH BASIN
CLOSURE ALTERNATIVES ANALYSIS

TITLE
CLOSURE IN PLACE
CONCEPTUAL DESIGN PLAN

PROJECT NO.	REV.	FIGURE
21454861	A	1

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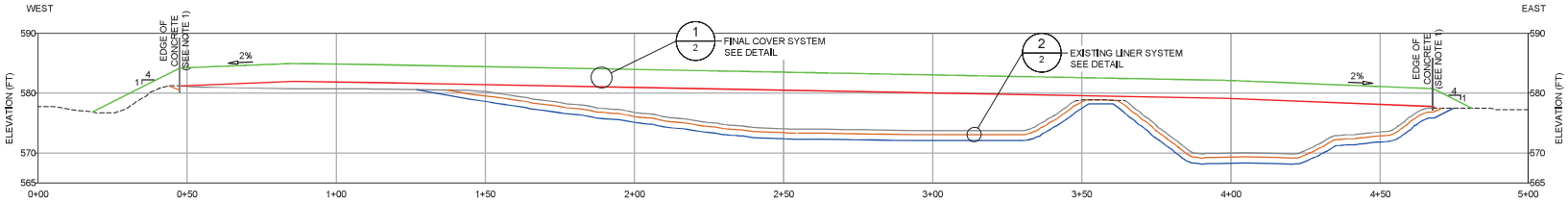

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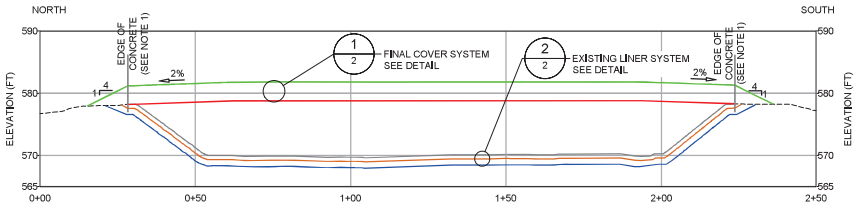
A/2 CROSS SECTION A

0 20 40
SCALE FEET



SCALE AS SHOWN
VERT. SCALE = 2X

B/2 CROSS SECTION B

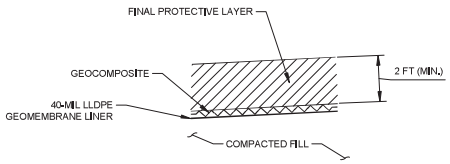
0 20 40
SCALE FEET

CROSS SECTION LEGEND

- PROPOSED TOP OF FINAL COVER SYSTEM
- PROPOSED TOP OF COMPACTED FILL
- EXISTING GROUND
- EXISTING LINER SYSTEM - TOP OF CONCRETE
- EXISTING LINER SYSTEM - TOP OF COMPACTED CLAY
- EXISTING LINER SYSTEM - GEOMEMBRANE

NOTE(S)

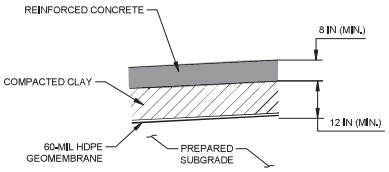
1. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021.



SCALE N.T.S. 1/2 FINAL COVER SYSTEM

NOTE(S)

FINAL PROTECTIVE LAYER WILL BE COMPOSED OF LOCALLY AVAILABLE SOILS COMPACTED TO BETWEEN 80% AND 95% OF THE STANDARD PROCTOR MAXIMUM DRY DENSITY FOR ESTABLISHMENT OF VEGETATION AND PROTECTION OF THE GEOMEMBRANE.



SCALE N.T.S. 2/2 EXISTING LINER SYSTEM

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-05
DESIGNED	JEO
PREPARED	KAC
REVIEWED	JJS
APPROVED	JEO

PROJECT
BOTTOM ASH BASIN
CLOSURE ALTERNATIVES ANALYSIS

TITLE
CLOSURE IN PLACE
SECTIONS AND DETAILS

PROJECT NO. 21454861 | REV. A | FIGURE 2

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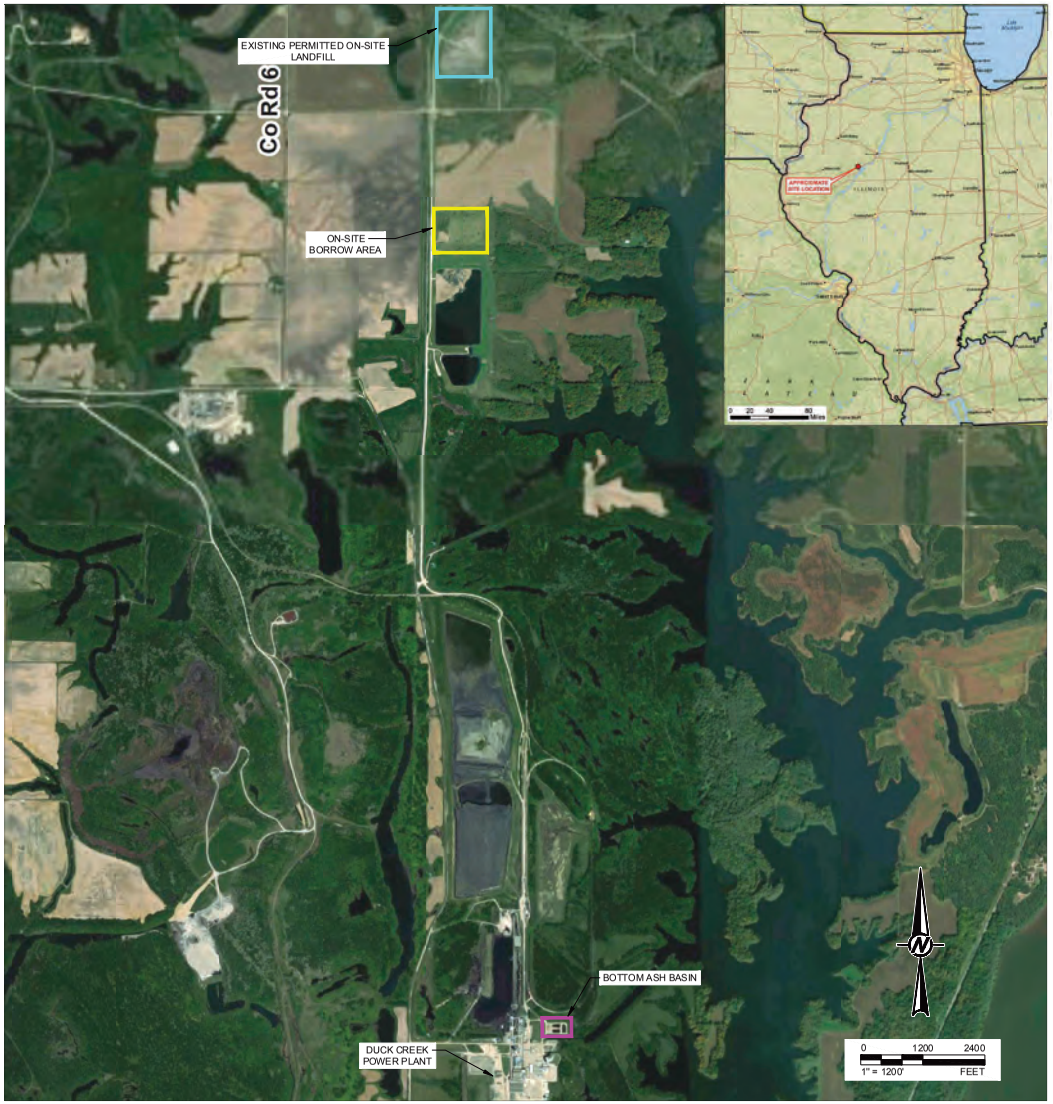
EXHIBIT 2

Closure-by-Removal Figures



ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021

PERMIT APPLICATION DRAWING LIST		
NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	EXCAVATION GRADES	A
4	FINAL GRADES	A
5	SECTIONS AND DETAILS	A

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM ESRI PROVIDED BASEMAP SURVEY. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
TITLE SHEET

PROJECT NO.	REV.	DRAWING
21454861	A	1

Electronic Filing: Received, Clerk's Office 06/20/2024

R002949

Path: \\golder.gds\corp\lakewood\staff\ks\Denver\acad\VISTRA\Duck Creek\99_PROJECTS\21454861\Bottom Ash\02_PRODUCTION\DWG\ | File Name: 1-TITLE SHEET.dwg | Last Edited By: jobermeyer Date: 2021-11-04 Time: 1:01:05 PM | Printed By: JObermeyer Date: 2022-01-25 Time: 4:03:12 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
0 1 in



LEGEND

- 580 — EXISTING GROUND CONTOURS (SEE NOTE 1)
- EDGE OF EXISTING CONCRETE (SEE NOTE 3)
- LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER
- EXISTING STORMWATER CHANNEL (SEE NOTE 4)
- EXISTING CULVERT (SEE NOTE 4)

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021.
4. LOCATIONS OF STORMWATER CHANNELS AND LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
5. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, IN COMBINATION WITH TOPOGRAPHIC SURVEY (NOTE 1).

0 30 60
1" = 30' FEET

Electronic Filing: Received, Clerk's Office 06/20/2024

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

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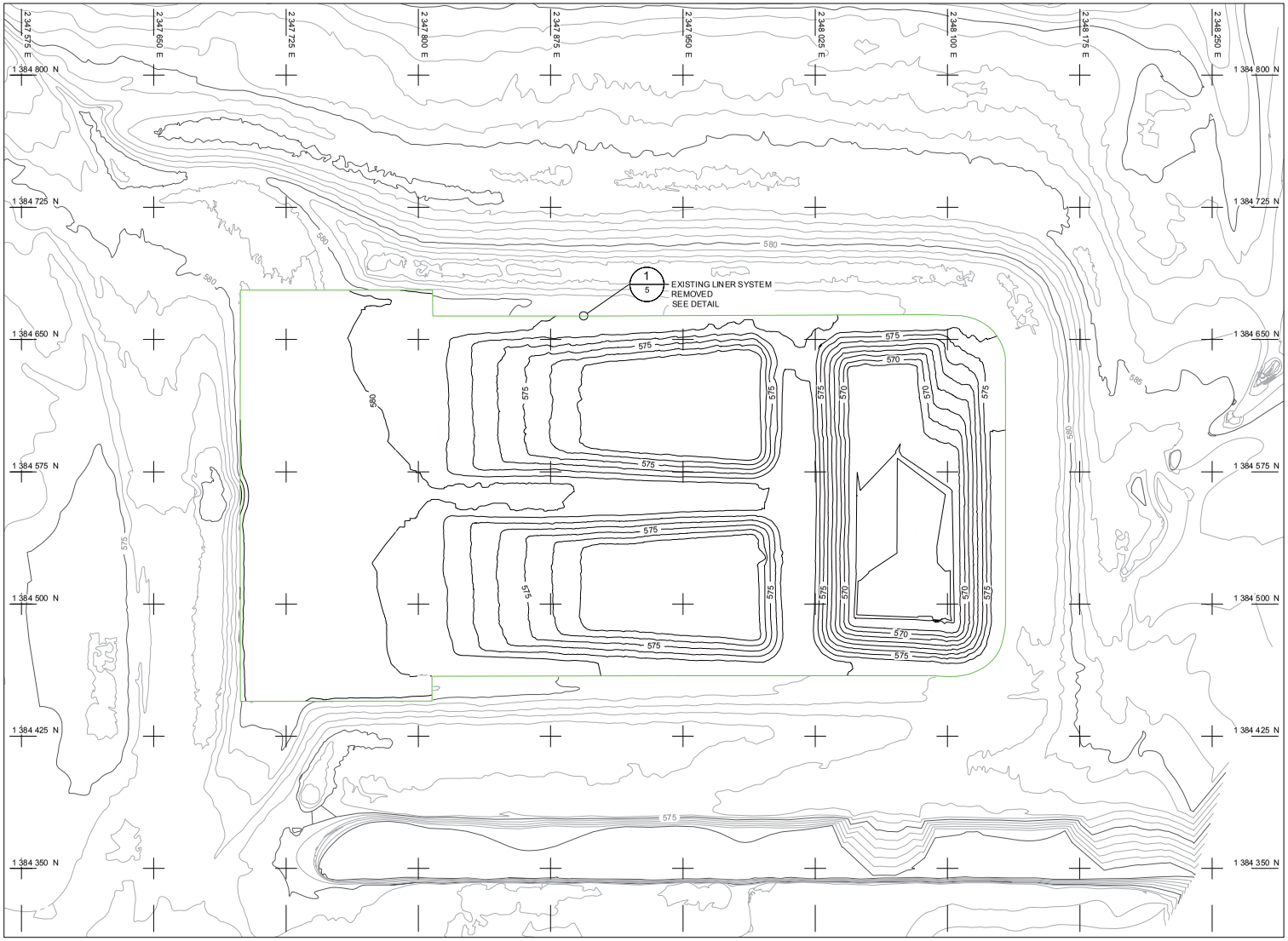
PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
EXISTING CONDITIONS

PROJECT NO. 21454861 | REV. A | DRAWING 2

R002950

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



LEGEND

- 580 — EXISTING GROUND CONTOURS (SEE NOTE 1)
- 575 — EXCAVATION CONTOURS (SEE NOTE 3)
- EXTENTS OF EXCAVATION

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. EXCAVATION GRADES ARE SHOWN AS A 20-INCH OFFSET BELOW THE EXISTING GRADES TO ACCOUNT FOR THE REMOVAL OF THE LINER SYSTEM.

0 30 60
1" = 30' FEET

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REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

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ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

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PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
EXCAVATION GRADES

PROJECT NO.	REV.	of	DRAWING
21454861	A		3

R002951

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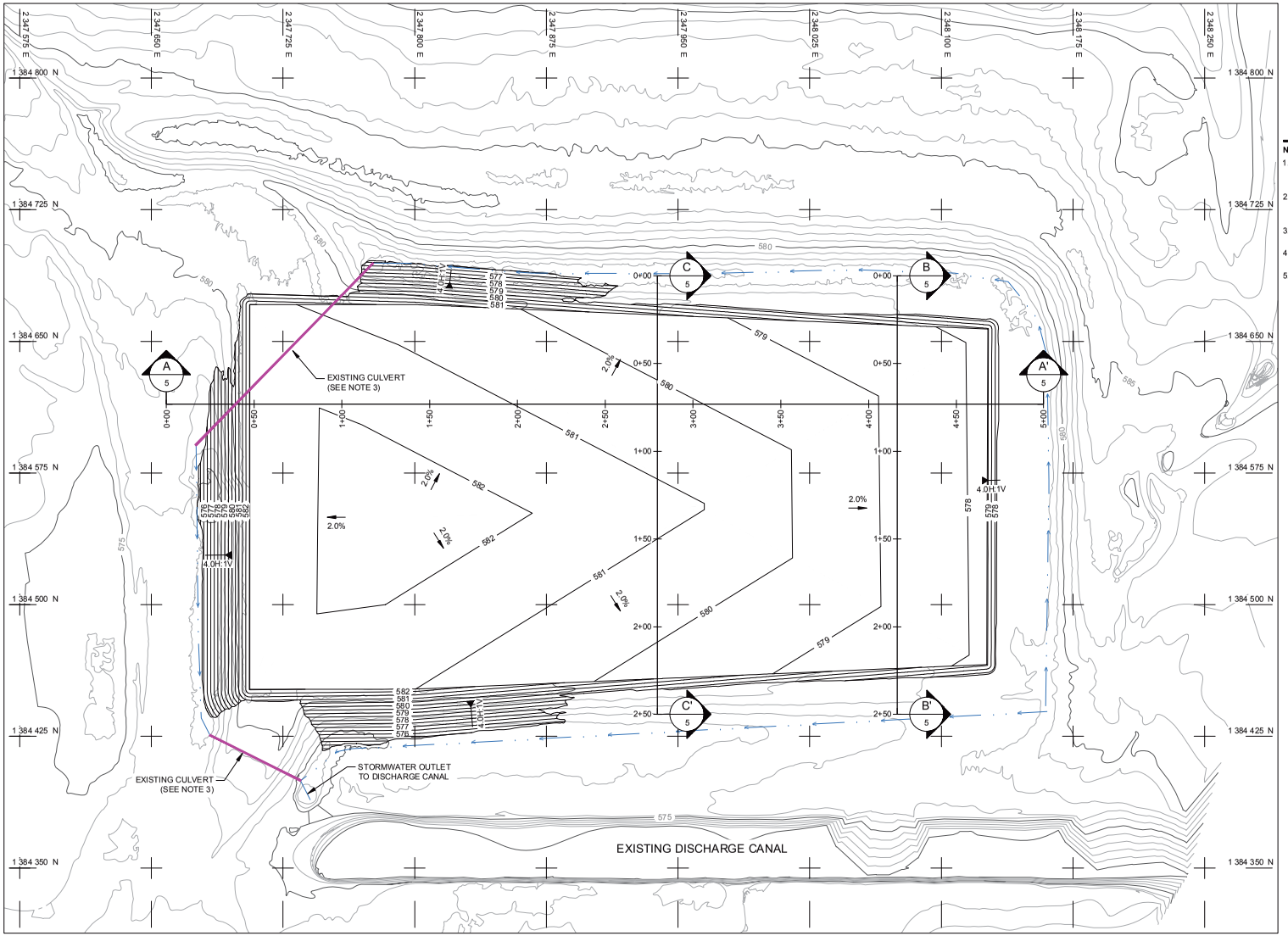

LEGEND

- 580 — PROPOSED TOP OF COMPACTED FILL ELEVATION CONTOURS
- 580 — EXISTING GROUND CONTOURS (SEE NOTE 1)
- EXISTING STORMWATER CHANNEL (SEE NOTE 3)
- EXISTING CULVERT (SEE NOTE 3)

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. LOCATIONS OF STORMWATER CHANNELS BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
4. COMPACTED FILL TO BE PLACED TO A MINIMUM OF 95 PERCENT OF STANDARD PROCTOR MAXIMUM DRY DENSITY TO LIMIT POTENTIAL FOR EXCESSIVE SETTLEMENT.
5. UPON COMPLETION OF COMPACTED FILL CONSTRUCTION, DISTURBED AREAS SHALL BE SEEDED AND MULCHED TO PROMOTE VEGETATIVE GROWTH AND LIMIT POTENTIAL FOR FUTURE EROSION.

0 30 60
1" = 30' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
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PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
FINAL GRADES

PROJECT NO. 21454861 | REV. A | DRAWING 4

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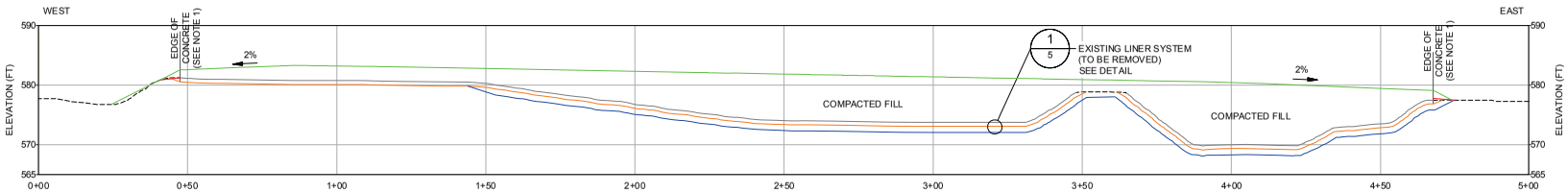
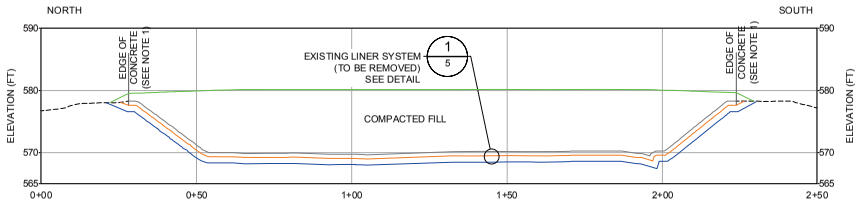
R002952

Electronic Filing: Received, Clerk's Office 06/20/2024



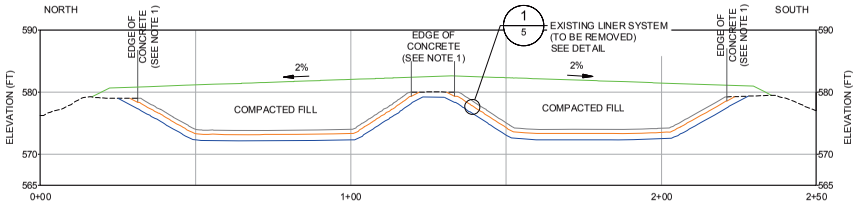
SCALE 1" = 20' VERT. SCALE = 2X — A/4 CROSS SECTION A

0 20 40 1" = 20' FEET



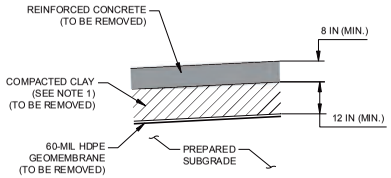
SCALE 1" = 20' VERT. SCALE = 2X — B/4 CROSS SECTION B

0 20 40 1" = 20' FEET



SCALE 1" = 20' VERT. SCALE = 2X — C/4 CROSS SECTION C

0 20 40 1" = 20' FEET



SCALE N.T.S. — 1/5 EXISTING LINER SYSTEM

CROSS SECTION LEGEND

- PROPOSED TOP OF COMPACTED FILL
- EXISTING GROUND
- EXISTING LINER SYSTEM - TOP OF CONCRETE (SEE NOTES 1 AND 2)
- EXISTING LINER SYSTEM - TOP OF COMPACTED CLAY (SEE NOTES 1 AND 2)
- EXISTING LINER SYSTEM - GEOMEMBRANE (SEE NOTES 1 AND 2)

NOTE(S)

1. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021. LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
2. CONCRETE, COMPACTED CLAY, AND GEOMEMBRANE COMPONENTS OF THE BOTTOM ASH BASIN LINER SYSTEM TO BE REMOVED AND DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL.
3. UP TO AN ADDITIONAL 12 INCHES OF SOIL MAY BE EXCAVATED FROM BENEATH THE LINER SYSTEM AND REPLACED WITH COMPACTED FILL.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER MEMBER OF WSP
GOLDER ASSOCIATES INC.
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PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
SECTIONS AND DETAILS

PROJECT NO. 21454861 — REV. A — DRAWING 5

R002953

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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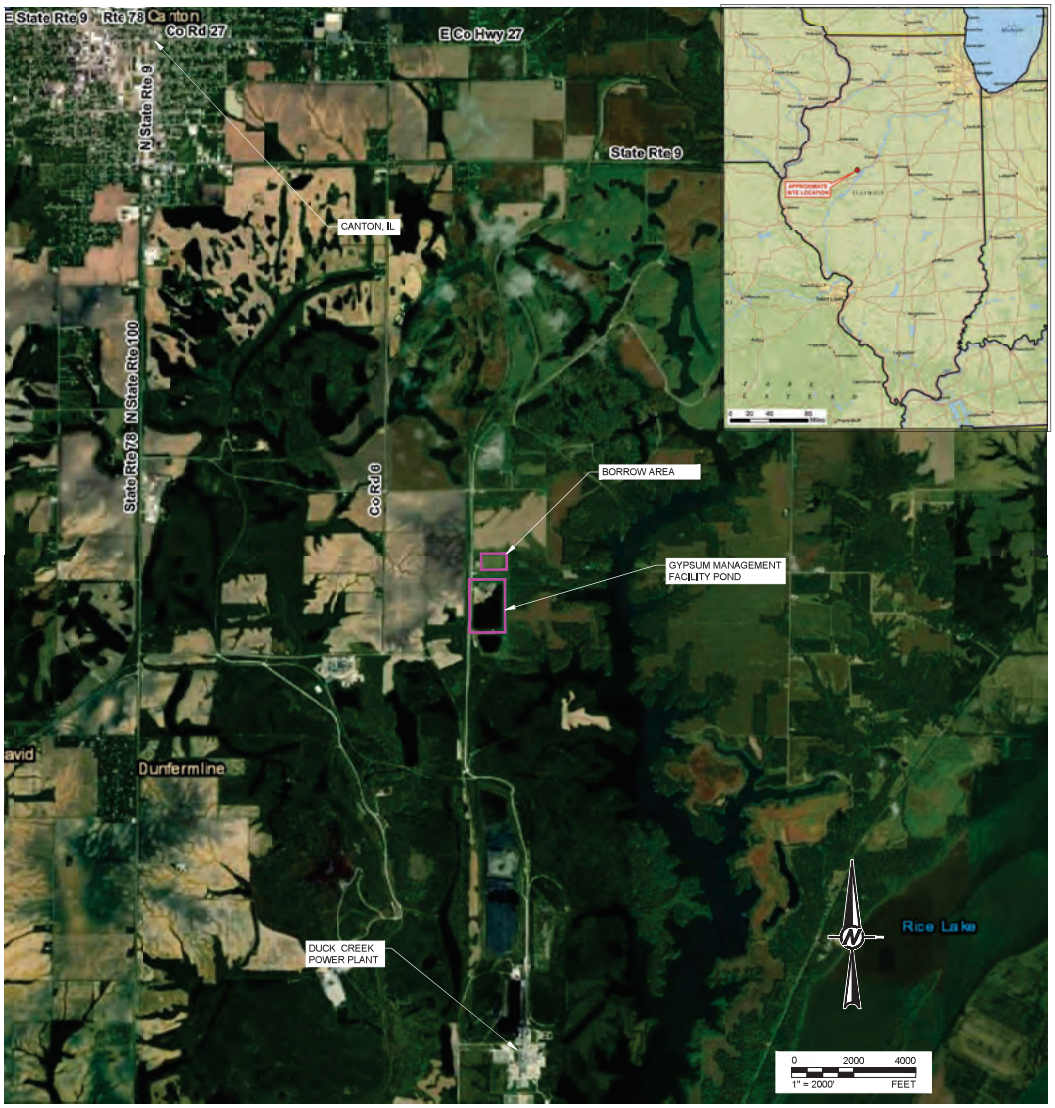
ATTACHMENT 2

Drawings

Electronic Filing: Received, Clerk's Office 06/20/2024



ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI USA 63021

PERMIT APPLICATION DRAWING LIST		
NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	GYPSUM REGRADING AND CONTAINMENT PLAN	A
4	FINAL COVER AND STORMWATER PLAN	A
5	SECTIONS	A
6	DETAILS (1 OF 2)	A
7	DETAILS (2 OF 2)	A

NOTE(S)
1. AERIAL IMAGERY FROM ESRI-PROVIDED BASEMAP SERVICE. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.
2. INSET MAP BOUNDARIES FROM ESRI-PROVIDED FEATURE SERVICE, USA STATE BOUNDARIES, 2021
3. INSET MAP BACKGROUND FROM ESRI-PROVIDED BASEMAP SERVICE. NATIONAL GEOGRAPHIC BASEMAP, 2021.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
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PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
TITLE SHEET

PROJECT NO.	REV.	1 of 7	DRAWING
21454861	A		1

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LEGEND

- 600 — EXISTING GROUND ELEVATION CONTOURS (NOTE 1)
- EXISTING ROAD
- LIMIT OF GMF POND LINER SYSTEM (NOTE 2)
- WATER LEVEL LINE (NOTE 3)
- EXISTING PIPING (NOTE 3)

NOTES

1. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
2. LIMIT OF LINER SYSTEM ESTIMATED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES, DATED 03/05/2009.
3. WATER LEVEL LINE AND EXISTING PIPING FROM INGENAE SURVEY RECORD DRAWING DATED 3/19/2021.
4. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020.

0 120 240
1" = 120' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

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DUCK CREEK POWER PLANT

CONSULTANT
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BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
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PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
EXISTING CONDITIONS

PROJECT NO.	REV.	2 of 7	DRAWING
21454861	A		2

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THIS DRAWING IS FOR DESIGN PURPOSES ONLY. IT HAS BEEN PREPARED TO CONFORM TO THE REQUIREMENTS OF A SPECIFIC PROJECT AND MAY NOT BE SUITABLE FOR USE ON ANY OTHER PROJECT. THE USE OF THIS DRAWING FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT WAS PREPARED IS AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO GOLDER. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AND SEALED FOR CONSTRUCTION. THE SIZE HAS BEEN MODIFIED FROM ANSI D
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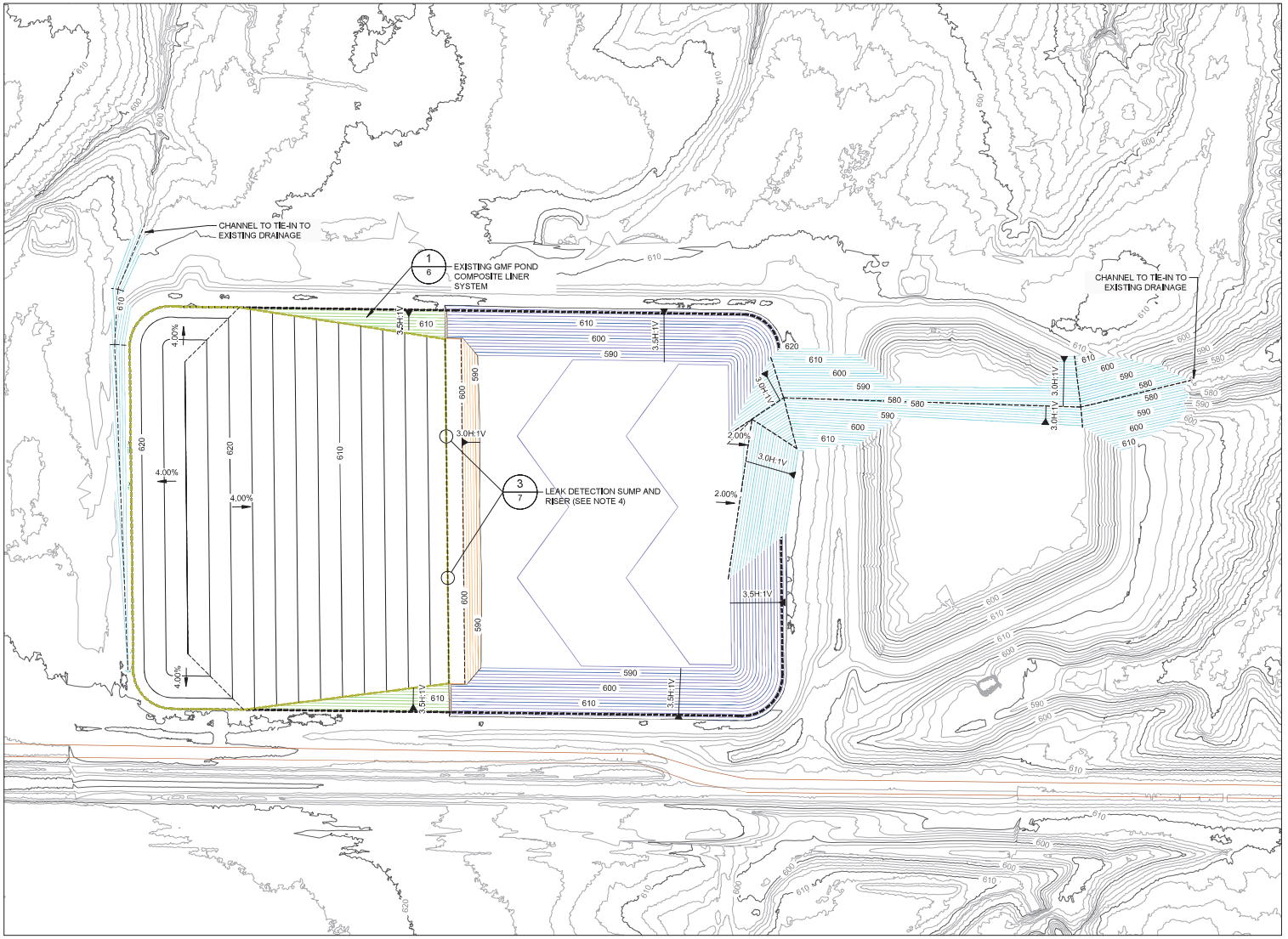

LEGEND

- 600 — TOP OF RELOCATED GYPSUM
- 600 — TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- 600 — TOP OF EXISTING CLAY LINER (SEE NOTE 1)
- 600 — DRAINAGE CHANNEL GRADES
- 600 — EARTHEN BERM GRADES
- 600 — EXISTING GROUND CONTOURS (SEE NOTE 2)
- EXISTING ROAD
- LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)
- LIMIT OF WASTE

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.
4. THE EXISTING LEAK DETECTION SYSTEM WILL BE ADAPTED TO THE CLOSURE FOOTPRINT. EXISTING LEACHATE COLLECTION PIPING WILL BE TERMINATED IN NEW SUMPS (TWO LOCATIONS WITH NEW RISERS FOR CONTINUED LEAK DETECTION CAPABILITY.

0 120 240
1" = 120' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
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DUCK CREEK POWER PLANT

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GOLDER MEMBER OF WSP
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UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
GYPSUM REGRADING AND CONTAINMENT PLAN

PROJECT NO. 21454861 | REV. A | 3 of 7 | DRAWING 3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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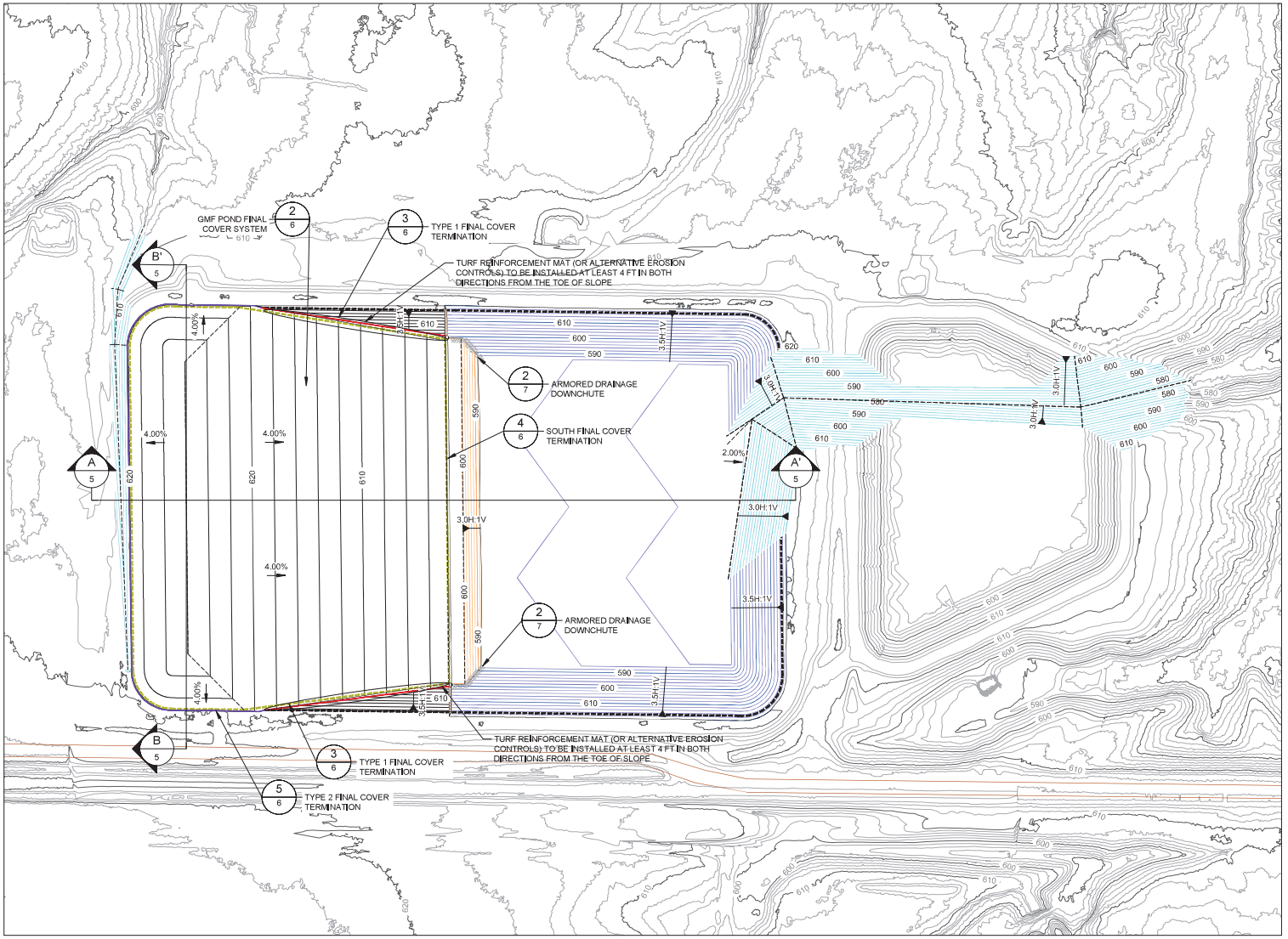

LEGEND

- TOP OF FINAL COVER SYSTEM
- TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- TOP OF EXISTING CLAY LINER (SEE NOTE 1)
- EARTHEN BERM GRADES
- EXISTING GROUND CONTOURS (SEE NOTE 2)
- EXISTING ROAD
- LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)
- LIMIT OF WASTE AT CLOSURE
- TYPE 1 FINAL COVER TERMINATION
- TYPE 2 FINAL COVER TERMINATION

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.

0 120 240
1" = 120' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

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DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP
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UNITED STATES
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www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
FINAL COVER AND STORMWATER PLAN

PROJECT NO.	REV.	4 of 7	DRAWING
21454861	A		4

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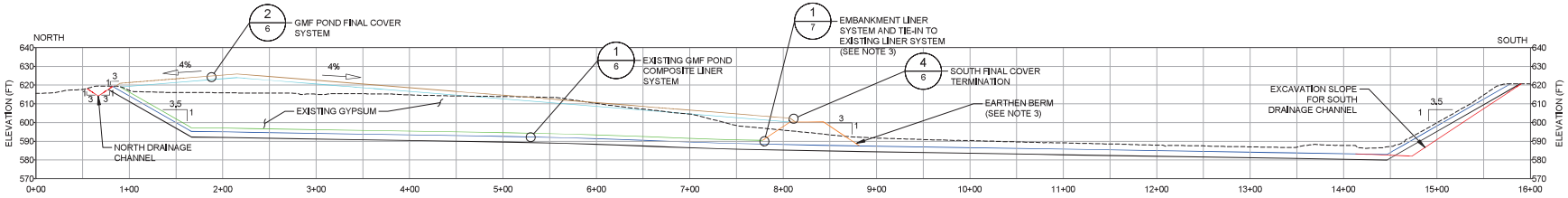
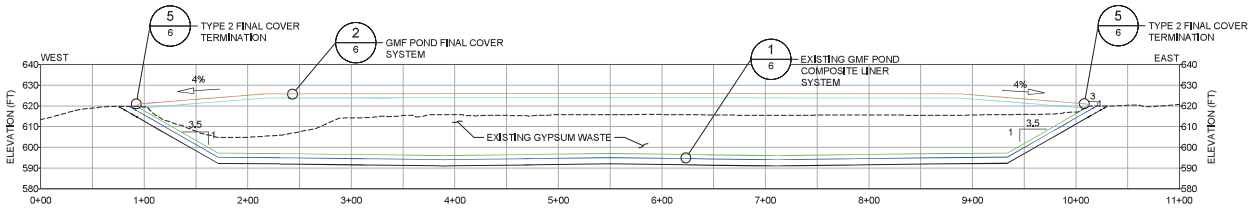


SCALE 1"=60' / VERT. SCALE X2 — A / 5 SECTION A-A'

0 60 120
1" = 60' FEET



SCALE 1" = 60' / VERT. SCALE X2 — B / 5 SECTION B-B'

0 60 120
1" = 60' FEET

LEGEND

- TOP OF FINAL COVER SYSTEM
- TOP OF RELOCATED GYPSUM
- TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- TOP OF EXISTING CLAY LINER (SEE NOTE 1)
- BOTTOM OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- EXISTING GROUND CONTOURS (SEE NOTE 2)
- EARTHEN BERM (SEE NOTE 3)
- DRAINAGE CHANNEL GRADING

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES SHOWN WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP
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BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
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PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
SECTIONS

PROJECT NO.	REV.	5 of 7	DRAWING
21454861	A		5

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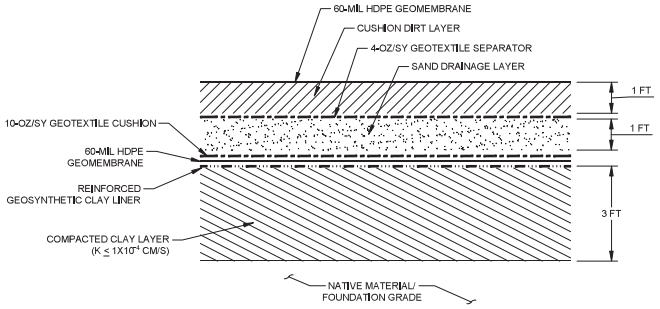
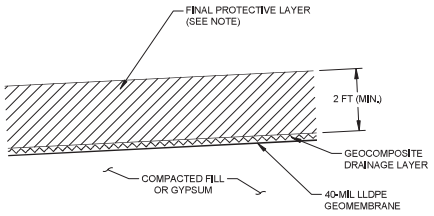


SCALE N.T.S. 1/6 EXISTING GMF POND COMPOSITE LINER SYSTEM



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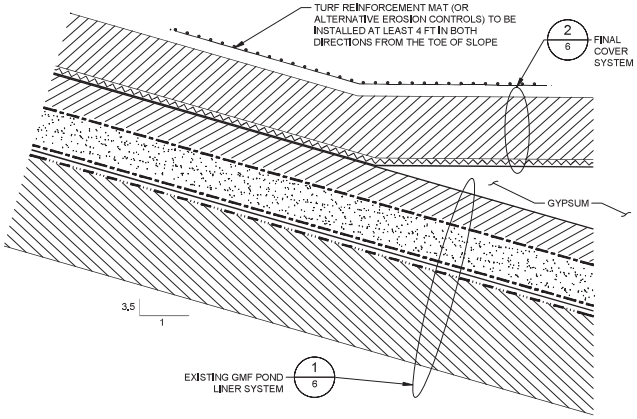

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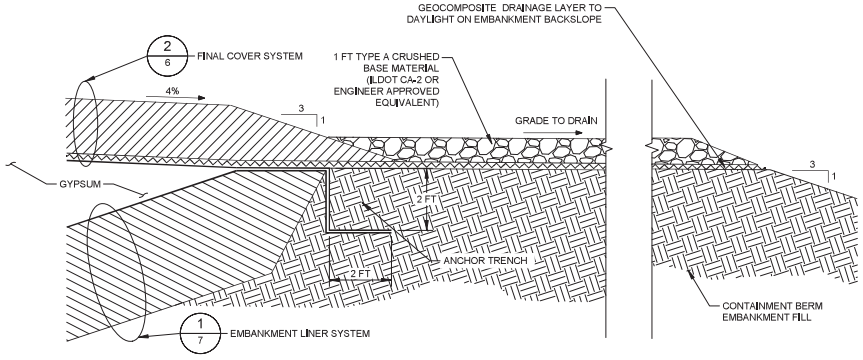

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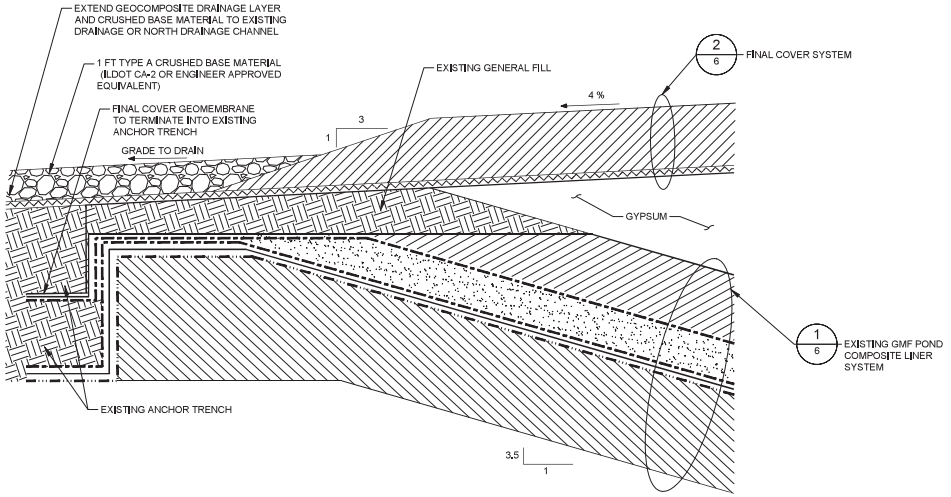

SCALE N.T.S. 5/6 TYPE 2 COVER TERMINATION

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TITLE
DETAILS (1 OF 2)

PROJECT NO.	REV.	6 of 7	DRAWING
21454861	A		6

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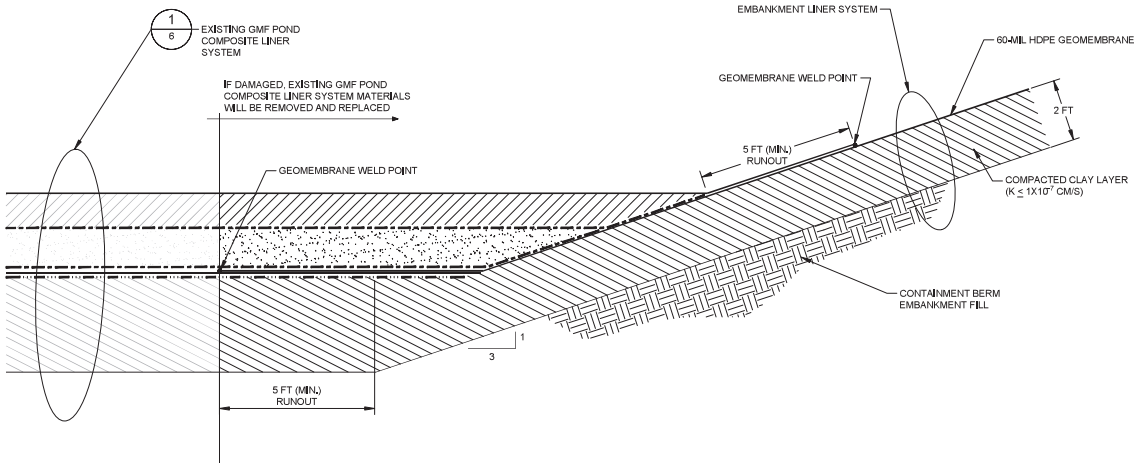
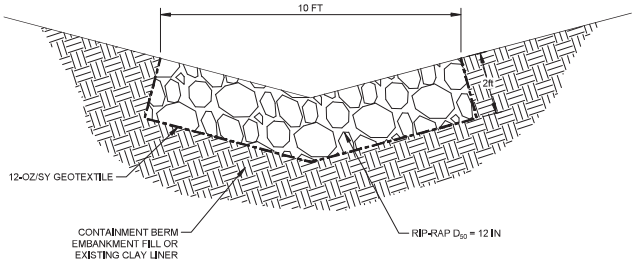


SCALE N.T.S. 1/7 EMBANKMENT LINER SYSTEM AND TIE-IN TO EXISTING COMPOSITE LINER SYSTEM



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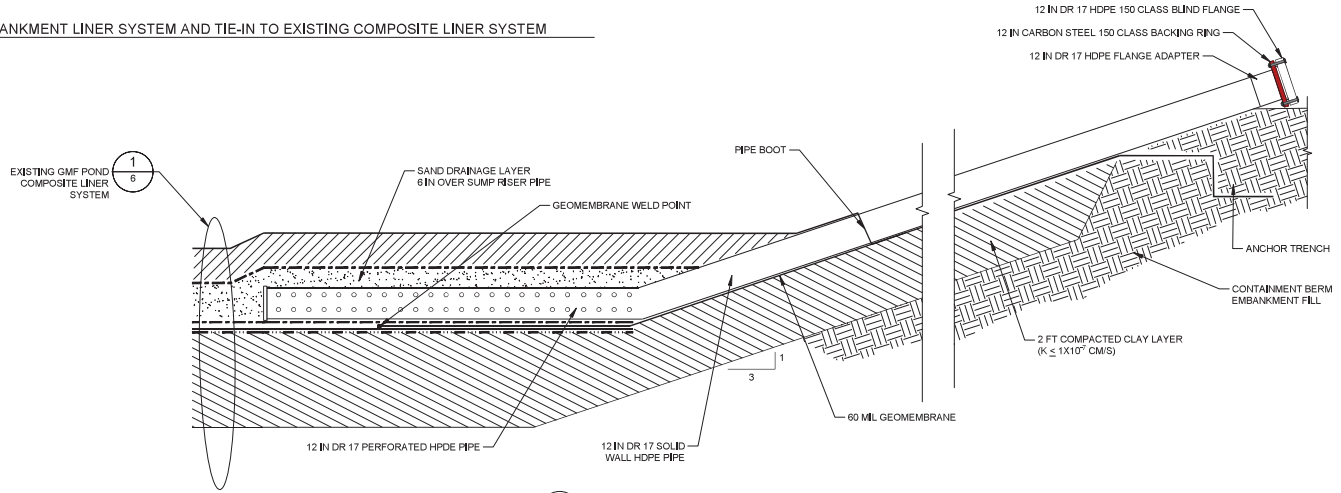

SCALE N.T.S. 3/7 LEAK DETECTION SYSTEM SUMP AND RISER

NOTE
EXISTING 6 INCH LEACHATE COLLECTION PIPE NOT SHOWN IN DETAIL.
LEACHATE COLLECTION PIPE WILL TERMINATE AND BE CAPPED AT THE TOE OF THE CONTAINMENT BERM

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PROJECT NO.	REV.	7 of 7	DRAWING
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ATTACHMENT 3

Final Protective Layer Demonstration

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Geosyntec consultants

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Technical Memorandum

Date:	January 25, 2022
To:	Victor Modeer, P.E., DGE
Copies to:	Phil Morris, Rhys Fuller
From:	John Seymour, P.E., Geosyntec Consultants (Geosyntec)
Subject:	Proposed Alternative Final Protective Layer Equivalency Demonstration Hennepin East Ash Pond and Duck Creek GMF Pond CCR Surface Impoundments Geosyntec Project: GLP8026

PROPOSAL

An alternative final protective layer is proposed by Dynegy Midwest Generation, LLC (DMG) for surface impoundments closed in place for the Hennepin Power Plant (HPP) East Ash Pond (EAP) and by Illinois Power Resources Generating, LLC (IPRG) for the Duck Creek Power Plant (DCPP) Gypsum Management Facility (GMF) Pond. The closure will be in accordance with IAC Part 845 Rule [1] (Part 845). Overall, the proposal will meet the requirements of Section 845.750 c) 2).

This Technical Memorandum presents a demonstration that a 2-foot-thick alternative final protective layer consisting of an 18-inch-thick soil layer and a 6-inch layer of topsoil provide equivalent or superior performance to the default protective layer set forth in Section 845.750 c) 2). The alternative final protective layer works in combination with an underlying low permeability (geomembrane) layer in place of the default three-foot thick, low permeability compacted earth layer. In addition, a cushion layer consisting of a geotextile (at HPP EAP) or a drainage layer consisting of a geocomposite (at DCPP GMF) are placed on top of the geomembrane prior to installation of the final protective layer. The combination of the above materials comprises the final “alternative final cover system”.

A discussion of how the closure, including the proposed alternative final cover system discussed herein, meets the performance standards is contained in the Closure Plan, which includes the Closure Alternatives Assessment required by Section 845.710.

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REQUIREMENTS OF SECTION 845

Section 845.750 provides requirements for both the final protective layer and underlying low permeability layer. They work in tandem to provide protection of groundwater and surface exposure conditions. A principal intention of the low permeability layer is to reduce the infiltration of liquid through the final cover system and into the CCR waste mass during post-closure conditions, in accordance with Section 845.720 (a), which states in part:

> *The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will*:
>
> *1) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate or contaminated run-off to the ground or surface waters or to the atmosphere;*

Specific default requirements for the final cover system are included in Section 845.750(c), which requires the final cover system to have either: 1) a three-foot thick soil low permeability compacted earth layer overlain by a three-foot-thick final protective layer (final protective layer), or 2) a geomembrane low permeability layer with a three-foot-thick final protective layer.

The specific Section 845.750 (c) (2) design requirements for the final protective layer are as follows (emphasis added):

> *Standards for the Final Protective Layer: The final protective layer must meet the following requirements,* ***unless the owner or operator demonstrates that another final protective layer construction technique or material provides equivalent or superior performance to the requirements of this subsection (c)(2)*** *and is approved by the Agency.*

Therefore, Section 845.750 (c) (2) specifically allows the use of an alternate final protective layer as long as it provides an equivalent or superior performance to the default standards set forth in Section 845.750(c)(2), which are as follows:

A) Cover the entire low permeability layer;

B) Be at least three feet thick, be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer;

C) Consist of soil material capable of supporting vegetation;

D) Be placed as soon as possible after placement of the low permeability layer; and

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E) Be covered with vegetation to minimize wind and water erosion.

The alternate design is only requesting an alternate to Section 845.740(c)(2)(B) related to the thickness of the of the final protective layer.

PROPOSED FINAL COVER SYSTEM SUMMARY

The proposed final cover systems for each site will include:

- A low permeability layer consisting of a linear low-density polyethylene (LLDPE) geomembrane that is at least 40-mil in thickness, placed on a smooth CCR subgrade.
- A geosynthetic cushion layer, such as a needle-punched, nonwoven geotextile (HPP EAP), or a geocomposite drainage layer (DCPP GMF), on top of the geomembrane.
    - The geocomposite drainage layer is comprised of a high-density polyethylene (HDPE) geonet covered with a geotextile filter fabric (typically a needle-punched, non-woven geotextile fabric)
- A final protective layer consisting of 18 inches of protective cover soil with a 6-inch layer of topsoil capable of supporting vegetation.

The final protective layer will meet all Section 845.750(c)(2) criteria, will not need any supplemental engineering measures, and will be designed by a qualified professional engineer licensed in Illinois.

The concepts of the alternative cover system are illustrated on **Figure 1**.

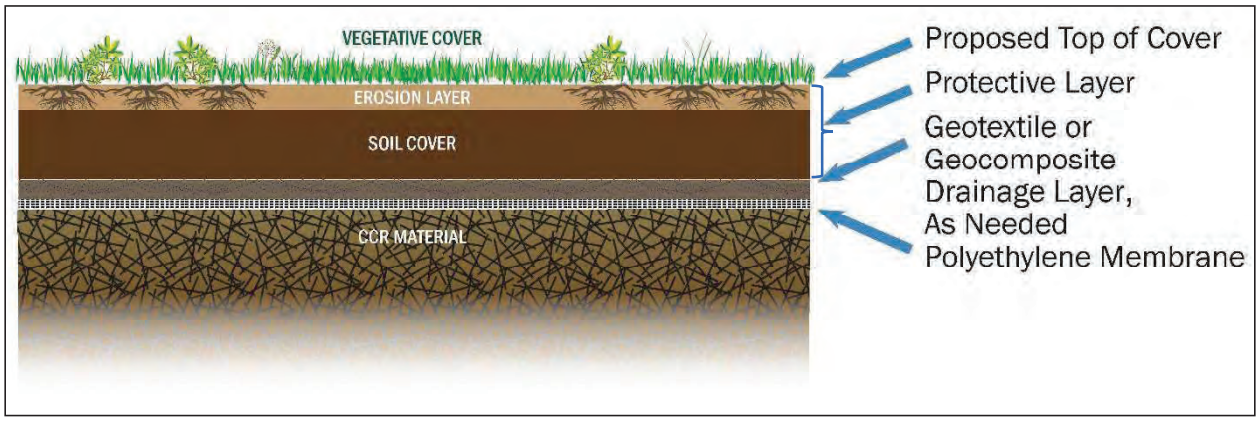

Figure 1: Proposed Alternative Final Cover System

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DEMONSTRATION

The proposed alternate final protective layer will address the five requirements of Section 845.750 (c)(2)(A) to (E), as described in this section.

Section 845.750(c)(2)(A) Cover the entire low permeability layer

The final protective layer will horizontally cover the entire low-permeability layer, as indicated in the following drawings for each CCR surface impoundment:

- Duck Creek GMF Pond: Closure-in place drawings 4, 5, and 6 within Attachment 2 to the Closure Plan [2].
- Hennepin East Ash Pond: Drawings C-101, C-102, and C-103 within Attachment C to the Closure Plan [3].

Therefore, the use of the two-foot-thick final protective layer will meet the minimum requirements of Section 845 750(c)(2)(A) because it will completely cover the low-permeability layer.

Section 845.750(c)(2)(B) Be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer

The existing Part 845, which has the same requirements as Part 814 (closure rule for landfills), requires a three-foot-thick final protective layer to protect the underlying low permeability layer from freeze-thaw effects and root penetration. However, when a geomembrane is used as the low permeability layer it does not need these protections since it is not subject to the same impacts (i.e., increase in hydraulic conductivity) as a compacted earth layer as discussed in more detail below.

Geomembrane low permeability layers will be used for both the HPP EAP and the DCPP GMF Pond. They have the following characteristics:

- Geomembranes do not have pores that can contain water and are therefore not susceptible to freeze-thaw damage that may reduce their performance as a low permeability layer and/or lead to degradation of the geomembrane.
    - In fact, geomembrane panel strength and stiffness both increase with decreasing temperatures ([4], [5]). In 1996, the United States Bureau of Reclamation [6] (USBR) performed testing of both geomembrane panels and seams subjected to up to 500 freeze-thaw cycles, in both constrained and unconstrained conditions, with temperature cycles as severe as +30º C to -20º C.

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  - The testing showed no changes in the strength of the geomembrane panels or seams. The USBR concluded that *"...there is simply "no change" in tensile behavior of geomembrane sheets or their seams after freeze-thaw cycling"*.
  - In 2013, the Geosynthetic Institute, upon reviewing the results of the USBR and other studies, concluded that *"the essential question often raised in this regard, i.e., "will freeze-thaw conditions affect geomembrane sheets or their seam behavior," is answered with a resounding "NO""* [7].

- Geomembranes are not susceptible to grass plant root penetration because the geomembranes do not provide organic nutrients to plant roots and do not have pores or other areas where roots can enter the geomembrane.
  - Consequently, geomembranes are not a hospitable material that would either encourage root penetration or allow root penetration. Additionally, the geomembrane will be covered with a geotextile cushion or geocomposite drainage layer, which will provide an additional barrier to root penetration.

U.S. EPA research [8] states that "…a typical minimum thickness of the cover soil is 0.45 to 0.6 m…" (18 to 24 inches) thick "… for cover systems with hydraulic barriers" (low permeability layer). This is particularly appropriate when using a geomembrane low permeability which is not susceptible to any impact from freezing. U.S. EPA research also states that cover thickness design for root penetration into the low permeability layer is only a concern for compacted clay layers or geosynthetic clay barriers. This is when using an appropriate design of cover vegetation.

Therefore, the use of the two-foot-thick final protective layer will provide equivalent or superior performance to the requirements of Section 845.750 (c) (2) (B) when coupled with a geotextile cushion or geocomposite drainage layer, and a geomembrane low permeability layer, as geomembranes are not susceptible to freeze-thaw damage or root penetration as compared to a low permeability compacted earth layer.

Section 845.750(c)(2)(C) Consist of soil material capable of supporting vegetation.

The uppermost six inches of the final protective layer will consist of topsoil that is capable of supporting vegetation, which is the same requirement as the default (three-foot thick) final protective layer. This is also consistent with the Federal CCR Rule, which requires a six-inch-thick erosion (topsoil) layer. Research [8] and Geosyntec's experience indicate topsoil layers are designed to have shallow-rooted grasses and most shallow-rooted grasses do not typically penetrate more than six inches into the subsurface. Shallow-rooted grasses will be specified based

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on recommendations from specialists at nurseries in the location of HPP and DCPP and Illinois Department of Transportation guidelines. The topsoil layer will be fertilized and/or amended, as necessary, on a site-specific basis based on agronomical soil testing, to provide a growing medium for the vegetation that provides the required levels of nutrients and water storage during drought conditions.

Grass species will also be selected on a site-specific basis to minimize long-term vegetation maintenance, based on the climatic conditions at each site and the soil types. Vegetation will be established by applying seed and mulch and watering to establish the vegetation. Temporary erosion control measures will also be used during vegetation establishment to protect the topsoil layer from erosion. These measures may include erosion control blankets (ECBs), silt fences, hydroseeding, and/or other methods. The Post-Closure Care Plan includes the commitment to maintain the vegetation of the surface for the closed DCPP GMF Pond in the Construction Permit Application, Attachment J [2] and the HPP EAP in the Construction Permit Application Attachment J [3].

The 18-inches of the protective layer below the topsoil will consist of a soil type suitable for retaining moisture to provide additional support for vegetation during times of drought, and to support any grass species with roots that exceed six inches. Such soil types may include silts, silty clays, lean clays, sandy clays, and/or sandy silts. A silty granular layer will be used at HPP EAP and a silty clay layer will be used at DCPP GMF.

Therefore, the use of the two-foot-thick protective layer will meet the requirements of Section 845.750(c)(2)(C), as the final protective layer will utilize soil capable of supporting vegetation.

Section 845.750(c)(2)(D) Be placed as soon as possible after placement of the low permeability layer

The HPP EAP Closure Plan (Section 4.7.2 [3]) states that the geotextile and cover soil "…will be placed as soon as practical after the geomembrane has been deployed and both quality assurance and quality control testing has been performed on the geomembrane seams." The DCPP GMF Closure Plan (Section 4.7.2 [2]) states the protective layer will be placed "…as soon as possible after placement of the low-permeability layer and will be covered with vegetation to limit wind and water erosion."

The use of a two-foot-thick protective layer will allow the final protective layer to be placed on top of the low permeability layer and vegetation to be established on top of the final protective

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layer sooner than if a three-foot thick final protective layer is used. This is due to the 33% reduction in earthwork volumes associated with the thinner 2-ft-thick final protective layer.

Therefore, the use of the two-foot-thick final protective layer will exceed the minimum requirements of Section 845.750(c)(2)(D), by allowing the protective layer to be installed sooner than when using a three-foot-thick protective layer.

Section 845.750(c)(2)(E) Be covered with vegetation to minimize wind and water erosion.

Vegetation will be established to cover the final protective layer immediately after the protective layer is installed, as noted in the discussion regarding Section 845.750(c)(2)(C). Additionally, the following design and engineering features, construction techniques, and maintenance procedures will be used to reduce the potential for wind and water erosion under both long-term conditions and during vegetation establishment.

- Design and Engineering Features
    - Final cover system slopes will be installed at relatively flat grades (e.g., typically 2.5 to 4%, with steeper slopes used only in limited areas). The use of flat grades will reduce water runoff velocities and therefore reduce the potential for water erosion of the final cover soils.
    - The geotextile cushion and geocomposite drainage layer provide cushioning and help to facilitate lateral drainage of infiltration off the geomembrane, thereby reducing the amount of water available for infiltration through the geomembrane. This layer is not required by Section 845.750 but it enhances the final cover system performance.
    - A stormwater management system consisting of channels and letdown structures is included in each Construction Permit Application and will be designed to collect stormwater in a controlled manner and route it off the final cover system which will minimize infiltration into the CCR waste mass. The stormwater management system will minimize the overland flow distance between stormwater channels. Channels will be lined with an appropriate material, based on estimated stormwater velocities, to limit water erosion.
- Construction Techniques
    - The final protective layer is typically the most susceptible to wind and water erosion in the period between the placement of the protective layer and the establishment of vegetation. To reduce the potential for both wind and water

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erosion during this time, the following approaches will be utilized:

- Temporary erosion and sediment controls (ESCs) will be installed to reduce the potential for erosion, such as erosion control blankets (ECBs), silt socks, silt fences, and other methods. These ECSs will be regularly inspected and maintained until vegetation is established.
- The entire surface of the final protective layer will be stabilized during seeding and until vegetation is established. Coverings may consist of straw mulch, hydroseeding binder, ECBs, or engineering growing media.
- The final protective layer will be regularly inspected and maintained during vegetation establishment. Any areas that become eroded by wind and water will be repaired until vegetation is established to a suitable level over the surface of the final cover.

- Maintenance Procedures
  - During the post-closure care period, vegetation established on the final protective cover layer will be regularly maintained using a written and IEPA-approved maintenance program. The program will consist of regular mowing and inspections. Any bare areas or areas of erosion will be repaired by seeding and stabilizing the area, and observing the area until vegetation becomes re-established.
  - The final cover slopes will be relatively flat (<5%); these slopes experience less erosion in general, especially less than typical landfill covers sloped at 25 to 33%. Typically, after three to five years, it is Geosyntec's experience that the cover vegetation becomes fully stabilized and experiences less erosion.

Therefore, the use of the two-foot-thick final protective layer will exceed the minimum requirements of Section 845 750 c) 2) E), using a robust program to support the establishment of protective vegetation, prevent and address any erosion that may occur during vegetation establishment, and monitor and maintain the vegetation during post-closure conditions.

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ADDITIONAL CONSIDERATIONS

Infiltration Analysis

The use of the proposed two-foot-thick final protective layer, when coupled with a geomembrane low permeability layer, will also meet the criteria contained within Section 845.750 (a) (1). Section 845.750 (a) (1) provides the following requirement:

> *Section 845.750(a)(1) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;*

Section 845.750(a)(1) is an important overall measure of the effectiveness of the final cover system because it requires control of post-closure infiltration of liquids through the final cover and into the waste and releases of CCR.

An infiltration analysis was performed to estimate post-closure liquid infiltration rates through both the default and the proposed alternate final cover systems. The following infiltration analysis discussion is provided for the proposed closure at the HPP EAP and DC GMF.

The cover systems for both the EAP and GMF have the same final cover system thickness configuration[1]. An infiltration analysis was performed by Ramboll in the HPP EAP Construction Permit Application [3] and in the DCPP GMF Construction Permit Application [2] using the Hydrologic Evaluation of Landfill Performance (HELP) software promulgated by the USEPA [9]. The HELP model estimates the infiltration rates from the top of the cover, through the final protective layer and through the low permeability layer (either a geomembrane or the three-foot thick compacted earth layer). The results are included in **Appendix A**. The resulting estimated infiltration rates are provided in **Table 1** for HPP EAP and in **Table 2** for DCPP GMF.

[1] The EAP has a 40 mil LLDPE with an overlying geotextile cushion, 18-inches of silty granular soil, and 6-inches of topsoil. The GMF has a 40 mil LLDPE with an overlying geocomposite drainage layer, 18-inches of silty clay soil, and 6-inches of topsoil.

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Table 1 – HPP Final Cover Systems for Infiltration Analysis

Description	Low Permeability Layer[2]	Final Protective Layer	Infiltration Rate[3]
Proposed Alternative Final Cover System	40-mil Linear Low-Density Polyethylene (LLDPE) Geomembrane	2 ft of cover material, including, from bottom to top, a protective geotextile cushion[4], 1.5 ft of sandy soil and 0.5 ft of silty, sandy clay topsoil	0.53 in/yr
Default Cover with Geomembrane Barrier	40-mil LLDPE Geomembrane	3 ft of cover material, including, from bottom to top, a protective geotextile cushion, 2.5 ft of silty sandy soil and 0.5 ft of silty, sandy clay topsoil	0.88 in/yr
Default Cover with Compacted Earth Layer	3-ft thick compacted earth layer (1×10^{-7} cm/sec)	3 ft of cover material, including, from bottom to top, 2.5 ft of silty sandy soil and 0.5 ft of silty, sandy clay topsoil	2.26 in/yr

The HPP analysis indicated that the proposed alternative final cover system with a geomembrane and a two-foot-thick final protective layer exceeds the performance offered by the default final cover system utilizing a geomembrane with the default three-foot-thick protective layer, with the infiltration rate reduced by a factor of 1.66.

Furthermore, the proposed alternative final cover system performance exceeds the performance of a final cover system using a three-foot-thick compacted earthen low permeability layer and a three-foot-thick final protective layer (a total cover thickness of six feet) by reducing infiltration by a factor of 4.26.

[2] All HELP run versions used a pinhole density of 1 hole per acre, installation defects of 1 hole/acre, and construction quality as "good".
[3] Infiltration is out the bottom of the low permeability layer.
[4] The geotextile cushion was not included in the HELP run as HELP does not include a default drainage value for geotextiles. If the geotextile were included, infiltration may reduce even further than indicated in Table 1, relative to the default cover.

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Table 2 – DCPP GMF Final Cover Systems for Infiltration Analysis

Description	Low Permeability Layer[5]	Protective Layer	Infiltration Rate
Proposed Alternative Final Cover System	40-mil Linear Low-Density Polyethylene (LLDPE) Geomembrane	2 ft of cover soil, including, from bottom to top, a geocomposite drainage layer[6], a 1.5 ft of silty clay soil, and 0.5 ft of silty clay topsoil	0.00025 in/yr
Default Cover with Geomembrane Barrier	40-mil LLDPE Geomembrane	3 ft of cover soil, including, from bottom to top, a geocomposite drainage layer, a 2.5 ft of silty clay soil, and 0.5 ft of silty clay topsoil	0.00026 in/yr
Default Cover with Compacted Clay Barrier	3-ft thick Clay Liner (1×10^{-7} cm/sec)	3 ft of cover soil, including, from bottom to top, 2.5 ft of silty clay soil and 0.5 ft of silty clay topsoil	2.1 in/yr

The DCPP GMF Pond analysis indicated that the proposed alternative final cover system with a geomembrane and a two-foot-thick final protective layer is essentially equivalent to the performance offered by the geomembrane with the default three-foot-thick final protective layer.

Furthermore, the proposed alternative final cover system performance exceeds the performance of a final cover system using a three-foot-thick compacted earth low permeability layer and a three-foot-thick soil protective layer (a total cover thickness of six feet) by reducing infiltration by a factor of nearly four orders of magnitude.

Environmental and Societal Benefits

The use of the proposed two-foot-thick final protective layer will provide the following additional environmental and societal benefits, relative to the default three-foot-thick final protective layer:

- The final cover system earthwork quantities will be reduced by 33% for each CCR surface impoundment. This will result in a corresponding 33% reduction in the amount of locally available soil fill that needs to be excavated, hauled to the construction location, and placed. This provides multiple benefits, such as:
    - Reduced disruption to offsite areas caused by the excavation of fill materials and corresponding disturbance to the natural environment.

[5] All HELP run versions used a pinhole density of 1 hole per acre, installation defects of 1 hole/acre, and construction quality as "good".

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  - Reduced haul truck traffic on local roadways, thereby reducing traffic impacts, roadway damage, air pollution, and carbon emissions.
  - Reduced earthwork effort during installation of the final cover system, thereby reducing air pollution and carbon emissions.
- Construction of the alternate final cover system can be completed faster than the default final cover, providing multiple benefits, such as:
  - Initiation of the reduction of infiltration at a sooner date than with the default final cover system.
  - Ceasing construction-related impacts to offsite residents (e.g., haul truck traffic, congestion) at a sooner date than otherwise possible.

SUMMARY

The proposed alternate final protective layer will:

- Provide equivalent or superior performance to the requirements of Section 845.750 (c)(2).
- Have a geotextile cushion or a geocomposite drainage layer, which are not required by Section 845.750, over the geomembrane that add both physical protection and a lateral drainage layer to reduce the amount of water available for infiltration through the geomembrane.
- Have a lower infiltration rate than the infiltration through the default final cover system.
- Meet or exceed the same criteria for long term performance and all other requirements of Section 845.750(c)(2).
- Provide other benefits by reducing the amount of final cover earthwork by 33% at each site.

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REFERENCES

[1] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[2] Golder Associates, "Final Closure Plan for the Gypsum Management Facility Pond, Duck Creek Power Plant," Canton, Illinois, 2022.

[3] Geosyntec Consultants, "Construction Permit Application Hennepin Power Plant East Ash Pond," Geosyntec Consultants, St. Louis, 2022.

[4] A. L. Rollin, J. Lafleur, M. Marcotte, O. Dascal and Z. Akber, "Selection Criteria for the Use of Geomembranes in Dams and Dykes in Northern Climate," in *Proceedings of the International Conference on Geomembranes*, Denver, Colorado, 1945.

[5] D. E. Thorton and P. Blackall, "Report EPA-3-76-13: Field Evaluation of Plastic Film Liners for Petroleum Storage Areas in the Mackenzie Delta," Canadian Environmental Protection Service, 1976.

[6] A. I. Comer and Y. G. Hsuan, "Report R-96-03: Freeze-Thaw Cycling and Cold Temperature Effects on Geomembrane Sheets and Seams," U.S. Bureau of Reclamation, 1996.

[7] Y. G. Hsuan, R. M. Koerner and A. I. Comer, "GSI White Paper #28: Cold Temperature and Freeze-Thaw Cycling Behavior of Geomembranes and their Seams," Geosynthetic Institute, Folsom, Pennsylvania, 2013.

[8] United States Environmental Protection Agency, "(Draft) Technical Guidance For RCRA/CERCLA Final Covers," Office of Solid Waste and Emergency Response, Washington D.C., 2004.

[9] T. Tolaymat and M. Krause, "Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual," United States Environmental Protection Agency, Washington, DC, 2020.

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APPENDIX A: HELP MODEL OUTPUT

A-1: HPP EAP- 2-FT FINAL PROTECTIVE COVER SOIL

A-2: HPP EAP-3-FT FINAL PROTECTIVE COVER SOIL

A-3: HPP EAP-3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL

A-4: DCPP GMF Pond- 2-FT FINAL PROTECTIVE COVER SOIL

A-5: A-4: DCPP GMF Pond- 3-FT FINAL PROTECTIVE COVER SOIL

A-6: A-4: DCPP GMF Pond- 3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL

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APPENDIX A-1
HENNEPIN POWER PLANT EAST ASH POND HELP RESULTS: 2-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP CIP (2 ft cover) **Simulated On:** 10/28/2021 14:14

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	6	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.3947	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness	=	18	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.4166	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-02	cm/sec

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

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Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness	=	372	inches
Porosity	=	0.541	vol/vol
Field Capacity	=	0.187	vol/vol
Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.1873	vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-05	cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness	=	48	inches
Porosity	=	0.451	vol/vol
Field Capacity	=	0.419	vol/vol
Wilting Point	=	0.332	vol/vol
Initial Soil Water Content	=	0.4207	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness	=	12	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.062	vol/vol
Wilting Point	=	0.024	vol/vol
Initial Soil Water Content	=	0.0649	vol/vol
Effective Sat. Hyd. Conductivity	=	5.80E-03	cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness	=	156	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.045	vol/vol
Effective Sat. Hyd. Conductivity	=	1.80E-01	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

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General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	80.6	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	510	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	3.196	inches
Upper Limit of Evaporative Storage	=	3.222	inches
Lower Limit of Evaporative Storage	=	0.852	inches
Initial Snow Water	=	0.274951	inches
Initial Water in Layer Materials	=	107.552	inches
Total Initial Water	=	107.827	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	41.3	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days
End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	70	%
Average 2nd Quarter Relative Humidity	=	66	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	77	%

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829
3.29051	4.017539	3.401471	3.029886	2.510213	1.863762

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

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Average Annual Totals Summary

Title: HEN EAP CIP (2 ft cover)
Simulated or 10/28/2021 14:16

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	8.075	[3.311]	14,948,903.1	22.69
Evapotranspiration	27.017	[3.834]	50,016,380.0	75.92
Subprofile1				
Percolation/leakage through Layer 3	**0.529518**	[0.021507]	980,296.3	1.49
Average Head on Top of Layer 3	18.5065	[0.739]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**0.319267**	[0.207637]	591,059.7	0.90
Water storage				
Change in water storage	0.1740	[0.9142]	322,172.8	0.49

* Note: Average inches are converted to volume based on the user-specified area.

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APPENDIX A-2
HENNEPIN POWER PLANT EAST ASH POND HELP RESULTS: 3-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP - Closure-in-Place **Simulated On:** 1/14/2022 8:20

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	6	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.2488	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness	=	30	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.3063	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-02	cm/sec

Layer 3
Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

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Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness	=	372	inches
Porosity	=	0.541	vol/vol
Field Capacity	=	0.187	vol/vol
Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.1873	vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-05	cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness	=	48	inches
Porosity	=	0.451	vol/vol
Field Capacity	=	0.419	vol/vol
Wilting Point	=	0.332	vol/vol
Initial Soil Water Content	=	0.4205	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness	=	12	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.062	vol/vol
Wilting Point	=	0.024	vol/vol
Initial Soil Water Content	=	0.0646	vol/vol
Effective Sat. Hyd. Conductivity	=	5.80E-03	cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness	=	156	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.045	vol/vol
Effective Sat. Hyd. Conductivity	=	1.80E-01	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

Electronic Filing: Received, Clerk's Office 06/20/2024

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	80.6	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	510	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	1.697	inches
Upper Limit of Evaporative Storage	=	3.222	inches
Lower Limit of Evaporative Storage	=	0.852	inches
Initial Snow Water	=	0.27495054	inches
Initial Water in Layer Materials	=	108.323	inches
Total Initial Water	=	108.598	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	41.3	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days
End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	70	%
Average 2nd Quarter Relative Humidity	=	66	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	77	%

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829018
3.29051	4.017539	3.401471	3.029886	2.510213	1.86376189

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: HEN EAP - CURRENT CONDITIONS
Simulated on: 1/14/2022 8:23

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	7.713	[3.344]	14,279,113.1	21.67
Evapotranspiration	26.948	[3.837]	49,888,594.9	75.73
Subprofile1				
Percolation/leakage through Layer 3	**0.880978**	[0.027359]	1,630,955.3	2.48
Average Head on Top of Layer 3	30.2516	[0.8802]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**0.544600**	[0.386956]	1,008,217.1	1.53
Water storage				
Change in water storage	0.3795	[1.1939]	702,590.4	1.07

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-3
HENNEPIN POWER PLANT EAST ASH POND HELP RESULTS: 3-FT OF COMPACTED EARTH LAYER, 3-FT OF FINAL PROTECTIVE COVER SOIL

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HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP - Closure-in-Place **Simulated On:** 10/13/2021 20:45

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	6	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.2488	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness	=	30	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.275	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-02	cm/sec

Layer 3
Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

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Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness	=	372	inches
Porosity	=	0.541	vol/vol
Field Capacity	=	0.187	vol/vol
Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.19	vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-05	cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness	=	48	inches
Porosity	=	0.451	vol/vol
Field Capacity	=	0.419	vol/vol
Wilting Point	=	0.332	vol/vol
Initial Soil Water Content	=	0.419	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness	=	12	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.062	vol/vol
Wilting Point	=	0.024	vol/vol
Initial Soil Water Content	=	0.0641	vol/vol
Effective Sat. Hyd. Conductivity	=	5.80E-03	cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness	=	156	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.045	vol/vol
Effective Sat. Hyd. Conductivity	=	1.80E-01	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

Electronic Filing: Received, Clerk's Office 06/20/2024

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	80.6	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	510	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	1.696	inches
Upper Limit of Evaporative Storage	=	3.222	inches
Lower Limit of Evaporative Storage	=	0.852	inches
Initial Snow Water	=	0.27495054	inches
Initial Water in Layer Materials	=	123.7	inches
Total Initial Water	=	123.975	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	41.3	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days
End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	70	%
Average 2nd Quarter Relative Humidity	=	66	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	77	%

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829018
3.29051	4.017539	3.401471	3.029886	2.510213	1.86376189

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: HEN EAP - Closure-in-Place (CLAY)
Simulated on: 10/13/2021 20:48

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	6.701	[3.161]	12,404,742.9	18.83
Evapotranspiration	26.571	[4.002]	49,190,796.8	74.67
Subprofile1				
Percolation/leakage through Layer 3	**2.261741**	[0.038582]	4,187,161.3	6.36
Average Head on Top of Layer 3	29.5380	[1.1069]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**1.697246**	[0.951224]	3,142,112.4	4.77
Water storage				
Change in water storage	0.6162	[1.663]	1,140,863.6	1.73

* Note: Average inches are converted to volume based on the user-specified area.

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APPENDIX A-4
DUCK CREEK POWER PLANT GYPSUM MANAGEMET FACILITY POND HELP RESULTS: 2-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/12/2022 9:32

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	6	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.4073	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	18	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.3829	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0338	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	4	%
Drainage Length	=	450	ft

Layer 4

Electronic Filing: Received, Clerk's Office 06/20/2024

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness	=	240	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.105	vol/vol
Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.105	vol/vol
Effective Sat. Hyd. Conductivity	=	6.70E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	90.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	15	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	3.294	inches
Upper Limit of Evaporative Storage	=	3.688	inches
Lower Limit of Evaporative Storage	=	1.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	34.543	inches
Total Initial Water	=	34.543	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	40.5	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days

Electronic Filing: Received, Clerk's Office 06/20/2024

End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	67	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	75	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/12/2022 9:36

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	12.581	[3.246]	685,044.7	34.24
Evapotranspiration	23.227	[2.957]	1,264,727.0	63.21
Subprofile1				
Lateral drainage collected from Layer 3	0.9541	[0.7929]	51,952.6	2.60
Percolation/leakage through Layer 4	0.000247	[0.00019]	13.5	0.00
Average Head on Top of Layer 4	0.0005	[0.0004]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000248	[0.00019]	13.5	0.00
Water storage				
Change in water storage	-0.0142	[1.0912]	-772.6	-0.04

* Note: Average inches are converted to volume based on the user-specified area.

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APPENDIX A-5
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND
HELP RESULTS: 3-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/13/2022 15:36

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	6	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.4073	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	30	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.3834	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0156	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	4	%
Drainage Length	=	450	ft

Layer 4

Electronic Filing: Received, Clerk's Office 06/20/2024

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness	=	240	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.105	vol/vol
Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.105	vol/vol
Effective Sat. Hyd. Conductivity	=	6.70E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	90.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	15	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	3.294	inches
Upper Limit of Evaporative Storage	=	3.688	inches
Lower Limit of Evaporative Storage	=	1.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	39.149	inches
Total Initial Water	=	39.149	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	40.5	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days

Electronic Filing: Received, Clerk's Office 06/20/2024

End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	67	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	75	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/13/2022 15:40

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	12.581	[3.246]	685,044.7	34.24
Evapotranspiration	23.227	[2.957]	1,264,727.0	63.21
Subprofile1				
Lateral drainage collected from Layer 3	0.9570	[0.8034]	52,108.0	2.60
Percolation/leakage through Layer 4	0.000258	[0.0002]	14.1	0.00
Average Head on Top of Layer 4	0.0005	[0.0004]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000258	[0.0002]	14.1	0.00
Water storage				
Change in water storage	-0.0171	[1.1899]	-928.6	-0.05

* Note: Average inches are converted to volume based on the user-specified area.

Electronic Filing: Received, Clerk's Office 06/20/2024

APPENDIX A-6
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND HELP RESULTS: 3-FT OF COMPACTED EARTH LAYER, 3-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/13/2022 15:07

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	6	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.461	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness	=	30	inches
Porosity	=	0.461	vol/vol
Field Capacity	=	0.36	vol/vol
Wilting Point	=	0.203	vol/vol
Initial Soil Water Content	=	0.461	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E-06	cm/sec

Layer 3
Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 4
Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness	=	240	inches
Porosity	=	0.437	vol/vol
Field Capacity	=	0.105	vol/vol

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Wilting Point	=	0.047	vol/vol
Initial Soil Water Content	=	0.1135	vol/vol
Effective Sat. Hyd. Conductivity	=	6.70E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	90.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	15	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	3.688	inches
Upper Limit of Evaporative Storage	=	3.688	inches
Lower Limit of Evaporative Storage	=	1.624	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	59.2	inches
Total Initial Water	=	59.2	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	40.5	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days
End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	67	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	75	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for: Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Electronic Filing: Received, Clerk's Office 06/20/2024

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Electronic Filing: Received, Clerk's Office 06/20/2024

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/13/2022 15:10

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	6.844	[2.987]	372,642.1	18.62
Evapotranspiration	27.772	[3.713]	1,512,183.1	75.57
Subprofile1				
Percolation/leakage through Layer 3	2.147626	[0.073824]	116,938.2	5.84
Average Head on Top of Layer 3	26.2293	[2.126]	---	---
Subprofile2				
Percolation/leakage through Layer 4	1.973425	[0.573329]	107,453.0	5.37
Water storage				
Change in water storage	0.1595	[1.2078]	8,686.9	0.43

* Note: Average inches are converted to volume based on the user-specified area.

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ATTACHMENT 4

Slope Stability Calculations

Electronic Filing: Received, Clerk's Office 06/20/2024

GOLDER
MEMBER OF WSP

CALCULATION

DATE January 25, 2022 **Reference No.** 21454861-13-R-1

PREPARED BY: Jason Obermeyer

CHECKED BY: Jeff Rusch

REVIEWED BY: Mark Haddock, PE **CLIENT NAME: Illinois Power Resources Generating, LLC**

SLOPE STABILITY ANALYSIS – GYPSUM MANAGEMENT FACILITY POND CLOSURE

1.0 OBJECTIVE

Evaluate slope stability for the Gypsum Management Facility (GMF) Pond closure design in terms of global stability and veneer stability for the final cover system and containment berm.

2.0 METHODOLOGY

Limit-equilibrium slope stability analyses were performed using Spencer's method of slices (Spencer 1967) in Slide2, a two-dimensional slope stability modeling software platform (Rocscience Inc. 2020). Spencer's method of slices considers both moment and force equilibrium. It is common geotechnical practice to analyze the stability of embankment slopes using limit-equilibrium methods.

2.1 Target Factors of Safety

The following target factors of safety are based on the values presented in Illinois Administrative Code Title 35, Subsection 845.460(a), as pertinent to the GMF Pond following closure:

- target minimum factor of safety under static long-term conditions = 1.5
- target minimum factor of safety under seismic loading conditions = 1.0

The locally available soils that will be used for closure construction have relatively high silt and clay contents. Therefore, they are not expected to be susceptible to liquefaction.

3.0 SLOPE STABILITY ANALYSIS

3.1 Geometry

A typical cross section through the containment berm along the south end of the closure footprint was selected for the slope stability analysis. This is identified as the critical cross section for slope stability following closure of the GMF Pond, as the GMF Pond is mostly incised around the remainder of the closure footprint perimeter.

The existing liner system will remain in place beneath the closure footprint and consists of (from top to bottom):

- 60-mil textured high-density polyethylene (HDPE) geomembrane
- 1 foot of cushion soil (primarily silt and clay)

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- 4-ounce-per-square-yard (oz/yd^2) nonwoven needle-punched (NWNP) geotextile
- 1 foot of granular drainage aggregate
- 10-oz/yd^2 NWNP geotextile
- 60-mil textured HDPE geomembrane
- reinforced geosynthetic clay liner (GCL)
- 3 feet of compacted clay

The containment berm is designed with 3H:1V slopes and a crest width of 36 feet. The final cover system will be sloped at 4%. The base of the final cover system is designed to meet the upstream edge of the containment berm crest and terminate with a 3H:1V slope to the crest. The final cover system will consist of the following components (from top to bottom):

- 2 feet of protective cover, anticipated to consist primarily of locally available low-plasticity silt or clay
- double-sided geocomposite drainage layer
- 40-mil textured linear low-density (LLDPE) geomembrane

A liner system will be installed on the upstream containment berm slope and tied into the existing liner system at the toe of the slope. The liner system will consist of the following components (from top to bottom):

- 60-mil textured HDPE geomembrane
- 2 feet of compacted clay

Downstream of the containment berm, the closure grades represent the top of the compacted clay layer in the existing liner system, as the components of the existing liner system above this layer will be removed during closure of the GMF Pond.

For simplification of the model geometry, the liner systems are each represented as a layer having a thickness of 2 feet and the final cover system geosynthetics are represented as a layer having a thickness of 1 foot.

Groundwater levels in the vicinity of the GMF Pond are elevated above the existing liner system. For slope stability analysis, the phreatic surface is modeled along the top of the compacted clay layer in the existing liner system. Within the closure footprint, the liner system will prevent the phreatic surface from rising above this level. Downstream of the containment berm, elevated groundwater is expected to present as surface water that will be managed in a stormwater channel, resulting in phreatic levels near the ground surface.

3.2 Approach and Input Parameters

The slope stability analysis uses the following approach and input parameters:

- Circular and non-circular slip surfaces are evaluated. Analysis of non-circular slip surfaces enables evaluation of veneer stability for the final cover system.
- Earthquake (seismic) loading conditions are simulated using a pseudostatic approach. The United States Geological Survey (USGS) Unified Hazard Tool indicates a 2% probability of exceeding a peak ground

acceleration (PGA) of 0.06 g in 50 years at the site. In an actual seismic event, the peak acceleration would be sustained for only a fraction of a second. A pseudostatic analysis conservatively models seismic events as a force with constant acceleration and direction (i.e., an infinitely long seismic pulse). Consequently, it is common geotechnical practice to reduce the predicted PGA when performing pseudostatic analyses. For conservatism, however, the pseudostatic analysis for the GMF Pond is conducted for the long-term condition using a horizontal seismic coefficient of 0.06, corresponding to the PGA.

- Material unit weights were selected based on engineering judgment.
- Strength parameters for zones that may consist of cohesive soils (i.e., containment berm, protective soil cover, and subsoil) are selected based on engineering judgment. These zones are assigned a friction angle of 28 degrees. Cohesion is neglected for conservatism.
- For conservatism, undrained strengths are applied for gypsum. A vertical stress ratio (ratio of undrained strength to initial vertical effective stress) of 0.22 is used, consistent with the typical value for normally consolidated fine-grained material (Mesri 1989).
- Strength parameters for the geosynthetic interfaces included in the liner systems and final cover systems associated with the closed GMF Pond are evaluated from laboratory testing data published by Koerner and Narejo (2005) and summarized in Table 1.
- The lowest geosynthetic interface strength parameters in a given system (liner or final cover) from Table 1 are selected for analysis. Adhesion is conservatively neglected for all geosynthetic interfaces.

Table 1: Characteristic Geosynthetic Interface Strengths

Interface	Peak Friction Angle	Peak Adhesion
Textured HDPE geomembrane against cohesive soil	18 degrees	209 psf
NWNP geotextile against cohesive soil	30 degrees	104 psf
NWNP geotextile against granular soil	33 degrees	0 psf
NWNP geotextile against textured HDPE geomembrane	25 degrees	167 psf
Textured HDPE geomembrane against reinforced GCL	23 degrees	167 psf
Reinforced GCL against cohesive soil	Use NWNP geotextile against cohesive soil	
Geocomposite against cohesive soil	Use NWNP geotextile against cohesive soil	
Geocomposite against textured LLDPE geomembrane	26 degrees	121 psf
Textured LLDPE geomembrane against cohesive soil	21 degrees	169 psf

Source: Koerner and Narejo 2005.

A summary of material properties used in the slope stability analysis is presented in Table 2.

Table 2: Material Properties

Zone	Unit Weight	Friction Angle	Cohesion or Adhesion	Vertical Stress Ratio
Existing liner system	120 pcf	18 degrees	0 psf	–
New liner system	120 pcf	18 degrees	0 psf	–
Cover geosynthetics	120 pcf	21 degrees	0 psf	–
Protective cover	120 pcf	28 degrees	0 psf	–
Containment berm	120 pcf	28 degrees	0 psf	–
Gypsum	100 pcf	–	–	0.22
Subsoil	120 pcf	28 degrees	0 psf	–

3.3 Results and Conclusions

The factor of safety for slope stability under static loading conditions is calculated as 1.6, as shown in Figure 1. The critical slip surface is surficial on the downstream face of the containment berm. The factor of safety for global stability under seismic loading conditions is calculated as 1.3, as shown in Figure 2. As with the static analysis, the critical slip surface is surficial on the downstream face of the containment berm.

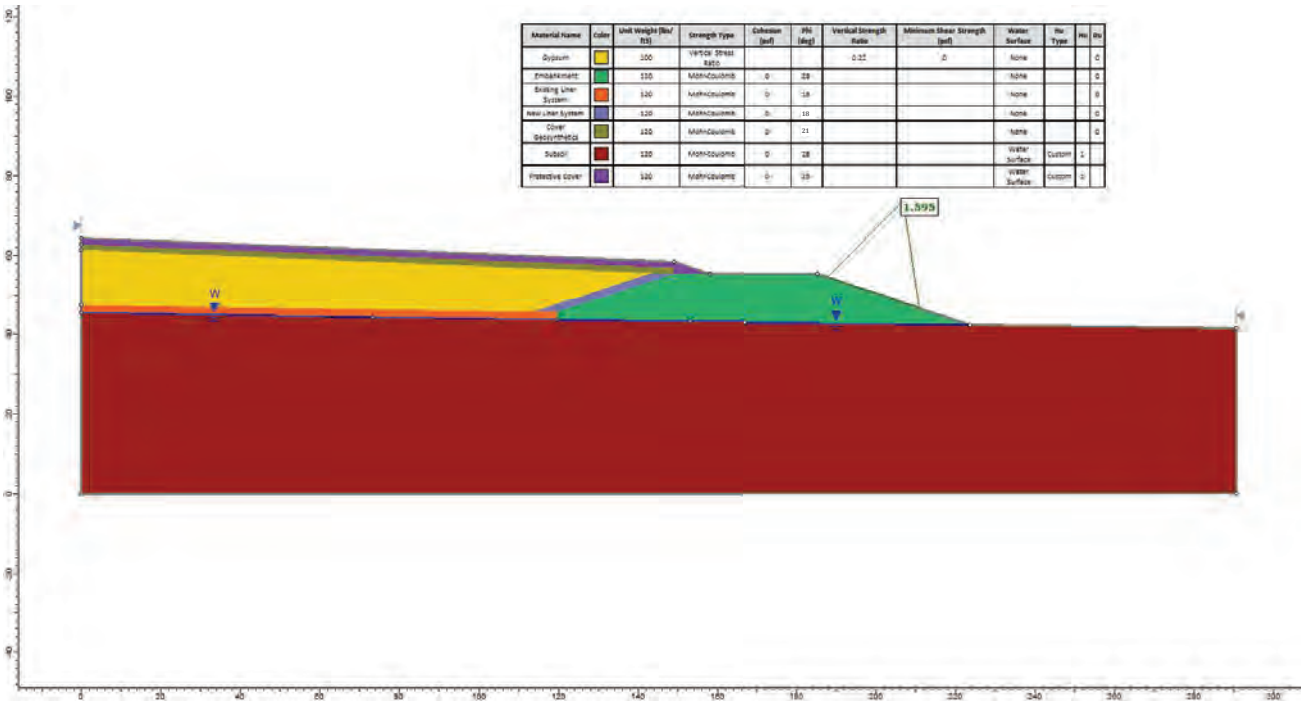

Figure 1: Analysis Result – Static Loading

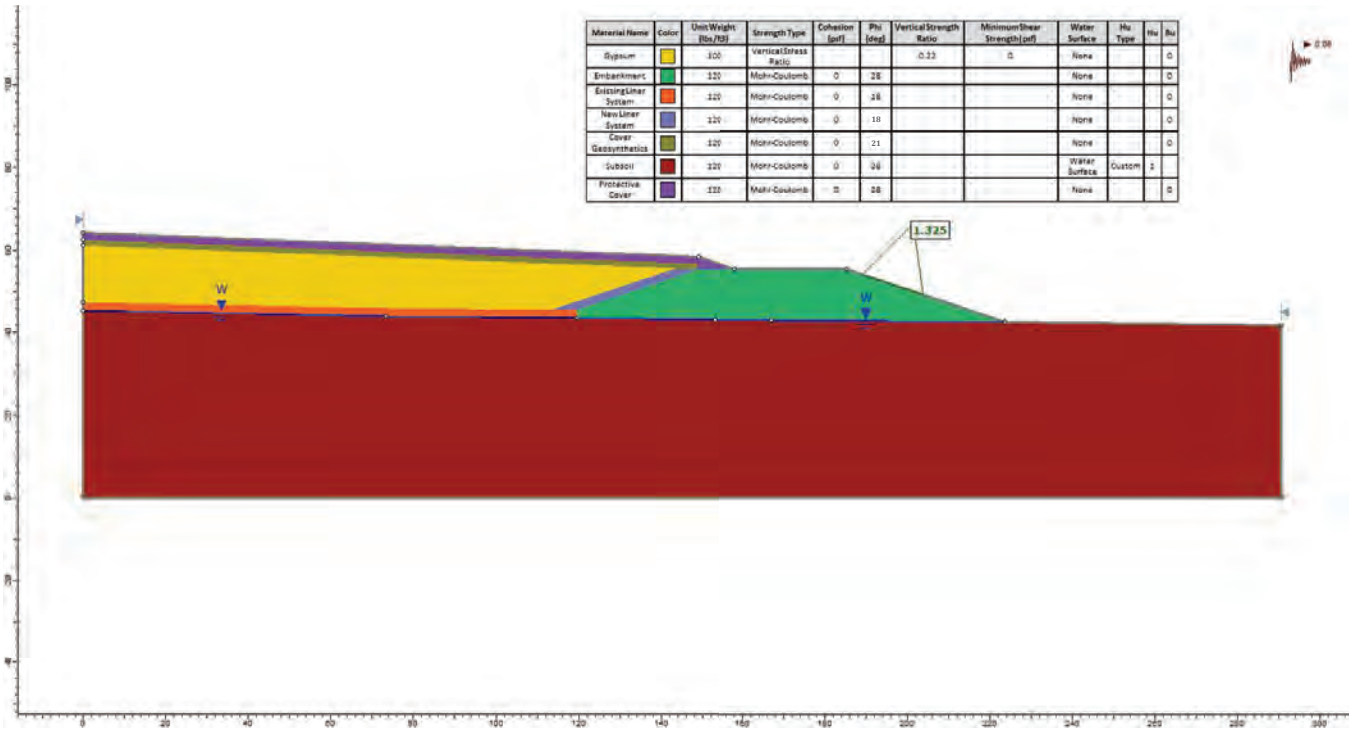

Figure 2: Analysis Result – Seismic Loading

Based on the factors of safety computed using the methods and assumptions described, the closed GMF Pond is expected to remain stable with an appropriate safety margin for global and veneer stability. A factor of safety greater that 1.5 was computed for static loading conditions. A factor of safety greater than 1.0 was computed for seismic loading conditions.

4.0 REFERENCES

Koerner G and Narejo D. 2005. Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces. Geosynthetic Research Institute, GRI Report #30. June 14.

Mesri G. 1989. A Reevaluation of $S_{u(mob)} = 0.22\sigma'_p$ Using Laboratory Shear Tests. Canadian Geotechnical Journal, No. 26, pp. 162-164.

RocScience Inc. 2020. Slide2 Version 9.012. Build date: December 11, 2020.

Spencer E. 1967. A Method of Analysis of the Stability of Embankments Assuming Parallel Inter-Slice Forces. Geotechnique, Vol. XVII, No. 1, pp. 11-26.

USGS (United States Geological Survey). 2014. Unified Hazard Tool. [Accessed January 25, 2022.] https://earthquake.usgs.gov/hazards/interactive/index.php.

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ATTACHMENT 5

Hydrologic Calculations

Electronic Filing: Received, Clerk's Office 06/20/2024

GOLDER
MEMBER OF WSP

CALCULATION

DATE January 25, 2022 **Reference No.** 21454861-13-R-1

PREPARED BY: Micah Richey

CHECKED BY: Brendan Purcell

REVIEWED BY: Jason Obermeyer **CLIENT NAME: Illinois Power Resources Generating, LLC**

HYDROLOGY CALCULATIONS FOR CLOSURE OF THE GYPSUM MANAGEMENT FACILITY POND AT THE DUCK CREEK POWER PLANT

1.0 OBJECTIVE

Evaluate the hydrology (routing of stormwater runoff) after closure of the Duck Creek Gypsum Management Facility (GMF) Pond. These calculations were done to support the closure plan by determining the minimum channel dimensions.

2.0 METHODOLOGY

The areas contributing to the GMF Pond were delineated in AutoCAD, as shown in Figure 1. The ground conditions were used to estimate a lag time using NRCS methodology (NRCS 1986). The calculations for the hydrologic parameters are included in Tables 1 and 2. The hydrologic parameters were used to model the stormwater runoff reporting to a proposed channel south of the closed GMF Pond and another proposed channel north of the closed GMF Pond during the 25-year, 24-hour design storm event using HEC-HMS software (USACE 2021). The channels were analyzed using Manning's equation to evaluate the steady-state hydraulics.

3.0 INPUTS AND ASSUMPTIONS

Information and assumptions regarding input parameters used in the analyses include the following:

- A curve number of 58 was used to be consistent with the closed condition of Meadow and hydrologic soil group B (NRCS 1986) based on a review of the Web Soil Survey in the vicinity of the GMF Pond (NRCS 2021).
- The design storm (25-year, 24-hour) depth from NOAA Atlas 14 (NOAA 2006) is 5.25 inches.
- Lag time was estimated using NRCS TR-55 methodology.
- Manning's number used for channel design was 0.030 for capacity and 0.035 for depth assuming a grass-lined channel.

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4.0 RESULTS AND CONCLUSIONS

The HEC-HMS model results provide the estimated peak flow from the 25-year, 24-hour design storm to discharge points of interest:

- The peak flow rate at the proposed stormwater channel south of the closed GMF Pond is estimated as 48.6 cubic feet per second (cfs).
- The peak flow rate at the proposed stormwater channel north of the closed GMF Pond is estimated as 12.6 cfs.

The output from the HEC-HMS model is shown in Table 3.

The channels were designed with dimensions as indicated in Table 4. Freeboard is shown to be at least 1 foot and at least one-half of the velocity head. The calculations indicate that the channel should function properly as designed.

5.0 REFERENCES

NOAA (National Oceanic and Atmospheric Administration). 2006. Precipitation-Frequency Atlas of the United States, Volume 2 Version 3.0.

NRCS (Natural Resources Conservation Service). 1986. Urban Hydrology for Small Watersheds. 2nd edition Technical Release 55). June.

NRCS. 2021. Web Soil Survey. [Accessed January 25, 2022.] http://websoilsurvey.sc.egov.usda.gov/.

USACE (United States Army Corps of Engineers). 2021. Hydrologic Modeling System (HEC-HMS), Version 4.8.0. Release date: April 8, 2021.

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https://golderassociates.sharepoint.com/sites/141778/project files/6 deliverables/reports/13-r-closure_plan_gypsum_mgmt_facility_pond/13-r-1/att5/att5_duck_creek_gmf_hydrologic_calculations.docx

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Tables

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TABLE 1
SUBBASIN SUMMARY TABLE

Illinois Power Resources Generating, LLC
Duck Creek Gypsum Management Facility Pond
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	JEO

Design Storm 25 -Year Recurrence Interval

Storm Duration (hours)	2-Year Depth (inches)	25 -Year Depth (inches)	Storm Distribution
24	3.01	5.25	II

Subbasin ID	Subbasin Area (ft^2)	Subbasin Area (acres)	Subbasin Area (sq mile)	CN = 58 Meadow HSG B (acres)	CN = 99 Open Water or Impervious (acres)	Composite SCS Curve No.	$S = \frac{1000}{CN} - 10$	Unit Runoff Q (in)	Runoff Volume (ac-ft)	Runoff Volume (ft^3)
CIP	1,871,960	42.97	0.0671	42.97		CN = 58	7.24	1.31	4.69	204,167
CIP N	445,396	10.22	0.0160	10.22		CN = 58	7.24	1.31	1.12	48,577

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TABLE 2
BASIN TIME OF CONCENTRATION CALCULATIONS

Illinois Power Resources Generating, LLC
Duck Creek Gypsum Management Facility Pond
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	JEO

					Flow Segment 1						Flow Segment 2						Flow Segment 3					
Subbasin ID	Subbasin Area (sq mile)	Composite Curve Number	Total Lag (0.6*Tc) (min)	Total Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)
CIP	0.0671	58	15.9	26.5	Sheet	100	0.040	G	Bermuda Grass		17.1	Shallow	550	0.040	U	Unpaved		2.8	Channel	1,700	0.0094	G	Grass-lined	1.07	6.6
CIP N	0.0160	58	13.9	23.1	Sheet	100	0.040	G	Bermuda Grass		17.1	Shallow	100	0.050	U	Unpaved		0.5	Channel	950	0.0105	G	Grass-lined	0.53	5.6

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TABLE 3
FLOW RESULTS FROM HEC-HMS

Illinois Power Resources Generating, LLC
Duck Creek Gypsum Management Facility Pond
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	JEO

HEC-HMS Basin Model:	GMF
HEC-HMS Met. Model:	25-yr, 24-hr
HEC-HMS Control Specs:	48-hr, 1-min

Hydrologic Element	Drainage Area (sq mile)	Peak Discharge (cfs)	Time of Peak	Total Volume (ac-ft)
CIP	0.067	48.6	02Jun2525, 01:10	4.7
CIP N	0.016	12.6	02Jun2525, 01:08	1.1

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TABLE 4
CHANNEL HYDRAULIC CALCULATIONS

Illinois Power Resources Generating, LLC
Duck Creek Gypsum Management Facility Pond
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	JEO

			Channel Design Geometry						Channel Roughness Parameters				Hydraulic Calculations							Channel Evaluations	
Reach Designation	Q25 from HEC-HMS (cfs)	HEC HMS Element ID for Q	Approximate Channel Length (ft)	Bed Slope (ft/ft)	Left Side Slope (H:1V)	Right Side Slope (H:1V)	Bottom Width (ft)	Minimum Channel Depth (ft)	Design Channel Lining		Mannings 'n' for Capacity (Depth Calculation)	Mannings 'n' for Stability (Velocity Calculation)	Maximum Velocity (ft/sec)	Maximum Normal Flow Depth (ft)	Froude Number	Normal Depth Shear Stress (lb/ft^2)	Stream Power (W/m^2)	Top Width of Flow (ft)	Top Width of Channel (ft)	Available Freeboard (ft)	
CIP	48.6	CIP	1,770	0.0075	3.0	3.0	0	11.7	G	Grass-lined	0.035	0.030	4.1	2.10	0.73	0.98	58.81	12.6	70.2	9.6	Suitable
CIP N	12.6	CIP N	950	0.0110	3.0	3.0	0	2.2	G	Grass-lined	0.035	0.030	3.4	1.18	0.80	0.81	39.86	7.1	13.2	1.0	Suitable

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Figures

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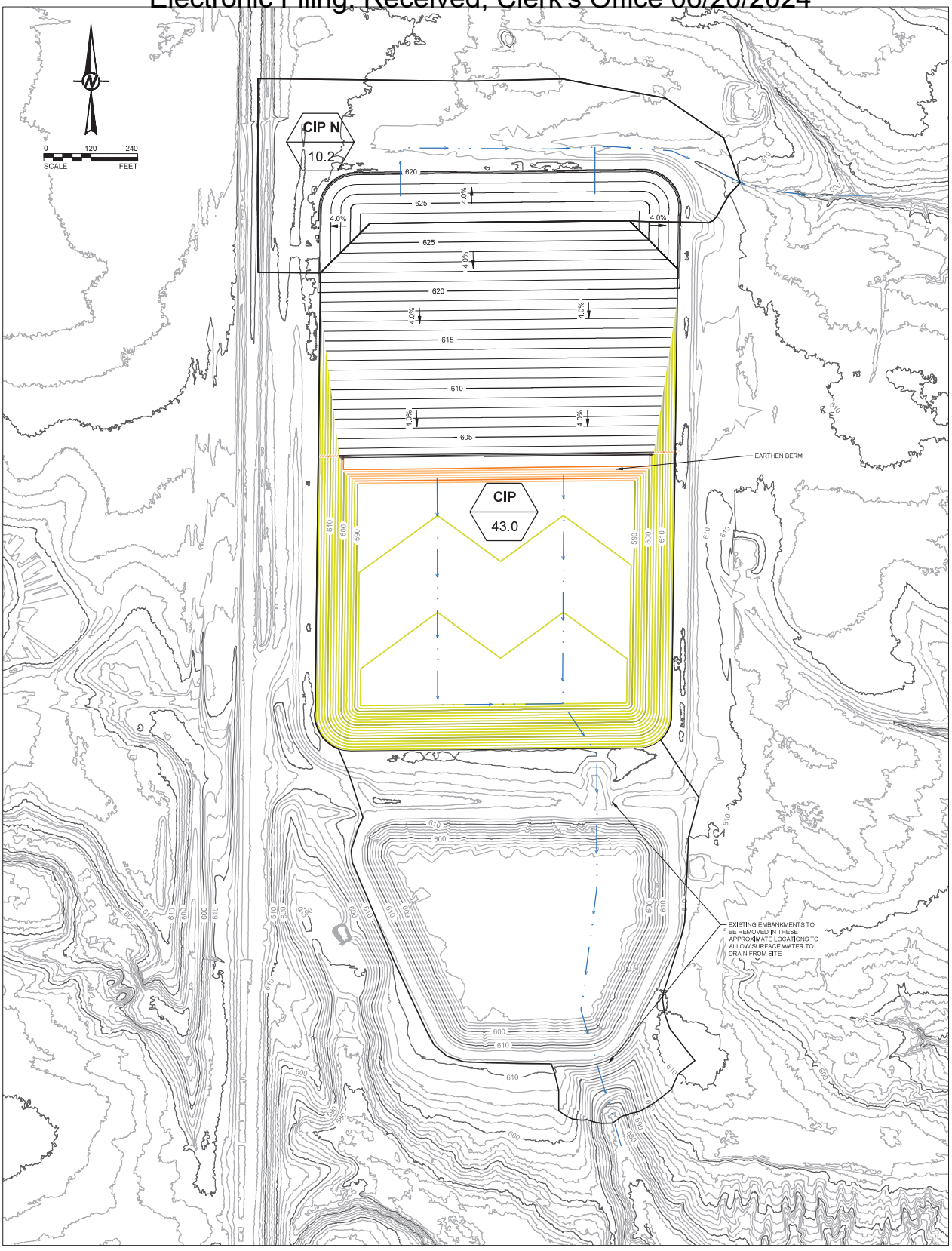

NOTE(S)

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES SHOWN ARE TOP OF CUSHION DIRT LAYER. ELEVATION CONTOURS WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES INC.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. THE PROPOSED STORMWATER DRAINAGE CONCEPT IS TO SHED WATER INTO EXISTING DRAINAGE CHANNELS NORTHEAST AND SOUTHEAST OF THE FACILITY. DRAINAGE TO THE SOUTHEAST WILL BE DIRECTED INTO AN OPEN CHANNEL CREATED BY REMOVING EXISTING EMBANKMENTS AND EXCAVATING BELOW EXISTING GRADES ALONG THE ROUTING SHOWN. THE OPEN CHANNEL WILL CONNECT INTO AN EXISTING DRAINAGE SOUTHEAST OF THE GMF POND.

LEGEND

- 600 — PROPOSED TOP OF COVER GRADES
- 600 — GMF POND BASE GRADES (SEE NOTE 1)
- 600 — EXISTING GROUND CONTOURS (SEE NOTE 2)
- 600 — EARTHEN BERM GRADES
- PROPOSED STORMWATER ROUTING (SEE NOTE 3)
- BASIN DELINEATION
- BASIN / ACRES

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GYPSUM MANAGEMENT FACILITY POND SURFACE WATER DRAINAGE BASINS

FIGURE 1

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APPENDIX I

Groundwater Monitoring Plan

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Intended for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

GROUNDWATER MONITORING PLAN

GYPSUM MANAGEMENT FACILITY POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

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GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND

Project Name	**Duck Creek Power Plant Gypsum Management Facility Pond**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Groundwater Monitoring Plan**
Revision	**FINAL**
Date	**October 25, 2021**

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LICENSED PROFESSIONAL CERTIFICATIONS

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Duck Creek Power Plant Gypsum Management Facility Pond), has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).



Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Duck Creek Power Plant Gypsum Management Facility Pond), has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).



Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

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Table E	Part 845 Groundwater Monitoring Program Parameters
Table F	Part 845 Sampling Schedule

TABLES (ATTACHED)

Table 1-1	Part 845 Requirements Checklist
Table 2-1	Monitoring Well Locations and Construction Details
Table 3-1	Background Groundwater Quality and Standards
Table 4-1	Sampling and Analysis Summary
Table 4-2	Detection and Reporting Limits for Part 845 Parameters

FIGURES (ATTACHED)

Figure 1-1	Site Location Map
Figure 1-2	Site Map
Figure 1-3	Uppermost Aquifer Groundwater Elevation Contours, April 14, 2021
Figure 2-1	IEPA Monitoring Program Well Network
Figure 2-2	Proposed Part 845 Groundwater Monitoring Well Network

APPENDICES

Appendix A	Statistical Analysis Plan

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ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
ASD	Alternate Source Demonstration
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
CSM	conceptual site model
DCPP	Duck Creek Power Plant
GMF Pond	Gypsum Management Facility Pond
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard
HCR	Hydrogeologic Site Characterization Report
HDPE	high-density polyethylene
ID	identification
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
mg/L	milligrams per liter
mil	millimeter
msl	mean sea level
NA	not applicable
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
NRT/OBG	Natural Resource Technology, an OBG Company
oz/yd^2	ounces per square yard
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
PMP	potential migration pathway
QA/QC	quality assurance/quality control
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RL	reporting limit
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency
WLO	water level only
WPCP	Water Pollution Control Permit

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (SIs): Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845) (Illinois Environmental Protection Agency [IEPA], April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Monitoring Plan (GMP) on behalf of Duck Creek Power Plant (DCPP), operated by Illinois Power Resources Generating, LLC (IPRG). This report will apply specifically to the CCR Unit referred to as the Gypsum Management Facility Pond (GMF Pond) (Vistra identification [ID] number [No.] 203, IEPA ID No. W0578010001-04, and National Inventory of Dams [NID] No. IL50573). This GMP includes Part 845 content requirements specific to 35 I.A.C. § 845.630 (Groundwater Monitoring System), 35 I.A.C. § 845.640 (Groundwater Sampling and Analysis), and 35 I.A.C. § 845.650 (Groundwater Monitoring Program) for the GMF Pond at the DCPP.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650 is included in **Table 1-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650.

1.2 Site Location and Background

The DCPP is located in Fulton County, Illinois, approximately six miles southeast of the town of Canton, Illinois. The GMF Pond is located north of the DCPP within Section 18, Township 6 North, Range 5 East (**Figure 1-1**). Prior to construction of the DCPP and associated facilities, strip mining of coal took place within the current property boundary. Currently, land use adjacent to the DCPP is primarily agriculture, pasture, and forested land with minimal development.

The GMF Pond is a 1,500-foot by 900-foot earthen berm double-lined CCR SI located north of the former DCPP. The GMF Pond decant water discharges to the lined GMF Recycle Pond located to the south of the GMF Pond (**Figure 1-2**). In addition to the GMF Pond, several other CCR units are located on the DCPP property, including the Landfill located due north of the GMF Pond; the closed units Ash Pond No. 1 and Ash Pond No. 2 located south of the GMF Pond; and the Bottom Ash Basin located between the former DCPP and the closed Ash Pond No. 1 and Ash Pond No. 2.

The GMF Pond, also referred to as the gypsum stack/management system, operates under IEPA Water Pollution Control Permit (WPCP) No. 2017-E0-62640, issued in December 2017. It consists of 1,500-foot by 900-foot earthen berm with 3.5:1 side slopes, a maximum elevation of 620 feet above mean sea level, a double geomembrane liner consisting of a 60-millimeter (mil) high-density polyethylene (HPDE) geomembrane liner, 12 inches of clay cushion, 4 ounces per square yard (oz/yd^2) non-woven geotextile filter fabric, 12 inches highly permeable granular drainage (sand), 10 oz/yd^2 non-woven geotextile filter fabric, 60-mil HPDE geomembrane liner, reinforced bentonite mat, 36 inches compacted clay all installed over in-situ foundation soil, and all pipes, pumps, and appurtenances necessary for the storage of approximately 3.6 million tons of gypsum at a maximum elevation of 715 feet above mean sea level with discharge to the Recycle Pond. The GMF Recycle Pond is lined with a 60-mil HDPE geomembrane liner, reinforced bentonite mat, and 36 inches of compacted clay.

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) coal unit at some portions of the DCPP property. Previous investigations completed outside of the GMF Pond indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The GMF Pond is located immediately adjacent to and downgradient of several former large surface mining areas.

1.3 Conceptual Model

Significant site investigation has been completed at the DCPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, the GMF Pond has been well characterized and detailed in the Hydrogeologic Site Characterization Report (HCR; Ramboll, 2021); included in the Operating Permit to which this Plan is attached). A conceptual site model (CSM) has been developed and is discussed below.

The three distinct hydrostratigraphic units summarized below have been identified at the GMF Pond based on stratigraphic relationships and common hydrogeologic characteristics:

- **Uppermost Aquifer:** At the GMF Pond, this unit includes the Peoria/Roxana Loess, the upper Radnor Till, and the shallow sands. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till (Natural Resource Technology, an OBG Company [NRT/OBG], 2017a). The shallow sands are laterally extensive across the GMF Pond, vary in thickness from less than one to 18 feet, and are generally located at an elevation of 570 to 590 feet above mean sea level (msl). Sand was completely removed where it was encountered during construction of the GMF Pond, putting the base of liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place. While the primary migration pathway is the shallow sand of the uppermost aquifer, the groundwater within the overlying Peoria/Roxanna Loess has the potential to be impacted and is considered a potential migration pathway (PMP).
- **Lower Radnor Till/Lower Confining Unit**: Underlying the uppermost aquifer, the lower Radnor Till is approximately 42 to 58 feet thick. Previous hydrogeologic studies indicate discontinuous sand lenses observed within the till are not hydraulically connected to the shallow sand unit (NRT/OBG, 2017a).
- **Bedrock Confining Unit**: The thick and low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, are estimated to have a thickness of approximately 300 to 400 feet.

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow in the sands is generally in a northwest to southeast direction (**Figure 1-3**). Seasonal variation of groundwater levels at the GMF Pond are present and may fluctuate approximately one to 10 feet. There is no observable seasonal variation of groundwater flow direction at the GMF Pond associated with the elevation changes. Groundwater flows toward the Duck Creek Cooling Pond located approximately 2,100 feet east of the GMF Pond. The surface water elevation of the Duck Creek Cooling Pond is estimated from 562.5 to 565 feet North American Vertical Datum of 1988 (NAVD88). Which is approximately 20 feet lower than downgradient groundwater at the GMF Pond.

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Part 845 parameters were monitored in the uppermost aquifer and PMP monitoring wells at the GMF Pond as part of the Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257 monitoring program beginning in 2015. These data were supplemented with sampling of additional locations in 2021. The results indicate that the following parameters were detected at concentrations or measurements greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs) and are considered potential exceedances:

- Antimony, arsenic, cobalt, lead, pH, sulfate, and thallium were detected at least once at concentrations or measurements greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). Lead, mercury, pH, and thallium were detected at concentrations or measurements greater than the GWPS in upgradient uppermost aquifer wells. Radium 226 and 228 combined was detected once at concentrations greater than the GWPS in the bedrock confining unit well.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPS, without an evaluation of background concentrations. Evaluation of background groundwater quality has been completed as part of this GMP, and compliance with Part 845 will be determined following the first round of groundwater sampling. The first round of groundwater sampling for compliance will be completed the quarter following issuance of the Operating Permit and in accordance with this GMP.

2. GROUNDWATER MONITORING SYSTEMS

2.1 Existing Monitoring Well Network and Analysis

This GMP is being provided to propose a groundwater monitoring network and monitoring program specific to the GMF Pond that will comply with Part 845. Monitoring networks and programs that apply to other units are not discussed in this GMP. Those programs will continue to be performed as specified in IEPA approvals. Any future modifications will be proposed and submitted to IEPA for approval in a separate document. The remaining discussion in this document will include only these networks and monitoring programs that are applicable and specific to the GMF Pond, specifically the IEPA WPCP monitoring network, the 40 C.F.R. § 257 monitoring network and the proposed Part 845 monitoring network.

2.1.1 IEPA Monitoring Program

Routine quarterly groundwater monitoring is completed at GMF Pond wells G50L/S, G51L/S, G52L/S, G53L/S, G54L/S, G55L/S, G56L/S, G57L/S, G58L/S, G59L/S, G60L/S, R61L/G61S, G62L, G63L/S, and G64L/S in accordance with the IEPA WPCP No. 2017-E0-62640. This permit also requires sampling G65L/S, G66L/S, G67L/S, G70L, G71L/S, and G72L/R72S at the GMF Recycle Pond. The boring logs, well construction forms, and other related monitoring well forms for the GMF Pond well network are included in Appendix B of the HCR (included in the Operating Permit to which this Plan is attached). The location of all IEPA monitoring wells is illustrated in **Figure 2-1**. Groundwater samples are collected quarterly and annually and are analyzed for the laboratory and field parameters listed in **Table A** below.

Table A. IEPA Groundwater Monitoring Program Parameters

Field Parameters			
pH	Temperature	Specific Conductance	
Groundwater Elevation	Depth to Water (bmp)	Bottom of Well Elevation	
Quarterly Parameters (Dissolved)			
Arsenic	Cadmium	Lead	Sulfate
Boron	Chloride	Manganese	Total Dissolved Solids (TDS)
Annual Parameters (Dissolved)			
Alkalinity, bicarbonate	Chromium	Mercury	Selenium
Alkalinity, carbonate	Cobalt	Nickel	Sodium
Ammonia as Nitrogen	Iron	Nitrate nitrogen	Zinc
Calcium	Magnesium	Potassium	

2.1.2 40 C.F.R. § 257 Monitoring Program

The 40 C.F.R. § 257 well network for the GMF Pond consists of seven monitoring wells installed nearby or adjacent to the GMF Pond in the uppermost aquifer. The GMF Pond 40 C.F.R. § 257 well network consists of three background monitoring wells (G02S, G50S, and G51S) and four compliance monitoring wells (G54S, G57S, G60S, and G64S). The boring logs, well construction forms, and other related monitoring well forms are available in the Operating Records as required by 40 C.F.R. § 257.91 for each monitored CCR Unit or CCR Multi-Unit, and are included in Appendix B of the HCR (included in the Operating Permit to which this Plan is attached).

Groundwater is being monitored at the GMF Pond in accordance with the Detection Monitoring Program requirements specified in 40 C.F.R. § 257.94. Details on the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the Sampling and Analysis Plan for the GMF Pond (NRT/OBG, 2017b).

Groundwater samples are collected semiannually and analyzed for the laboratory and field parameters from Appendix III of 40 C.F.R. § 257, summarized in **Table B** below.

Table B. 40 C.F.R. § 257 Groundwater Monitoring Program Parameters

Field Parameters[1]		
pH	Groundwater Elevation	
Appendix III Parameters (Total, except TDS)		
Boron	Chloride	Sulfate
Calcium	Fluoride	TDS

[1]Dissolved oxygen, temperature, specific conductance, oxidation/reduction potential, and turbidity were recorded during sample collection.

Results and analysis of groundwater sampling are reported annually by January 31 of the following year and made available on the CCR public website as required by 40 C.F.R. § 257.

2.1.3 Part 845 Well Installation and Monitoring

In 2021, one additional monitoring well (G54C) was installed between the GMF Pond and the GMF Recycle Pond to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet below ground surface (bgs) as specified in 35 I.A.C. § 845.620(b). Additionally, a porewater sample was collected from a temporary leachate monitoring location (XTPW02) installed within the GMF Pond to characterize the CCR materials.

Prospective Part 845 monitoring wells were sampled for eight rounds from February to August 2021 and the results were assessed for selection of the GMF Pond Part 845 monitoring well network. Groundwater samples were collected and analyzed for 35 I.A.C. § 845.600 parameters as summarized in **Table C** below.

Table C. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

Data and results from the Part 845 background monitoring were included in the water quality discussion included in the HCR (included in the Operating Permit to which this Plan is attached). The data collected from background locations during the Part 845 monitoring were used to evaluate and calculate background concentrations for the GMF Pond. The evaluation and discussion are included in **Section 3.2** of this report.

Data collected from the 40 C.F.R. § 257 monitoring network from 2015 to 2021, and from the Part 845 background monitoring were used for selection of the Part 845 monitoring well network proposed in **Section 2.2**.

2.2 Proposed Part 845 Monitoring Well Network

The groundwater monitoring network proposed in this plan will include seven wells screened in the uppermost aquifer (G02S, G50S, G51S, G54S, G57S, G60S, and G64S), three wells screened in the PMP (G54L, G60L, and G64L), and one temporary water level only monitoring point (X301) that is located in a riser along the south end of the pond for monitoring the phreatic surface within the GMF Pond. The proposed network is summarized in **Table D** below and displayed on **Figure 2-2**. Ten wells (three background and seven compliance) will be used to monitor groundwater concentrations within the hydrostratigraphic units.

The groundwater samples collected from the ten wells will be used to monitor and evaluate groundwater quality and demonstrate compliance with the groundwater quality standards listed in 35 I.A.C. § 845.600(a). The proposed monitoring wells will yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 35 I.A.C. § 845.630(a)(2)). Monitoring well depths and construction details are listed in **Table 2-1** and summarized in **Table D** below.

Table D. Proposed Part 845 Monitoring Well Network

Well ID	Monitored Unit	Well Screen Interval (feet bgs)	Well Type[1]
G02S	UA	23.0 – 28.0	Background
G50S	UA	29.2 – 34.0	Background
G51S	UA	24.0 – 28.8	Background
G54L	PMP	27.3 – 36.8	Compliance
G54S	UA	43.5 – 48.0	Compliance
G57S	UA	29.7 – 34.2	Compliance
G60L	PMP	20.1 – 24.9	Compliance
G60S	UA	31.1 – 35.9	Compliance
G64L	PMP	18.1 – 27.5	Compliance
G64S	UA	34.5 – 39.0	Compliance
X301[2,3]	CCR	NA	WLO

[1] Well Type refers to the role of the well in the monitoring network.
[2] Well is to be used for water level data collection only.
[3] Location is temporary pending implementation of impoundment closure per an approved Construction Permit Application.
NA = not applicable
UA = uppermost aquifer
WLO = water level only

2.3 Well Abandonment

No wells are currently proposed for abandonment.

3. APPLICABLE GROUNDWATER QUALITY STANDARDS

3.1 Groundwater Classification

Groundwater at the GMF Pond meets the definition of Class I – Potable Resource Groundwater (35 I.A.C. § 620.210), based on the following criteria:

- Groundwater in the uppermost aquifer extends ten feet or more below the land surface.
- Field hydraulic conductivity tests performed in the unlithified geologic materials that include loess, shallow sand, and intermediate sand at the GMF Pond resulted in an overall (geometric mean) horizontal hydraulic conductivity exceeding the 1 x 10^{-4} centimeters per second (cm/s) criterion.

However, background (upgradient) groundwater originates from areas north and west of the GMF Pond that have been surface mined and present a significant alternative source for groundwater impacts.

3.2 Statistical Evaluation of Background Groundwater Data

A Statistical Analysis Plan (**Appendix A**) has been developed to describe procedures that will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring.

In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality was either the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). A comparison of the statistical background concentrations and groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) and the resulting GWPSs are summarized in **Table 3-1**.

3.3 Applicable Groundwater Protection Standards

The applicable GWPSs will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The results of the statistical analysis of background groundwater data (**Table 3-1**) indicate that most background concentrations in the uppermost aquifer are less than the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1). Therefore, for these parameters, the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) will be applied to the results from the proposed groundwater monitoring network. The exception being lead, where the background concentration is greater than the 35 I.A.C. § 845.600(a)(1) standard (0.015 milligrams per liter [mg/L] versus 0.0075 mg/L). In this instance, the GWPS will be the background concentration.

Under most circumstances, the GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Exceptions are when there are high percentages (greater than 50 percent) of non-detects in compliance well data, for which

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a future mean (for 50 to 70 percent non-detects) or median (for greater than 70 percent non-detects) will be compared to the GWPS. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Evaluation of the applicable standards will occur in conjunction with the analysis of groundwater quality results. Background calculations and the resulting concentrations may be updated as appropriate, in accordance with the Statistical Analysis Plan included in **Appendix A.**

4. GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards included in 40 C.F.R. § 257.94(e), 40 C.F.R. § 257.95(h), and 35 I.A.C. § 845.600(a). The groundwater monitoring program will include sampling and analysis procedures that are consistent and that provide an accurate representation of groundwater quality at the background and compliance wells as required by 35 I.A.C. § 845.630. As discussed in **Section 2**, three monitoring programs specific to the GMF Pond exist: IEPA WPCP monitoring program, the 40 C.F.R. § 257 monitoring program, and the proposed Part 845 monitoring program. These programs will continue to be monitored as specified in IEPA approvals or 40 C.F.R. § 257. Upon approval of the Operating Permit applications (and by extension the GMP) for the GMF Pond, the monitoring program required by IEPA WPCP will be discontinued following approval of a future permit modification submittal and will be replaced by the proposed Part 845 monitoring program. It is expected that upon USEPA approval of Part 845, the 40 C.F.R. § 257 monitoring program and reporting will be eliminated, and the proposed Part 845 monitoring and reporting included in this Plan will continue until requirements of Part 845 have been achieved.

4.1 Monitoring Networks and Parameters

4.1.1 IEPA Groundwater Monitoring

The existing IEPA monitoring program was discussed in detail in **Section 2.1.1**. Monitoring wells are sampled on a quarterly and yearly frequency for the parameters required under IEPA WPCP 2017-EO-62640. Well locations and parameters will continue to be monitored as required by the WPCP until IEPA approves the Operating Permit (and by extension the GMP) for the GMF Pond.

4.1.2 40 C.F.R. § 257 Groundwater Monitoring

The existing 40 C.F.R. § 257 monitoring program was discussed in detail in **Section 2.1.2**. Seven wells (three background and four compliance) are sampled for Appendix III parameters on a semi-annual frequency. No changes are proposed to this monitoring network. Well locations and parameters will continue to be monitored and reported as required by 40 C.F.R. § 257 until USEPA approves Part 845.

4.1.3 Part 845 Groundwater Monitoring

The proposed Part 845 monitoring network will consist of three background monitoring wells (G02S, G50S, and G51S), seven compliance monitoring wells (G54L, G54S, G57S, G60L, G60S, G64L, and G64S), and one temporary water level only monitoring point (X301) to monitor potential impacts from the GMF Pond (**Figure 2-2**). The monitoring wells are screened within the uppermost aquifer (G02S, G50S, G51S, G54S, G57S, G60S, and G64S) and PMP (G54L, G60L, and G64L) along the perimeter of the GMF Pond. Groundwater samples will be collected and analyzed for the laboratory and field parameters in **Table E** below.

Table E. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential will be recorded during sample collection.

All parameters listed above were sampled a minimum of eight times by October 18, 2021 to establish background groundwater quality in accordance with 35 I.A.C. § 845.650 (b)(1)(A). Discussion of background groundwater quality is included in **Section 3.2**.

4.2 Sampling Schedule

Groundwater sampling for the Part 845 monitoring well network will initially be performed quarterly according to the following schedule:

Table F. Part 845 Sampling Schedule

Frequency	Duration
Monthly (groundwater elevations only)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).
Quarterly (groundwater quality)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii), or upon IEPA approval of an alternate schedule as allowed by 35 I.A.C. § 845.650(b)(4).
Semi-annual (groundwater quality)	Begins: Following 5 years of quarterly groundwater monitoring and IEPA approval of a demonstration that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and not exhibiting statistically-significant increasing trends, monitoring effectiveness is not compromised by a semi-annual schedule, and sufficient data has been collected to characterize groundwater.
	Ends: Following detection of a statistically-significant increasing trend in groundwater concentrations or an exceedance of the standards in 35 I.A.C. § 845.600 (quarterly

	monitoring shall be resumed in these circumstances), or following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).

4.3 Groundwater Sample Collection

Groundwater sampling procedures have been developed and the collection of groundwater samples is being implemented to meet the requirements of 35 I.A.C. § 845.640. In addition to groundwater well samples, quality assurance samples will be collected as described in **Section 4.5** (**Table 4-1**).

4.4 Laboratory Analysis

Laboratory analysis will be performed consistent with the requirements of 35 I.A.C. § 845.640(j) by a state-certified laboratory using methods approved by IEPA and USEPA. Laboratory methods may be modified based on laboratory equipment availability or procedures, but the Reporting Limit (RL) for all parameters analyzed, regardless of method, will be lower than the applicable groundwater quality standard. RLs for the applicable parameters are summarized in **Table 4-2**. Concentrations lower than the RL will be reported as less than the RL.

4.5 Quality Assurance Program

Consistent with the requirements of 35 I.A.C. § 845.640(a)(5), the sampling and analysis program includes procedures and techniques for quality assurance/quality control (QA/QC). Additional quality assurance samples to be collected will include the following:

- Field duplicates will be collected at a frequency of one per group of ten or fewer investigative water samples.
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.
- The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:
  - Regular generation of instrument calibration curves to assure instrument reliability
  - Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
  - Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
  - Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
  - Analysis of method blanks to assure that the system is free of contamination

Water quality meters used to measure pH and turbidity will be calibrated according to manufacturer’s specifications. At a minimum, it is recommended that calibration of pH occur daily prior to sampling and checked for accuracy at the end of each day. Unusual or suspect pH measurements during sampling events will be flagged, evaluated, and additional calibration may

be performed throughout the sampling events. Turbidity meters will be checked daily, prior to and following sampling. Unusual measurements or erratic meter performance will be flagged and evaluated for overall effects on the data prior to reporting.

4.6 Groundwater Monitoring System Maintenance Plan

Consistent with the requirements of 35 I.A.C. § 845.630(e)(2), maintenance will be performed as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring wells will be inspected during each groundwater sampling event; inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional
- Checks to assure that well caps are intact and vented, unless in flood-prone areas in which case caps will not be vented
- Annual measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well
- Checks to assure that wells are clear of internal obstructions, and flow freely

If maintenance of a monitoring well cannot address an identified deficiency, a replacement well will be installed.

4.7 Statistical Analysis

Statistical analysis will be consistent with procedures listed in 35 I.A.C. § 845.640(f). A Statistical Analysis Plan, provided in **Appendix A**, has been developed to summarize the statistical procedures that will be used to evaluate the groundwater results.

4.8 Data Reporting

Data reporting for the 40 C.F.R. § 257 monitoring program will be consistent with recordkeeping, notification, and internet posting requirements described in 40 C.F.R. § 257.105 through 257.107.

Groundwater monitoring and analysis completed in accordance with the Part 845 monitoring under an approved monitoring program will be reported to IEPA within 60 days after completion of sampling and the data placed in the facility's operating record as required by 35 I.A.C. § 845.610(b)(3)(D). Within 14 days of posting to the operating record, information will be posted to the publicly accessible internet site "Illinois CCR Rule Compliance Data and Information" as required by 35 I.A.C. § 845.810(d). Information will also be submitted to IEPA annually by January 31 as required by 35 I.A.C. § 845.550, for data collected the preceding year. The report will include the status of the groundwater monitoring and any required corrective action plan for the GMF Pond in addition to other requirements detailed in 35 I.A.C. § 845.610(e).

4.9 Compliance with Applicable On-site Groundwater Protection Standards

In accordance with 35 I.A.C. § 845.600(a)(1), the groundwater protection standard at the waste boundary will be the higher of either the 35 I.A.C. § 845.600 standard or the concentration determined by background groundwater monitoring.

As provided in 35 I.A.C. § 845.780(c)(2), at the end of the 30-year post-closure care period, groundwater monitoring will continue to be conducted in post-closure care until the groundwater results show the concentrations are:

- Below the GWPS in 35 I.A.C. § 845.600; and
- Not increasing for those constituents over background, using the statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g), provided that:
  - Concentrations have been reduced to the maximum extent feasible; and
  - Concentrations are protective of human health and the environment.

Following detection of an exceedance of the GWPS, an Alternate Source Demonstration (ASD) will be evaluated as described in **Section 4.10**.

4.10 Alternate Source Demonstrations

As allowed in 35 I.A.C. § 845.650(e), following detection of an exceedance of the GWPS, an ASD will be evaluated and, if completed, submitted to IEPA within 60 days. The ASD will provide lines of evidence that a source other than the GMF Pond caused the contamination and the GMF Pond did not contribute to the contamination, or that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction.

The ASD will include information and analysis that supports the conclusions and a certification of accuracy by a qualified professional engineer. Once the ASD is approved by IEPA, the Part 845 groundwater monitoring will continue as defined in **Section 4.1.3**.

If an ASD is not completed and submitted, or IEPA does not approve the ASD, a notification of the exceedance will be provided to IEPA and placed in the operating record. Additional actions will also be completed as required by 35 I.A.C § 845.650(d)(1) through (3), including initiation of an assessment of corrective measures under 35 I.A.C § 845.660. As allowed in 35 I.A.C § 845.650(e)(7) a petition for review of IEPA's non-concurrence under 35 I.A.C. § 105 may also be filed.

4.11 Assessment of Corrective Measures and Corrective Action

As described in 35 I.A.C. § 845.660, if the ASD summarized in **Section 4.10** has not been approved by IEPA, an assessment of corrective measures will be initiated within 90 days of the detection of a result exceeding 35 I.A.C. § 845.600 standards (*i.e.,* receipt of laboratory data). The assessment of corrective measures will include at least the following (35 I.A.C. § 845.660 (c)):

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- The time required to begin and complete the corrective action plan; and

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- The institutional requirements, such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the corrective action plan.

Within one year of completing the assessment of corrective measures, a corrective action plan will be developed to identify the selected remedy in accordance with 35 I.A.C. § 845.670. If closure of the CCR Unit is required, a closure alternatives analysis will be completed as specified in 35 I.A.C. § 845.710. The analysis and selected alternative will be submitted to IEPA in a Closure Plan as specified by 35 I.A.C. § 845.720. Groundwater monitoring proposed in this Addendum will continue as specified until the post closure care period has expired and IEPA has approved termination of post-closure care.

5. REFERENCES

Illinois Environmental Protection Agency, 2021. *Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845.* April 15, 2021.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017a. *Hydrogeologic Monitoring Plan, Duck Creek GMF Pond – CCR Unit ID 203 and Duck Creek Landfill – CCR Unit ID 204.* October 17, 2017.

Natural Resource Technology, an OBG Company. (NRT/OBG), 2017b. *Sampling and Analysis Plan, Final, Duck Creek GMF Pond, Duck Creek Power Station, Canton, Illinois, Project No. 2285, Revision 0.* October 17, 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. *Hydrogeologic Site Characterization Report. Gypsum Management Facility Pond. Duck Creek Power Plant*. Canton, Illinois.

United States Environmental Protection Agency (USEPA), March 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance*. Office of Resource Conservation and Recovery, Program Implementation and Information Division, United States Environmental Protection Agency, Washington D.C. EPA/530/R-09/007.

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TABLES

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TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in GMP
845.630	**Groundwater Monitoring Systems**	
845.630(a)(2)	Potential contaminant pathways must be monitored.	Sections 2.2 & 4.1.3 Table 2-1
845.630(a) 845.630(b) 845.630(c)	At least two upgradient wells and four downgradient wells (min. 1 and 3, but requires additional documentation)	Sections 2.2 & 4.1.3 Table 2-1 Figure 2-2
845.630(a) 845.630(b) 845.630(c)	Downgradient Well Density	Figure 2-2
845.630(a)(2)	Downgradient wells at waste boundary	Figure 2-2
845.640	**Groundwater Sampling and Analysis Requirements**	
845.640(a)	Consistent sampling and analysis procedures	Section 4 Tables 4-1 & 4-2
845.640(b)	Methods are appropriate	Section 4 Tables 4-1 & 4-2
845.640(c)	Groundwater elevations must be measured in each well prior to purging, each time groundwater is sampled.	Section 4.3
845.640 (d)(e)(f)(g)(h)	Establishment of background and application of statistical methods	Sections 3 & 4.7 Appendix A
845.640(i)	Analyze total recoverable metals	Section 4.1.3
845.640(j)	Analyze groundwater samples using a certified laboratory	Section 4.4

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TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in GMP
845.650	**Groundwater Monitoring Program**	
845.650(a)	Must include monitoring for all constituents with a groundwater protection standard in Section 845.600(a), calcium, and turbidity	Section 4.1.3
845.650(b)(c)	Groundwater Monitoring Frequency	Sections 4.1.3 & 4.2
845.650(d)(e)	Exceedances of the groundwater protection standard	Sections 4.9, 4.10, & 4.11
845.650(b)(2) and (3)	Staff gauge/ piezometer to monitor head in impoundment	Sections 2.2 & 4.1.3 Figure 2-1 (X301)
NA	Staff gauge/ piezometer to monitor head of neighboring surface water body	NA

[O: CJC 09/17/21; C: LDC 09/20/21]

Notes:
GMP = Groundwater Monitoring Plan
NA = Not Applicable

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TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Well Number	Type	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G02S	B	UA	09/29/2003	--	621.66	Top of Disk	619.18	23.00	28.00	596.18	591.18	28.00	589.20	5	2	40.512879	-89.991105
G50S	B	UA	03/13/2007	623.65	623.65	Top of Riser	620.83	29.17	33.98	591.66	586.85	34.30	586.50	4.8	2	40.508672	-89.990607
G51S	B	UA	01/28/2008	619.66	619.66	Top of Riser	616.83	24.01	28.79	592.82	588.04	29.16	587.70	4.8	2	40.50656	-89.990864
G54L	C	UA/PMP	02/12/2009	622.95	622.95	Top of Riser	620.18	27.32	36.75	592.86	583.43	37.22	583.00	9.4	2	40.504524	-89.988927
G54S	C	UA	02/12/2009	622.98	622.98	Top of Riser	620.25	43.50	47.97	576.75	572.28	48.41	571.80	4.5	2	40.504525	-89.98894
G57S	C	UA	01/30/2009	622.76	622.76	Top of Riser	620.20	29.65	34.18	590.55	586.02	34.62	582.20	4.5	2	40.505608	-89.987043
G60L	C	UA/PMP	01/17/2008	615.39	615.39	Top of Riser	612.69	20.12	24.91	592.57	587.78	25.28	587.40	4.8	2	40.506745	-89.986816
G60S	C	UA	01/16/2008	615.03	615.03	Top of Riser	612.33	31.12	35.91	581.21	576.42	36.29	574.30	4.8	2	40.506732	-89.986815
G64L	C	UA/PMP	01/22/2009	622.46	622.46	Top of Riser	620.24	18.12	27.48	602.12	592.76	27.95	592.30	9.4	2	40.508378	-89.987007
G64S	C	UA	01/22/2009	623.06	623.06	Top of Riser	620.25	34.50	38.99	585.75	581.26	39.48	580.30	4.5	2	40.508365	-89.987011
X301	WLO	S	--	--	--	--	--	--	--	--	--	--	--	--	--	40.504777	-89.990046

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
Type refers to the role of the well in the monitoring network: background (B), compliance (C), or water level measurements only (WLO)
WLO wells are temporary pending implementation of impoundment closure per an approved Construction Permit application
-- = data not available
BGS = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
PVC = polyvinyl chloride
S = source water
UA = uppermost aquifer
UA/PMP = uppermost aquifer/potential migration pathway

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TABLE 3-1. BACKGROUND GROUNDWATER QUALITY AND STANDARDS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Parameter	Background Concentration	845 Limit	Groundwater Protection Standard	Unit
Antimony, total	0.003	0.006	0.006	mg/L
Arsenic, total	0.0092	0.010	0.010	mg/L
Barium, total	0.28	2.0	2.0	mg/L
Beryllium, total	0.001	0.004	0.004	mg/L
Boron, total	0.21	2	2	mg/L
Cadmium, total	0.001	0.005	0.005	mg/L
Chloride, total	17	200	200	mg/L
Chromium, total	0.0059	0.1	0.1	mg/L
Cobalt, total	0.002	0.006	0.006	mg/L
Fluoride, total	0.498	4.0	4.0	mg/L
Lead, total	0.015	0.0075	0.015	mg/L
Lithium, total	0.02	0.04	0.04	mg/L
Mercury, total	0.00098	0.002	0.002	mg/L
Molybdenum, total	0.0023	0.1	0.1	mg/L
pH (field)	7.4 / 6.6	9.0 / 6.5	9.0 / 6.5	SU
Radium 226 and 228 combined	2	5	5	pCi/L
Selenium, total	0.0012	0.05	0.05	mg/L
Sulfate, total	55	400	400	mg/L
Thallium, total	0.001	0.002	0.002	mg/L
Total Dissolved Solids	483	1200	1200	mg/L

Notes:
For pH, the values presented are the upper / lower limits
Groundwater protection standards for calcium and turbidity do not apply per 35 I.A.C. § 845.600(b)
mg/L = milligrams per liter
SU = standard units
pCi/L = picocuries per liter

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TABLE 4-1. SAMPLING AND ANALYSIS SUMMARY
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Parameter	Analytical Method [1]	Number of Samples	Field Duplicates [2]	Field Blanks [3]	Equipment Blanks [3]	MS/MSD [4]	Total	Container Type	Minimum Volume [5]	Preservation (Cool to 4 °C for all samples)	Sample Hold Time from Collection Date
Metals											
Metals [6]	6020, Li - EPA 200.7	10	1	0	0	1	12	plastic	600 mL	HNO_3 to pH<2	6 months
Mercury	7470A or 6020	10	1	0	0	1	12	plastic	400 mL	HNO_3 to pH<2	28 days
Inorganic Parameters											
Fluoride	9214 or EPA 300	10	1	0	0	1	12	plastic	300 mL	Cool to 4 °C	28 days
Chloride	9251 or EPA 300	10	1	0	0	1	12	plastic	100 mL	Cool to 4 °C	28 days
Sulfate	9036 or EPA 300	10	1	0	0	1	12	plastic	50 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540 C	10	1	0	0	1	12	plastic	200 mL	Cool to 4 °C	7 days
Radium											
Radium 226	9315 or EPA 903	10	0	0	0	0	10	plastic	1000 mL	HNO_3 to pH<2	6 months
Radium 228	9320 or EPA 904	10	0	0	0	0	10	plastic	1000 mL	HNO_3 to pH<2	6 months
Field Parameters											
pH	SM 4500-H+ B	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Dissolved Oxygen [8]	SM 4500-O/405.1	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Temperature [8]	SM 2550	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential [8]	SM 2580 B	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Specific Conductance [8]	SM 2510 B	10	NA	NA	NA	NA	10	flow-through cell	NA	none	immediately
Turbidity [7]	SM 2130 B	10	NA	NA	NA	NA	10	flow-through cell or hand-held turbidity meter	NA	none	immediately

[O: CJC 09/17/21; C: LDC 09/20/21]

Notes:
[1] Analytical method numbers are from SW-846 unless otherwise indicated. Analytical methods may be updated with more recent versions as appropriate.
[2] Field duplicates will be collected at a frequency of one per group of 10 or fewer investigative water samples. Field duplicates will not be collected for radium analysis.
[3] Field blanks will be collected at the discretion of the project manager; Equipment blanks will be collected at a rate of 1 per sampling event if non-dedicated equipment is used.
[4] Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer investigative water samples per CCR unit/multi-unit. Additional volume to be determined by laboratory.
[5] Sample volume is estimated and will be determined by the laboratory.
[6] Metals = antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, lead, lithium, molybdenum, selenium, thallium. Metals may be analyzed via ICP/ ICP-MS USEPA methods 6010 or 6020 depending on laboratory instrument availability
[7] If turbidity exceeds 10 NTUs, a duplicate sample filtered through a .45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
[8] Parameter collected for quality assurance and quality control for field sampling purposes only; not required to be collected or reported under Part 845; collection of parameter may be discontinued without notification.
< = less than
°C = degrees Celsius
GMF = Gypsum Management Facility
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
NTU = nephelometric turbidity unit

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TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
GMF POND
CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Metals							
Antimony	7440-36-0	mg/L	6020	0.006	0.006	0.003	0.00036
Arsenic	7440-38-2	mg/L	6020	0.01	0.01	0.001	0.00013
Barium	7440-39-3	mg/L	6020	2	2	0.001	0.00028
Beryllium	7440-41-7	mg/L	6020	0.004	0.004	0.001	0.000017
Boron	7440-42-8	mg/L	6020	NS	2	0.01	0.0023
Cadmium	7440-43-9	mg/L	6020	0.005	0.005	0.001	0.000042
Calcium	7440-70-2	mg/L	6020	NS	NS	0.15	0.15
Chromium	7440-47-3	mg/L	6020	0.1	0.1	0.004	0.00027
Cobalt	7440-48-4	mg/L	6020	0.006	0.006	0.002	0.000017
Lead	7439-92-1	mg/L	6020	0.015	0.0075	0.001	0.000025
Lithium	7439-93-2	mg/L	6020 or EPA 200.7	0.04	0.04	0.02	0.0001
Mercury	7439-97-6	mg/L	6020 or 7470A	0.002	0.002	0.0002	0.000078
Molybdenum	7439-98-7	mg/L	6020	0.1	0.1	0.001	0.000063
Selenium	7782-49-2	mg/L	6020	0.05	0.05	0.001	0.00032
Thallium	7440-28-0	mg/L	6020	0.002	0.002	0.001	0.000062
Inorganics							
Fluoride	7681	mg/L	9214 or EPA 300	4	4	0.25	0.065
Chloride	16887-00-6	mg/L	9251 or EPA 300	250 [3]	200	1	0.15
Sulfate	18785-72-3	mg/L	9036 or EPA 300	250 [3]	400	1	0.24
Total Dissolved Solids	10052	mg/L	SM 2540C	500 [3]	1200	17	--
Other							
Radium 226 and 228 combined	7440-14-4	pCi/L	9315/9320 or EPA 903/904	5	5	-- [6]	-- [7]

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TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

GMF POND

CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Field							
pH	NA	SU	SM 4500-H+ B	NS	6.5-9.0	NA	NA
Oxidation/Reduction Potential	NA	mV	SM 2580 B	NS	NS	NA	NA
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	NS	NS	NA	NA
Temperature	NA	°C	SM 2550	NS	NS	NA	NA
Specific Conductivity	NA	µS/cm	SM 2510 B	NS	NS	NA	NA
Turbidity	NA	NTU	SM 2130 B	NS	NS	NA	NA

[O: CJC 09/17/21; C: LDC 09/20/21]

Notes:

[1] Analytical method numbers are from SW-846 unless otherwise indicated. Metals will be analyzed via Method 6020 or 6010 depending on laboratory equipment availability. Selected method will ensure reporting limits (RL) are below Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600 groundwater protection standards.

[2] USEPA MCL = United States Environmental Protection Agency Maximum Contaminant Level.

[3] USEPA SMCL = United States Environmental Protection Agency Secondary Maximum Contaminant Level.

[4] RLs will be less than the 35 I.A.C. § 845.600 groundwater protection standards.

[5] RLs and method detection limits (MDL) will vary depending on the laboratory performing the work.

[6] All radium results will be reported (values may be positive or negative) and will include uncertainty and the calculated MDC.

[7] Laboratories calculate a minimum detectable concentration (MDC) based on the sample.

°C = degrees Celsius

µS/cm = microSiemens per centimeter

CAS = Chemical Abstract Number

MDL = Method detection limit as established by the laboratory

mg/L = milligrams per liter

mV = millivolts

NS = No standard

NTU = nephelometric turbidity unit

pCi/L = picoCuries per liter

RL = Reporting limit as established by the laboratory

SM = Standard Methods for the Examination of Water and Wastewater

SU = standard units

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FIGURES

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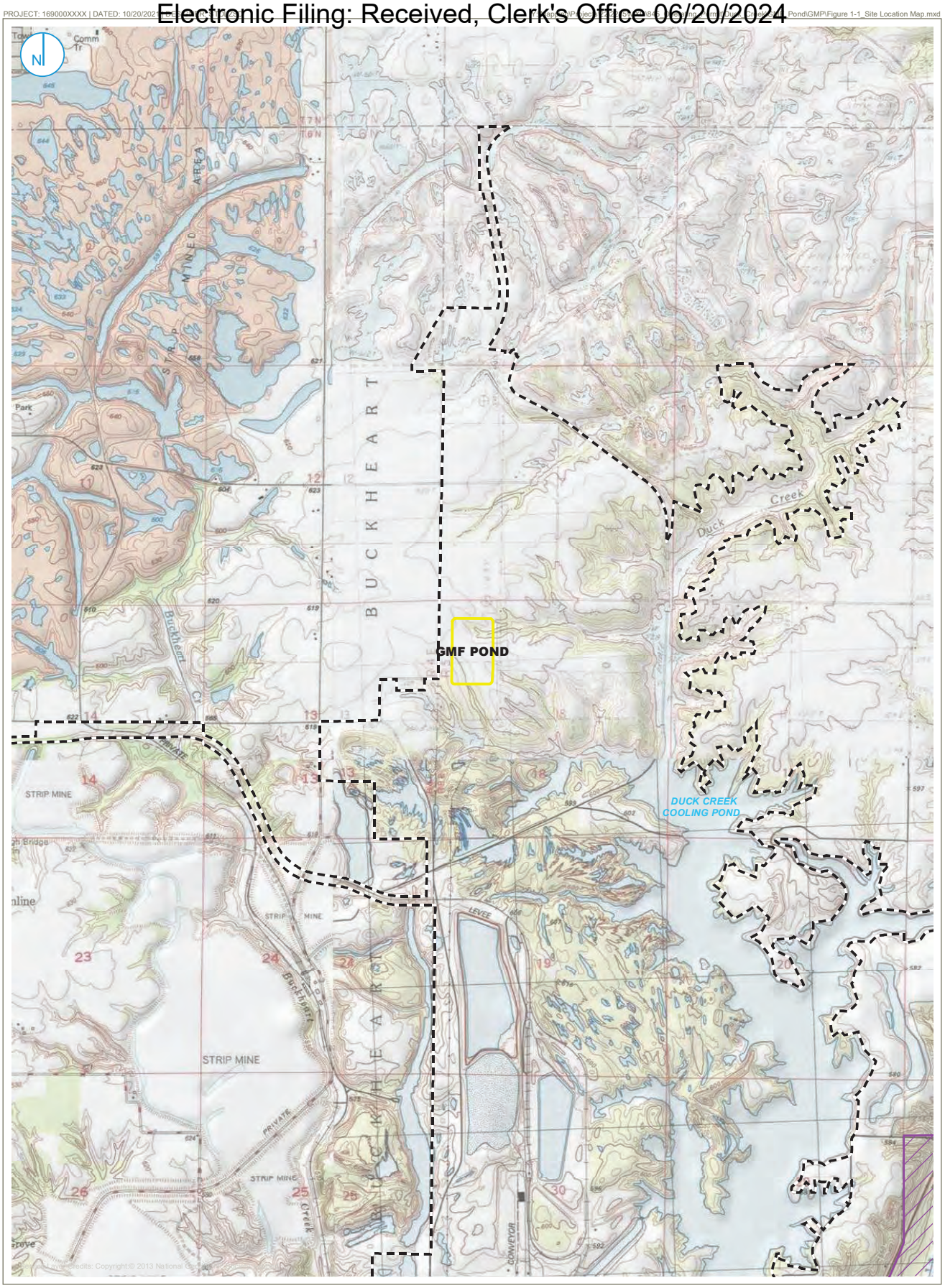
PROJECT: 169000XXXX | DATED: 10/20/2021 | DESIGNER: [illegible] | Pond\GMP\Figure 1-1_Site Location Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY
RICE LAKE STATE RECREATION AREA

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-1

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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PROJECT: 169000XXXX | DATED: 9/21/2021 | DESIGN: ... | ...\GMF_Pond\GMP\Figure 1-2_Site Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

SITE MAP

FIGURE 1-2

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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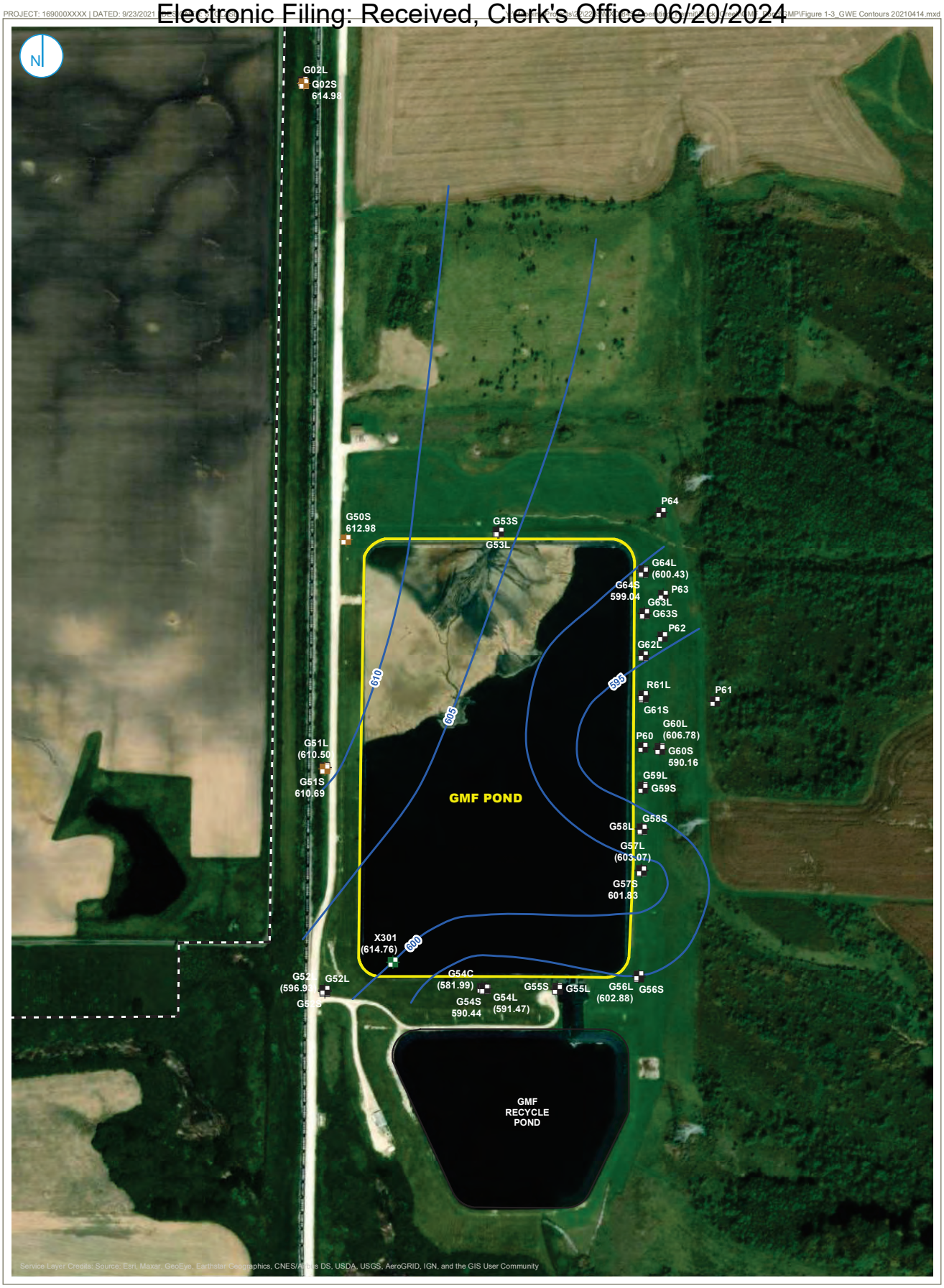
PROJECT: 169000XXXX | DATED: 9/23/2021 | DESIGN: ... | Figure 1-3_GWE Contours 20210414.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS APRIL 14, 2021

FIGURE 1-3

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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PROJECT: 169000XXXX | DATED: 10/19/2021 | DESIGNER: [illegible] | IEPA Monitoring Program Well Network.mxd



MONITORING WELL
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

IEPA MONITORING PROGRAM WELL NETWORK

FIGURE 2-1

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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PROJECT: 169000XXXX | DATED: 10/18/2021 | DESIGNED BY: [illegible] | Proposed 845 GW Monitoring Well Network.mxd



BACKGROUND WELL
COMPLIANCE WELL
SOURCE SAMPLE LOCATION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 150 300 Feet

PROPOSED PART 845 GROUNDWATER MONITORING WELL NETWORK

FIGURE 2-2

GROUNDWATER MONITORING PLAN
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

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APPENDIX A
STATISTICAL ANALYSIS PLAN

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Prepared for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

STATISTICAL ANALYSIS PLAN

GYPSUM MANAGEMENT FACILITY POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

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STATISTICAL ANALYSIS PLAN
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND

Project Name	**Duck Creek Power Plant Gypsum Management Facility Pond**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Statistical Analysis Plan**
Version	**FINAL**
Date	**October 25, 2021**

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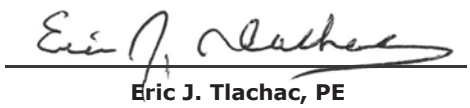
Brian G. Hennings, PG
Senior Managing Hydrogeologist



Eric J. Tlachac, PE
Senior Managing Engineer



Rachel A. Banoff, EIT
Project Statistician

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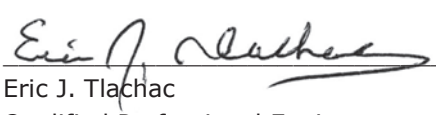
LICENSED PROFESSIONAL CERTIFICATIONS

This certification is based on the description of the statistical methods selected to evaluate groundwater as presented in the following Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond. The procedures described in the plan will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in the United States Environmental Protection Agency (USEPA)'s *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring. In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality will be either the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). Groundwater Protection Standards (GWPS) will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Description of the statistical methods chosen for analysis of groundwater monitoring data and application of these methods for determining exceedances of the GWPS identified in 35 I.A.C. § 845.600(a) is provided in this Statistical Analysis Plan.

35 I.A.C. § 845.640 Statistical Analysis (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the statistical methods summarized above and described in this document (Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.



Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021



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35 I.A.C. § 845.640 Statistical Analysis (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

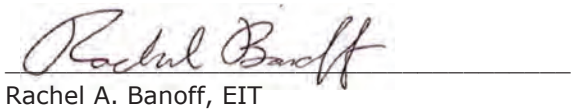




Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

35 I.A.C. § 845.640 Statistical Analysis

I, Rachel A. Banoff, a qualified professional, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Gypsum Management Facility Pond), are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.



Rachel A. Banoff, EIT
Project Statistician
Date: October 25, 2021

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TABLES (IN TEXT)

Table A Statistical Calculations Used in Compliance Monitoring Procedures

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ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
ANOVA	analysis of variance
CCR	coal combustion residuals
COC	constituents of concern
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
LTL	lower tolerance limit
MSE	mean squared error
P	probability
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
ROS	regression on order statistics
SI	surface impoundment
SSI	statistically significant increase
SWFPR	site-wide false positive rate
Unified Guidance	*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009)
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

In April 2021, the Illinois Environmental Protection Agency (IEPA) issued a final rule for the regulation and management of Coal Combustion Residuals (CCR) in surface impoundments (SIs) under the Standards for the Disposal of CCR in Surface Impoundments: Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845). Facilities regulated under Part 845 are required to develop and sample a groundwater monitoring well network to evaluate whether impounded CCR materials are impacting downgradient groundwater quality. The groundwater quality evaluation must include selection and certification by a qualified professional engineer of the statistical procedures to be used. The procedures described in the evaluation will be used to establish background conditions and implement compliance and corrective action monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. This Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA's) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance*) (March 2009).

This Statistical Analysis Plan does not include procedures for groundwater sample collection and analysis, as these activities are conducted in accordance with the Sampling and Analysis Plan prepared for each CCR unit in accordance with 35 I.A.C. § 845.640. This Statistical Analysis Plan will be used as the primary reference for evaluating groundwater quality during operation and post-closure care.

1.1 Statistical Analysis Objectives

This Statistical Analysis Plan is intended to provide a logical process and framework for conducting the statistical analyses of data obtained during groundwater monitoring conducted in accordance with the Sampling and Analysis Plan for each CCR unit. The Statistical Analysis Plan will enable a qualified professional engineer to certify that the selected statistical methods are appropriate for evaluating the groundwater monitoring data for the applicable CCR unit(s).

1.2 Statistical Analysis Plan Approach

The main sections of this Statistical Analysis Plan should be viewed as a "generic" outline of statistical methods utilized for each CCR unit and constituent required to be monitored. The statistical analysis of the groundwater monitoring data, however, will be conducted on an individual-constituent or well basis, and may involve the use of appropriate statistical procedures depending on multiple factors such as detection frequency and normality distributions.

The CCR Rule outlines two phases of groundwater monitoring:

- Background Monitoring in accordance with 35 I.A.C. § 845.650(b)(1)
- Compliance Monitoring in accordance with 35 I.A.C. § 845.650

Each phase of the groundwater monitoring program requires specific statistical procedures to accomplish the intended purpose. During the background monitoring phase, background groundwater quality will be established utilizing upgradient and background wells and downgradient groundwater quality data will be collected to facilitate statistics in subsequent phases. Compliance Monitoring is then initiated through the evaluation of the downgradient

groundwater monitoring data for exceedances of the groundwater protection standard (GWPS) established by Part 845 (concentration specified in 35 I.A.C. § 845.600 or an IEPA-approved background concentration). The developed statistical analysis plan will be implemented for each monitoring phase and in accordance with the statistical procedures.

2. BACKGROUND MONITORING AND DATA PREPARATION

The background and compliance monitoring wells were sampled and analyzed for constituents, as listed in Part 845 (antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, pH, radium 226 and 228 combined, selenium, sulfate, thallium, total dissolved solids, and turbidity), during the baseline phase of the groundwater monitoring program.

The background monitoring well(s) were placed upgradient of the CCR unit, or at an alternative background location, where they are not affected by potential leakage from the CCR unit. Compliance monitoring wells were placed at the waste boundary of the CCR unit, along the same groundwater flow path. As 35 I.A.C. § 845.630(a) specifies, the location of these wells ensures that background accurately represents the quality of unaffected groundwater, while compliance wells accurately represent groundwater quality at the waste boundary and monitor all potential contaminant pathways.

As required by 35 I.A.C. § 845.650(a)(1), eight sampling events were completed within 180 days of April 21, 2021. As outlined, groundwater sampling procedures included sampling of the background and compliance wells using low-flow sampling methods, collection of one field quality control sample per event, and groundwater samples were not field filtered before laboratory analysis of total recoverable metals.

Following completion of the eight sampling events, background groundwater quality was established for Part 845 constituents. Groundwater monitoring will be conducted quarterly for at least the first five years. In accordance with 35 I.A.C. § 845.650(b)(4), after the first five years, a request to reduce the monitoring frequency to semiannual may be submitted to IEPA if all of the following can be demonstrated:

- Groundwater monitoring effectiveness will not be compromised by the reduced frequency
- Sufficient data has been collected to characterize groundwater
- Monitoring to date does not show any statistically significant increasing trends
- The concentrations of monitored constituents at the compliance monitoring wells are below the applicable GWPSs established in 35 I.A.C. § 845.600

The following subsections outline the statistical tests and procedures (methods) that will be utilized to evaluate data collected for each constituent in both background and compliance wells for Background and Compliance Monitoring. When necessary and contingent upon equivalent statistical power, an alternative test not included in this Statistical Analysis Plan may be chosen due to site-specific data requirements.

2.1 Sample Independence

Independence of sample results is a major assumption for most statistical analyses. To ensure physical independence of groundwater sampling results, the minimum time between sampling events must be longer than the time required for groundwater to move through the monitoring well. The sampling schedules for both the baseline and compliance monitoring periods are specified in 35 I.A.C. § 845.650(b) and may conflict with the statistical assumption of independence of sample results.

2.2 Non-Detect Data Processing

The reporting limit (RL) will be used as the lower level for the reporting of non-detected groundwater quality data. For all summary statistics (box plots, timeseries, etc.), the RL will be substituted for concentrations reported below the RL, including non-detects. With professional judgement, analytical results between the RL and the method detection limit, *i.e.,* estimated values, typically identified with a "J" flag, may be utilized if provided by the laboratory.

For all statistical test procedures:

- If the frequency of non-detect data are less than or equal to 15 percent, half of the RL will be substituted for these data
- If the non-detect frequency is between 15 percent and 50 percent, either the Kaplan-Meier or robust regression on order statistics (ROS) will be used to estimate the mean and standard deviation adjusted for the presence of left-censored values
- If the non-detect frequency is greater than 50 percent, a non-parametric test will be used
- If only one background result is detected that value will be used as the non-parametric upper prediction limit (UPL)

2.3 Testing for Normality

Many statistical analyses assume that sample data are normally distributed (parametric). However, environmental data are frequently not normally distributed (nonparametric). 35 I.A.C. § 845.640(g) requires the knowledge of the background data distribution for comparison to compliance results. The *Unified Guidance* document recommends the Shapiro-Wilk normality test for sample sizes of 50 or less, and the Shapiro-Francia normality test for sample sizes greater than 50.

When possible, transformation of datasets to achieve normal distributions is preferred.

2.4 Testing for Outliers

Part 845 constituents will be screened for the existence of outliers using a method described by the *Unified Guidance*. Outliers are extreme data points that may represent an anomaly or erroneous data point. To test for outliers, one or more of the following outlier tests will be utilized:

- Dixon's test, for well-constituent pairs with less than 25 samples, assumes normally distributed data.
- Rosner's test, for well-constituent pairs with more than 20 samples, assumes normally distributed data.
- Grubb's test for well-constituent pairs with seven or more samples, assumes normally distributed data.
- Time series, box-whisker plots, and probability plots provide visual tools to identify potential outliers, and evaluation of seasonal, spatial, or temporal variability for both normally and non-normally distributed data.

Data quality control, groundwater geochemistry, and sampling procedures will be evaluated as potential sources of error leading to an outlier result. The outlier tests cannot be used alone to determine whether a value is a true outlier that should be excluded from future statistical

analysis. Corroborating evidence needed to exclude values includes a discrete data reporting or analytical error, or potential laboratory bias. Absent corroborating evidence, the flagged values are considered true, but extreme, values in the data set. Professional judgement will be used to exclude extreme outliers from further statistical analyses. Outliers will be retained in the database.

With professional judgement, a confirmatory sample may be collected to allow for the distinction between an outlier and a true representation of groundwater quality at the monitoring point. If re-sampling is conducted, this sample will be collected within 90 days following outlier identification. If the confirmatory sample indicates the original result as an outlier, it will be reported as such.

2.5 Trend Analysis

Statistical analyses supporting the lack of trend are a fundamental step to confirm the assumption that groundwater quality values are stationary or constant over time at a CCR unit. These analyses allow for evaluation of variation in the background and compliance data for each constituent over time. A statistically significant increasing trend in background data could indicate an existing release from the CCR unit or alternate source, requiring further investigation. In addition, statistically significant trending background data can result in increased standard deviation and, therefore, greater prediction or control limits. Consequently, the increased prediction or control limit will have less power or ability to identify a release from the CCR unit.

A linear regression, coupled with a t-test for slope significance at a 95 percent confidence level (0.05 significance level), may be used on datasets for each constituent with few non-detects and a normally distributed variance of the mean to evaluate time trends. The Theil-Sen trend line, coupled with the Mann-Kendall test for slope significance at a 95 percent confidence level (0.05 significance level), will be used for datasets with frequent non-detects or non-normal variance. Similarly, trend analyses could also be used on compliance data to evaluate a possible release from the CCR unit.

2.6 Spatial Variation

Spatial trends and/or variation between background wells could indicate an existing release from a CCR unit. If the spatial variability is not due to an existing release, intrawell comparisons in compliance wells may be used to account for spatial variability and monitor for a future release. However, the CCR unit being monitored was placed into service prior to the start of groundwater monitoring and it is unknown whether a previous release has occurred. Accordingly, intrawell comparisons in compliance wells cannot be used to determine the occurrence of a future release. Interwell comparisons between compliance wells and background wells will be used.

2.7 Temporal Variation

Time series plots can be used to identify temporal dependence. Potentially significant temporal components of variability can be identified by graphing single constituent data from multiple wells together on a time series plot. With temporal dependence, the time series plot as a pattern of parallel traces, in which the individual wells will tend to rise and fall together across the sequence of sampling dates. Time series plots can be helpful by plotting multiple constituents over time for the same well, or averaging values for each constituent across wells on each sampling event and then plotting the averages over time. In either case, the plots can signify whether the general concentration pattern over time is simultaneously observed for different

constituents. If so, it may indicate that a group of constituents is highly correlated in groundwater or that the same artifacts of sampling and/or lab analysis impacted the results of several monitoring parameters.

Hydrologic factors such as drought, recharge patterns or regular (*e.g.,* seasonal) water table fluctuations may be responsible for the temporal variation. In these cases, it may be useful to test for the presence of a significant temporal effect by first constructing a parallel time series plot and then running a formal one-way analysis of variance (ANOVA) ($\alpha = 0.05$) for temporal effects. A one-way ANOVA for temporal effects considers multiple well data sets for individual sampling events or seasons as the relevant statistical factor. If event-specific analytical differences or seasonality appear to be an important temporal factor, the one-way ANOVA for temporal effects can be used to formally identify seasonality, parallel trends, or changes in lab performance that affect other temporal effects. The one-way ANOVA for temporal effects assumes that the data groups are normally distributed with constant variance. It is also assumed that for each of a series of background wells, measurements are collected at each well on sampling events or dates common to all the wells. Results of the ANOVA can also be used to create temporally stationary residuals, where the temporal effect has been 'subtracted from' the original measurements. These stationary residuals may be used to replace the original data in subsequent statistical testing.

If the data cannot be normalized, a similar test for a temporal or seasonal effect can be performed using the Kruskal-Wallis test ($\alpha = 0.05$). Each sampling event should be treated as a separate 'well,' while each well is treated as a separate 'sampling event.' In this case, no residuals can be computed since the Kruskal-Wallis test employs ranks of the data rather than the measurements themselves.

Where both spatial and temporal variation occur, two-way ANOVA can be considered where both well location and sampling event/season are treated as statistical factors. This procedure is described in Davis (1994).

2.8 Updating Background

Updating the background dataset periodically by adding recent results to an existing background dataset can improve the statistical power and accuracy of the statistical analysis, especially for non-parametric prediction intervals. The *Unified Guidance* recommends updating statistical limits (background) when at least four to eight new measurements (every 1 to 2 years under a quarterly monitoring program), are available for comparison to historical data. Professional judgement will be used to evaluate whether any background data appear to be affected by a release and need to be excluded from a background update. A t-test for equal means (if normal data distribution) or appropriate non-parametric test (if non-normal data distribution) such as a Mann-Whitney (or Wilcoxon) rank-sum or box-whisker plots, will be conducted to evaluate whether the two groups of background sample populations are statistically different prior to updating any background datasets. A 0.05 significance level will be utilized when evaluating the two populations, with the null hypothesis that they are equivalent. In addition, time series graphs or other trend evaluation statistics will be conducted on the new background dataset to verify the absence of a release or changing groundwater quality. If the tests indicate that there are no statistical differences between the two background populations, the new data will be combined with the existing dataset. If the two populations are found to be different, the data will be reviewed to evaluate the cause of the difference. If the differences appear to be caused by a

release (if the new data are significantly higher, or lower for pH), then the previous background dataset may continue to be used. Furthermore, verified outliers will not be added to an existing background dataset. In accordance with the *Unified Guidance*, continual background updates will not be conducted due to the lack of sufficient samples for a statistical comparison.

3. COMPLIANCE MONITORING

Compliance monitoring is designed to monitor groundwater for evidence of a release by comparing Part 845 constituents in compliance wells to both background concentrations and the GWPS. Compliance Monitoring will begin the 1st quarter following approval of this Groundwater Monitoring Plan and issuance of the Operating Permit. The selected Compliance Monitoring statistical method used to compare compliance groundwater quality data for each constituent to the GWPS will provide for adequate statistical power, error levels and individual test false positive rates, and be appropriate for the distribution and detection frequency of the background dataset. Statistical power is the ability of a statistical test to detect a true exceedance.

In accordance with 35 I.A.C. § 845.610(b)(3)(D), compliance monitoring statistical analyses will be completed and submitted to IEPA within 60 days after completion of sampling.

3.1 GWPS Establishment and Exceedance Determination

In accordance with 35 I.A.C. § 845.600(a), the GWPS will be the constituent concentrations specified in 35 I.A.C. § 845.600(a)(1) except for when the background concentration is greater, or no concentration is specified (*i.e.,* for calcium and turbidity), in which case the GWPS will be the background concentration. The GWPS based on background concentration will be calculated using a parametric upper tolerance limit (UTL), a parametric UPL for a future mean, or a non-parametric UPL for a future median.

Statistical calculations that will be utilized in Compliance Monitoring procedures are summarized in **Table A** below and listed in **Sections 3.1.1** through **3.1.7**. Depending on the distribution of the data and the percentage of non-detects, it may be more appropriate to use a parametric model over a non-parametric model. As necessary, other techniques as mentioned in the *Unified Guidance* and/or new methods will be implemented.

Table A. Statistical Calculations Used in Compliance Monitoring Procedures

Compliance Monitoring						
Significant Trend?	Background Data			Compliance Data		
	Percent Non-Detects	Distribution	GWPS Determination	Percent Non-Detects	Distribution	Method to Determine Exceedance
No	0 ≤ 50	Normal	35 I.A.C § 845.600(a)(1) constituent concentration or The Upper Tolerance Limit	≤75	Normal	Parametric Lower Confidence Limit around a Normal Mean
				≤75	Log-Normal	Parametric Lower Confidence Limit around a Lognormal Geometric Mean
				NA	Non-Normal	Non-Parametric Lower Confidence Limit around a Median
				>75	Unknown/ Cannot be determined	
	50 ≤ 70	Normal	The Upper Prediction Limit for a Future Mean	NA	NA	Future mean
	>70	Non-Normal	Upper Prediction Limit for a Future Median	NA	NA	Future median
	100	Non-Normal	Double Quantification Rule	NA	NA	Individual Retesting Values
Yes	0 ≤ 50	Normal	UCL of Confidence Band around Linear Regression	≤75	Residuals after subtracting trend are normal, equal variance	Lower Limit from Confidence Band around Linear Regression
	50 ≤ 100	Non-Normal	UCL of Confidence Band around Thiel-Sen trend line	≤75	Residuals not normal	Lower Limit from Confidence Band around Thiel-Sen

3.1.1 The Upper Tolerance Limit

The UTL will be used to calculate the GWPS when pooled background data are normally distributed, with a non-detect frequency of 50 percent or less. When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects. The *Unified Guidance* recommends 95 percent confidence level and 95 percent coverage (95/95 tolerance interval).

- When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects (simple substitution), and the normal mean and standard deviation will be calculated.

- The Kaplan-Meier or the ROS method will be used when the detection frequency is between 15 percent and 50 percent. The Kaplan-Meier method assesses the linearity of a censored probability plot to determine whether the background sample can be approximately normalized. If so, then the Kaplan-Meier method will be used to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. The Kaplan-Meier or ROS estimate of the mean and standard deviation will be substituted for the sample mean and standard deviation.
- If background normality cannot be achieved, non-parametric UTLs will not be calculated until a minimum of 60 background samples have been collected (to achieve 95 percent coverage).

The parametric UTL on a future mean will be calculated from the background dataset as follows:

$$UTL = \overline{x} + \kappa\,(n, \gamma, \alpha - 1) \cdot s$$

$\overline{x}$ = background sample mean

s = background sample standard deviation

$\kappa\,(n, \gamma, \alpha - 1)$ = one-sided normal tolerance factor based on the chosen coverage (γ) and confidence level (α -1) and the size of the background dataset (n). Values are tabulated in Table 17-3 in Appendix D of the *Unified Guidance*. If exact values are not provided, then κ values can be estimated by linear interpolation.

If the UTL is constructed on the logarithms of original observations to achieve normality, where $\overline{y}$ and s_y are the log-mean and log-standard deviation, the limit will be exponentiated for back-transformation to the concentration scale as follows:

$$UTL = \exp\left[\overline{y} + \kappa\,(n, \gamma, \alpha - 1) \cdot s_y\right]$$

$\overline{y}$ = background sample log-mean

s_y = background sample log-standard deviation

When the GWPS is based on the 35 I.A.C. § 845.600(a)(1) constituent concentrations or a UTL derived from the background dataset, an exceedance in compliance wells relative to the GWPS will be evaluated using confidence intervals. A confidence interval defines the upper and lower bound of the true mean of a constituent concentration in groundwater within a specified confidence range.

- Non-detects in compliance data will be handled similarly to upgradient analyses, with half the RL substituted for non-detects when the frequency is 15 percent or less.
- The Kaplan-Meier, or the ROS method, will be used when the detection frequency is between 15 percent and 50 percent to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. These estimates will then be substituted for the sample mean and standard deviation.

Once the GWPS is established for background data using the UTL, either parametric or non-parametric confidence intervals will be computed for each constituent in compliance wells to identify GWPS exceedances.

3.1.2 Parametric Confidence Intervals around a Mean

If compliance data are approximately normal, one-sided parametric confidence intervals around a sample mean will be constructed for each constituent and well pair. The lower confidence limit (LCL) will be calculated as:

$$LCL_{1-\alpha} = \overline{x} - t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

$\overline{x}$ = compliance sample mean

s = compliance sample standard deviation

n = compliance sample size

$t_{1-\alpha,n-1}$ = obtained from a Student's t-table with (n–1) degrees of freedom (Table 16-1 in Appendix D of the *Unified Guidance*)

The chosen t value will aim to achieve both a low false-positive rate, and high statistical power. Minimum α values are tabulated in Table 22-2 of Appendix D of the *Unified Guidance*. The selected minimum α value, from which the t value will be derived, will have at least 80 percent power (1-β = 0.8) when the underlying mean concentration is twice the GWPS.

If compliance data are distributed lognormally, the LCL will be computed around the lognormal geometric mean as:

$$LCL_{1-\alpha} = \exp\left(\overline{y} - t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

$\overline{y}$ = compliance sample log-mean

s_y = compliance sample log-standard deviation

3.1.3 Non-Parametric Confidence Intervals around a Median

Non-parametric confidence intervals around the median will be computed if the compliance data contain greater than 50 percent non-detects or are not normally distributed. The mathematical algorithm used to construct non-parametric confidence intervals is based on the probability (*P*) that any randomly selected measurement in a sample of n concentration measurements will be less than an unknown *P* x 100th percentile of interest (where *P* is between 0 and 1). Then the probability that the measurement will exceed the *P* x 100th percentile is (1–*P*). The number of sample values falling below the *P* x 100th percentile out of a set of n should follow a binomial distribution with parameters n and success probability *P*, where 'success' is defined as the event that a sample measurement is below the *P* x 100th percentile. The probability that the interval formed by a given pair of order statistics will contain the percentile of interest will then be determined by a cumulative binomial distribution *Bin(x;n,p)*, representing the probability of *x* or fewer successes occurring in *n* trials with success probability p. *P* will be set to 0.50 for an interval around the median.

The sample size n will be ordered from least to greatest. Given *P* = 0.50, candidate interval endpoints will be chosen by ordered data values with ranks close to the product of (n+1) x 0.50. If the result of (n+1) x 0.50 is a fraction (for even-numbered sample sizes), the rank values immediately above and below will be selected as possible candidate endpoints. If the result of (n+1) x 0.50 is an integer (for odd-numbered sample sizes), one will be added to and subtracted

from the result to get the upper and lower candidate endpoints. The ranks of the endpoints will be denoted L* and U*. For a one-sided LCL, the confidence level associated with endpoint L* will be computed as:

$$1 - \alpha = Bin(L^* - 1; n, 0.50) = \sum_{x=L^*}^{n} \binom{n}{x} \left(\frac{1}{2}\right)^n$$

If the candidate endpoint(s) do not achieve the desired confidence level, new candidate endpoints (L*–1) and (U*+1) and achieved confidence levels will be calculated. If one candidate endpoint equals the data minimum or maximum, only the rank of the other endpoint will be changed. Achievable confidence levels are tabulated using these equations in Table 21-11 in Appendix D of the *Unified Guidance*.

Both parametric and non-parametric confidence limits will then be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance monitoring wells. A GWPS exceedance is determined if the LCL exceeds the GWPS.

3.1.4 The Upper Prediction Limit for a Future Mean

The parametric UPL for a future mean will be used to calculate the GWPS if the pooled background data contain 50 to 70 percent non-detects and normality can be achieved. The Kaplan-Meier or ROS methods will be used to estimate the mean and standard deviation. The non-parametric UPL for a future median will be calculated as the GWPS if background samples cannot be normalized or contain greater than 70 percent non-detects. The parametric UPL for a future mean will be calculated from the background dataset at follows:

$$UPL_{1-\alpha} = \overline{x} + \kappa s$$

$\overline{x}$ = background sample mean

s = background standard deviation

κ = multiplier based on the order (p) of the future mean to be predicted, the number of compliance wells to be tested (w), the background sample size (n) the number (c) of constituents of concern (COCs), the "1-of-m" retesting scheme, and the evaluation schedule (annual, semi-annual, quarterly). Values are tabulated in 19-5 to 19-9 in Appendix D of the *Unified Guidance*.

The mean of order p will be computed for each well and compared against the UPL. For any compliance point mean that exceeds the limit, p additional resamples may be collected at that well for a 1-of-2 retesting scheme. Resample means will then be compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when the initial mean and all resample means exceed the UPL.

3.1.5 The Non-Parametric Upper Prediction Limit for a Future Median

The non-parametric UPL for a future median will be used to calculate the GWPS if the pooled background data contain greater than 70 percent non-detects and normality cannot be achieved. Non-parametric methods assume that the data does not have an underlying distribution. To calculate the non-parametric UPL on a future value, the target per-constituent false positive rate (α_{const}) will be determined as follows:

$$\alpha_{const} = 1 - (1 - \alpha)^{1/c}$$

α = the site-wide false positive rate (SWFPR) of 0.10 recommended by the *Unified Guidance*

c = the number of monitoring constituents

The number of yearly statistical evaluation (nE) will be multiplied by the number of compliance wells (w) to determine the look-up table entry, w*. The background sample size (n) and w* will be used to select an achievable per-constituent false positive rate value in Table 19-24 of Appendix D in the *Unified Guidance*. The chosen achievable per-constituent false positive rate value will determine the type of non-parametric prediction limit (maximum or 2nd highest value in background) and a retesting scheme for a future median. The background data will be sorted in ascending order, and the upper prediction limit will be set to the appropriate order statistic previously determined by the achievable per-constituent false positive rate value in Table 19-24. If all constituent measurements in a background sample are non-detect, the Double Quantification rule will be used. The use of the Double Quantification rule in Compliance Monitoring will only be applicable if the RL is above the 35 I.A.C. § 845.600(a)(1) constituent concentration or a constituent concentration is not specified in § 845.600(a)(1). This scenario is highly unlikely. The constituent will also be removed from calculations identifying the target false positive rate.

Two initial measurements per compliance well will be collected. If both do not exceed the upper prediction limit, a third initial measurement will not be collected since the median of order 3 will also not exceed the limit. If both exceed the prediction limit, a third initial measurement will not be collected since the median will also exceed the limit. If one initial measurement is above and one below the limit, a third initial observation may be collected to determine the position of the median relative to the UPL. Up to three resamples will be collected in order to assess the resample median. In all cases, if two or more of the compliance point observations are non-detect, the median will be set equal to the RL. The median value for each compliance well will be compared to the UPL. For the 1-of-2 retesting scheme, if any compliance point median exceeds the limit, up to three additional resamples will may be collected from that well. The resample median will be computed and compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when either the initial median, or both the initial median and resample median exceed the UPL.

If the concentrations of detected constituents are below the established GWPS, Compliance Monitoring will continue.

3.1.6 Parametric Linear Regression and Confidence Band

If the t-test detects a significant trend in the parametric linear regression line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. If this is not accounted for, a wider confidence interval will inevitably be calculated for a given confidence level and sample size (n). A wider confidence interval will result in less statistical power, or ability to demonstrate an exceedance or return to compliance. When a linear trend line has been estimated, a series of confidence intervals is estimated at each point along the trend. This creates a simultaneous confidence band that follows the trend line. As the underlying population mean increases or decreases, the confidence band does also to reflect this change at that point in time.

Linear regression will be used when background or compliance data are approximately normally distributed, with a constant sample variance around the mean, and the frequency of non-detects is low. The linear regression of concentration against sampling date (time) will be computed as follows:

$$\hat{b} = \sum_{i=1}^{n} (t_i - \overline{t}) \cdot x_i / (n-1) \cdot s_t^2$$

x_i = i^{th} concentration value and

t_i = i^{th} sampling date

$\overline{t}$ = sampling mean date

s_t^2 = variance of the sampling dates

This estimate leads to the following regression equation:

$$\hat{x} = \overline{x} + \hat{b} \cdot (\mathrm{t} - \overline{t})$$

$\overline{x}$ = mean concentration level

$\hat{x}$ = estimated mean concentration at time t

The regression residuals will also be computed at each sampling event to ensure uniformity and lack of significant skewness. Regression residuals will be computed at each sampling event as follows:

$$r_i = x_i - \hat{x}_i$$

The estimated variance around the regression line, or mean squared error (MSE) will be computed as follows:

$$s_e^2 = \frac{1}{n-2} \sum_{i=1}^{n} r_i^2$$

The confidence intervals around a linear regression trend line given confidence level (1-α) and a point in time (t_0), will be computed as follows:

$$LCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-1} \cdot \left[\frac{1}{n} + \frac{(t_0 - \overline{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$$UCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-2} \cdot \left[\frac{1}{n} + \frac{(t_0 - \overline{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$\hat{x}_0$ = estimated mean concentration from the regression equation at time t_0

$F_{1-2\alpha,2,\mathrm{n}-2}$ = upper (1-2α)th percentage point from an F-distribution with 2 and (n-2) degrees of freedom

For background data, the UCL around the linear regression line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the linear regression line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is determined when the LCL based on the trend line first exceeds the GWPS.

3.1.7 Non-Parametric Thiel-Sen Trend Line and Confidence Band

If the Mann-Kendall test detects a significant trend in the non-parametric Thiel-Sen line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. The Thiel-Sen trend line will be used as a non-parametric alternative to linear regression when trend residuals cannot be normalized or if there are a higher percentage of non-detects in either background or compliance data. The Thiel-Sen trend line estimates the median concentration over time by combining the median pairwise slope with the median concentration value and the median sample date. To compute the Thiel-Sen line, the data will first be ordered by sampling event x1, x2, xn. All possible distinct pairs of measurements (x_i, x_j) for j > i will be considered and the simple pairwise slope estimate will be computed for each pair as follows:

$$m_{ij} = (x_j - x_i)/(j - i)$$

With a sample size of n, there will be a total of N = n(n-1)/2 pairwise estimates (m_{ij}). If a given observation is a non-detect, half the RL will be substituted. The N pairwise slope estimates (m_{ij}) will be ordered from least to greatest (renamed m(1), m(2),..m(N)). The Thiel-Sen estimate of slope (Q) will be calculated as the median value of the list depending on whether N is even or odd as follows:

$$Q = \begin{cases} m_{([N+1]/2)} \; if \; N \; is \; odd \\ (m_{(N/2)} + m_{([N+2]/2)})/2 \; if \; N \; is \; even \end{cases}$$

The sample concentration magnitude will be ordered from least to greatest, x(1), x(2), to x(n) and the median concentration will be calculated as follows:

$$\tilde{x} = \begin{cases} x_{([n+1]/2)} \; if \; n \; is \; odd \\ (x_{(n/2)} + x_{([n+2]/2)})/2 \; if \; n \; is \; even \end{cases}$$

The median sampling date ($\tilde{t}$) with ordered times (t(1), t(2), to t(n)) will also be determined in this way. The Thiel-Sen trend line will then be computed for an estimate at any time (t) of the expected median concentration (x) as follows:

$$x = \tilde{x} + Q \cdot (\mathrm{t} - \tilde{t}) = (\tilde{x} - Q \cdot \tilde{t}) + Q \cdot \mathrm{t}$$

To construct a confidence band around the Thiel-Sen line, sample pairs (ti, xi) will be formed with a sample date (ti) and the concentration measurement from that date (xi). Bootstrap samples (B) will be formed by repeatedly sampling n pairs at random with replacement from the original sample pairs. This will be repeated 500 times. For each bootstrap sample, a Thiel-Sen trend line will be constructed using the equation above. A series of equally spaced time points (tj) will be identified along the range of sampling dates represented in the original sample, j =1 to m. The Thiel-Sen trend line associated with each bootstrap replicate will be used to compute an estimated concentration ($\hat{x}_j^B$). An LCL will be constructed for the lower α^{th} percentile $\hat{x}_j^{[\alpha]}$ from the distribution of estimated concentrations at each time point (tj). For a UCL, compute the upper (1-α)th percentile, $\hat{x}_j^{[1-\alpha]}$ at each time point (tj).

For background data, the UCL around the Thiel-Sen trend line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the Thiel-Sen trend line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is confirmed when the LCL based on the trend line first exceeds the GWPS.

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3.2 Determination of Statistically Significant Increases over Background

In accordance with 35 I.A.C. §§ 845.610(b)(3)(B) and 845.640(h), individual monitoring event concentrations for each constituent detected in the compliance monitoring wells during compliance monitoring sampling events will be compared to the background concentration as determined by the methods described above. An exceedance of the background concentration for any constituent measured at any compliance monitoring well, or constituent detection if not detected in the background samples, constitutes a Statistically Significant Increase (SSI). An exception to this method is pH, where two-sided (upper and lower) tolerance limits are established from the distribution of the background groundwater quality data. An exceedance of either the UTL or lower tolerance limit (LTL) would constitute an SSI for pH.

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4. REFERENCES

Davis, C.B., 1994. *Environmental Regulatory Statistics.* In GP Patil & CR Rao (Eds.) *Handbook of Statistics, Volume 12: Environmental Statistics*, Chapter 26. New York: Elsevier Science B.V.

United States Environmental Protection Agency (USEPA), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*. EPA 530-R-09-007. March 2009.

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APPENDIX J

Post-closure Care Plan

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POST-CLOSURE PLAN FOR EXISTING CCR SURFACE IMPOUNDMENT
40 C.F.R. § 257.104 and 35 I.A.C. 845.780
REV 0 – 10/30/2021

SITE INFORMATION

Site Name / Address	Duck Creek Power Plant / 17751 North Cilco Road, Canton, IL 62234		
Owner Name / Address	Illinois Power Generating Company / 6555 Sierra Drive Irving, Texas 75039		
CCR Unit	GMF Pond	Closure Method and Final Cover Type	Close In-Place Geomembrane with Soil and Vegetation Cover

POST-CLOSURE PLAN DESCRIPTION

40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1) – Length of post-closure care period.	Post-closure care will be conducted for a period of 30 years as required by 40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1), except as provided by 40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2).
40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2) - Circumstances extending the post closure care period.	If at the end of the post-closure care period the CCR unit is operating under assessment monitoring in accordance with §257.95, the post-closure care as described in this plan will continue until returning to detection monitoring in accordance with §257.95. Under 35 I.A.C. 845.780(c)(2), the post-closure care period will be extended until groundwater monitoring data demonstrate that concentrations are below the groundwater protection standards in Section 845.600 and are not increasing for those constituents over background, using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that concentrations have been reduced to the maximum extent feasible and concentrations are protective of human health and the environment.
40 C.F.R. § 257.104(d)(1)(i) and 35 I.A.C. 845.780(d)(1)(A) – A description of the monitoring and maintenance activities required in 40 C.F.R. § 257.104(b) and 845.780(b), and the frequency at which these activities will be performed, to maintain the integrity and effectiveness of the final cover system, maintain the groundwater monitoring system and monitor the groundwater.	Pursuant to § 257.104(b)(1) and 35 I.A.C. 845.780(b)(1), throughout the post-closure care period, periodic visual observations of the final cover system and stormwater management system will be performed at least annually for evidence of settlement, subsidence, erosion, or other damage that may adversely affect the integrity and effectiveness of the final cover system. When practical, visual observations of the final cover will be made concurrent with groundwater monitoring activities. Noted evidence of damage, such as damage to the geosynthetic components, rills, surface cracks and settlement, will be repaired to maintain the integrity and effectiveness of the final cover system. Vegetation will be established and maintained on the final cover system, including storm drainage areas, where appropriate, to provide long-term erosion control. Established vegetation and the slope design of the final cover system will prevent potential erosion and damage

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	that may be caused by run-on and run-off. Repair activities may include, but are not limited to, repairing, or replacing damaged geosynthetic components, replacing and compacting soil cover, repairing drainage channels that have been eroded, filling in depressions with soil, regrading, and reseeding areas of failed vegetation, as necessary. Pursuant to § 257.104(b)(3) and 35 I.A.C. 845.780(b)(3), the groundwater monitoring system will be maintained, and groundwater will be monitored as required by 40 C.F.R. § 257.90 through 40 C.F.R. § 257.98 and 35 I.A.C. 845.600 through 35 I.A.C. 845.680. Monitoring wells will be inspected during each groundwater sampling event. Monitoring wells and associated instrumentation will be maintained so that they perform to the design specifications throughout the life of the monitoring program. Groundwater monitoring frequency will be at least quarterly, except as provided in 40 C.F.R. § 257.94(d), 257.94(c), and 35 I.A.C. 845.650(b)(4).
40 C.F.R. § 257.104(d)(1)(ii) and 35 I.A.C. 845.780(d)(1)(B) – The name, address, telephone number and email address of the person or office to contact about the facility during the post-closure care period.	Illinois Power Generating Company 6555 Sierra Drive Irving, Texas 75039 800.633.4704 ccr@dynegy.com
40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) – A description of the planned uses of the property during the post-closure period.	The CCR unit is located at a retired electric generation facility. Planned uses of the property during the post-closure period are currently unknown, except for post-closure care of the CCR unit. Post-closure use of the property will not disturb the integrity of the final cover system or other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements of 40 C.F.R. Part § 257, Subpart D and 35 I.A.C. Part 845. Any other disturbance will be conducted following a demonstration that it will not increase the potential threat to human health or the environment, as required by 40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780 (d)(1)(C). The demonstration will be certified by a qualified professional engineer and submitted to the Illinois Environmental Protection Agency (IEPA). Per 40 C.F.R. § 257.104(d)(1)(iii) notification shall be provided to the State Director that the demonstration has been placed in the operating record and on the owners or operator's publicly accessible internet site. Following closure of the CCR unit, a notation on the deed to the property, or some other instrument that is normally examined during title search, will be recorded in accordance with 40 C.F.R. § 257.102(i) and 35 I.A.C. 845.760(h). The notation will notify potential purchasers of the property that the land has been used as a CCR unit and its use is restricted under the post-closure care requirements in 40 C.F.R. 40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) or groundwater monitoring requirements per 35 I.A.C. 845.740(b). Within 30 days of recording the deed notation, a notification stating that the notation has been recorded will be submitted to the IEPA and placed in the facility's operating record per 845.760(h)(3). The notification will be placed on

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	the owner or operator's publicly accessible CCR Web site in accordance with 40 C.F.R. § 257.107(i)(9) and 35 I.A.C. 845.810(e) and placed in the facility's operating record as required by 35 I.A.C. 845.800(d)(26) and §257.105(i)(9).
40 C.F.R. § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3)– Amendments to the initial or subsequent written post-closure plan.	Pursuant to 40 C.F.R. § 257.104(d), the initial post closure care plan for the Duck Creek GMF Pond was prepared on October 17, 2016. That plan is being amended pursuant to 40 C.F.R. § 257.104(d)(3)(i). This plan also serves as the initial post-closure care plan, prepared in accordance with 35 I.A.C. 845.780(d). Pursuant to § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3), an operating permit modification application to amend the initial or any subsequent written post-closure care plan developed under 35 I.A.C. 845.780 (d)(1) and § 257.104(d)(1) will be submitted to IEPA. The written post-closure care plan will be amended whenever there is a change in the operation of the CCR surface impoundment that would substantially affect the written post-closure care plan in effect; or unanticipated events necessitate a revision of the written post-closure care plan, after post-closure activities have started. The written post-closure care plan will be amended at least 60 days before a planned change in the operation of the facility or CCR surface impoundment, or within 60 days after an unanticipated event requires the need to revise the existing plan. If the plan is revised after post-closure activities have started, a request to modify the operating permit, including an amended written post-closure care plan, will be submitted to the IEPA within 30 days following the triggering event.
40 C.F.R. § 257.104(d)(4) and 35 I.A.C. 845.780(d)(4) – Qualified professional engineering certification.	Certification by a qualified professional engineer will be appended to this plan and any amendment of this plan.
35 I.A.C. 845.780(e) – Termination of post-closure care.	Upon completion of the post-closure period, a request to terminate post-closure care will be submitted to the IEPA. The request will include a certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the post-closure care plan specified in 35 I.A.C. 845.780(d) and the requirements of 35 I.A.C. 845.780.
40 C.F.R. § 257.104(e) and 35 I.A.C. 845.780(f) – Notification of completion of the post-closure care period.	A notification of completion of post-closure care will be prepared and placed in the facility's operating record within 30 days after IEPA approval of the request to terminate post-closure care. The notification will be placed in the facility's operating record in accordance with 35 I.A.C. 845.800(d)(31) and § 257.105(i)(13). The notification will be placed on the owner or operator's publicly accessible CCR Internet site in accordance with the requirements of § 257.107(i)(13) and 35 I.A.C. 845.810(e). The IEPA will be notified when the notification has been placed in the operating record and on the owner or operator's publicly accessible Internet site in accordance with the requirements of § 257.106(i)(13).

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Certification Statement 40 C.F.R. § 257.104 (d)(4) and 35 I.A.C. 845.780(d)(4) – Amended/Initial Written Post Closure Plan for a CCR Surface Impoundment

CCR Unit: Illinois Power Resources Generating, LLC; Duck Creek Power Plant; GMF Pond

I, John R. Hesemann, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above referenced CCR Unit, that the information contained in the amended/initial written post closure plan, dated October 30, 2021, meets the requirements of 40 C.F.R. § 257.104 and 35 I.A.C. 845.780.

John R. Hesemann

Printed Name

9/28/2021

Date



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APPENDIX K

Legal Description

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Land Description of the Duck Creek Power Plant
GMF Pond Facility Boundary
39.42 Acres

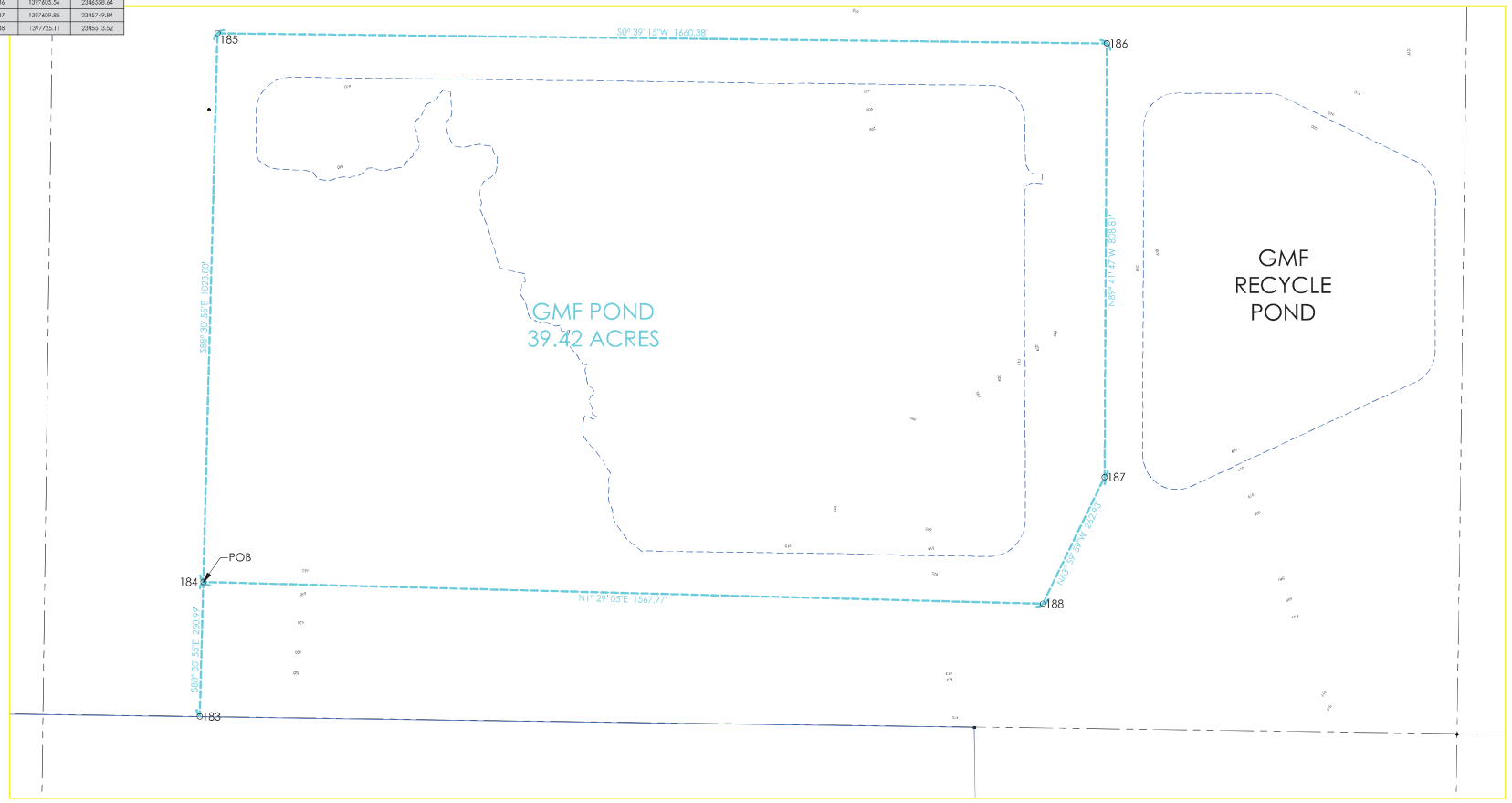
Part of the Northwest Quarter of Section 18, Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County, Illinois and being more particularly described as follows:

Commencing at the Four Way Township Corner Being the same as the Southeast corner of Section 36 T. 6 N., R. 4 E., also being the same as the Southwest corner of Section 31 T. 6 N., R. 5 E. of the Fourth Principal Meridian; thence North 0 degrees 46 minutes 44 seconds East along the Township line dividing T. 6 N., R 4 E. and T. 6 N., R. 5 E. a distance of 20,948.09 feet; thence South 88 degrees 30 minutes 55 seconds East a distance of 250.99 feet to the Point of Beginning of the Tract described herein; thence continuing South 88 degrees 30 minutes 55 seconds East a distance of 1023.8 feet; thence South 0 degrees 39 minutes 15 seconds west, a distance of 1660.38 feet; thence North 89 degrees 41 minutes 47 seconds West a distance of 808.81 feet; thence North 63 degrees 59 minutes 59 seconds West, a distance of 262.93 feet; thence North 01 degrees 29 minutes 05 seconds East a distance of 1567.77 feet to the Point of Beginning and containing 39.42 Acres.

FACILITY CORNER COORDINATES		
Point #	Northing	Easting
183	1399298.86	2345303.24
184	1399292.36	2345554.14
185	1399265.83	2346577.60
186	1397605.56	2346558.64
187	1397609.85	2345749.84
188	1397735.11	2345513.52

Luminant

ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT



SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN MARCH 16 THROUGH JUNE 29, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS SHOWN HEREON ARE BASED ON NAVD 1988.

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:		Date:
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7		
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9		
10		
11		
12		
13		

Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

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Drawing Name:
GMF POND BOUNDARY EXHIBIT

Date:	Project No.
9/21/2021	
Type: SITE	Drawing No. 3
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

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Land Description of the Duck Creek Power Plant
GMF Pond Facility Boundary
39.42 Acres

Part of the Northwest Quarter of Section 18, Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County, Illinois and being more particularly described as follows:

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184	1399292.36	2345554.14
185	1399265.83	2346577.60
186	1397605.36	2346558.64
187	1397609.85	2345749.84
188	1397725.11	2345513.52

Luminant

ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT

0' 100' 200'

LEGEND
- SECTION LINE
- RESTRICTED USE BOUNDARY
- APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE
- FACILITY BOUNDARY
- N0° 47' 10"E 3100.48' RECORD BOUNDARY DIMENSIONS
- FOUND SURVEY MARKER AS NOTED
- M DENOTES MEASURED DIMENSION

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN MARCH 16 THROUGH JUNE 29, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS SHOWN HEREON ARE BASED ON NAVD 1988.



IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:		Date:
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Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

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Drawing Name:
GMF POND BOUNDARY EXHIBIT

Date:	Project No.
9/21/2021	
Type: SITE	Drawing No. 4
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

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APPENDIX L

Public Meetings Information

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Dianna Tickner
Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

January 28, 2022

Illinois Environmental Protection Agency
DWPC – Permits MC # 15
ATTN: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: 35 IAC 845.220(a)(9) Certification Statement
Duck Creek Power Plant GMF Pond (IEPA ID # W0578010001-04)

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundment and in accordance with 35 IAC 845.220(a)(9), Illinois Power Resources Generating, LLC certifies that the public notification and public meetings required under 35 IAC 845.240 were completed. Please find enclosed both the public meeting summary and listserv.

Sincerely,
Illinois Power Resources Generating, LLC

Dianna Tickner
Director, Decommissioning & Demolition

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Duck Creek Public Meeting Issues Summary, December 7, 2021

On Sunday, November 7, 2021, Illinois Power Resource Generating, LLC made available to the public its plans to close the GMF Pond and Bottom Ash Basin (BAB) CCR surface impoundments located at Duck Creek Power Plant. On Tuesday, December 7, 2021, Illinois Power Resource Generating, LLC held in-person and virtual public meetings at 3:00 pm and 5:30 pm to present its decision-making process, a comparison of projected groundwater impacts for the alternatives presented, and an objective comparison of the pros and cons of each alternative presented. During the question-and-answer portion of the meeting, the public asked questions related to the closure and, the company-provided answers.

As required by Section 845.240(g), Illinois Power Resource Generating, LLC distributed to those public meeting attendees who requested a copy a general summary of the issues raised by the public, a response to those issues or comments raised by the public, and a summary of any revisions, changes, and considerations made to the closure plans, on December 21, 2021.

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
1.	Engineered Final Cover System at the GMF Pond	The final cover system includes a 60-mil high-density polyethylene (HDPE) geomembrane and 2 feet of soil on top of the geomembrane to protect the geomembrane from damage. Vegetative grass with a shallow root system will be planted on the final cover system. The geomembrane will be rolled out in panels. The panels will be heat sealed to each other. In combination with the existing liner system, the final cover system will provide complete encapsulation of the material within the GMF Pond. The final cover system will be monitored for 30 years. If preferential pathways for water infiltration through the final cover system were to form, they would be detected during the monitoring and inspections and would be corrected. Groundwater data will continue to be collected to monitor system performance. Groundwater data will be publicly available.	The issue of geomembrane service life was raised. A significant amount of research has been conducted to evaluate the expected service life of geomembranes under different field conditions. The Geosynthetics Research Institute developed the foremost technical paper on this topic entitled "Geomembrane Lifetime Predictions: Unexposed and Exposed Conditions" (Koerner et al., 2011) to summarize the findings from a 12-year study on this topic and to provide guidance on the expected service life for geomembranes. The expected service life of a geomembrane is dependent on whether it is exposed or unexposed to ultraviolet radiation and other environmental factors, as well as the in-service temperature of the geomembrane. The geomembrane in the final cover system over the GMF Pond will be covered with soil, so it will be unexposed. Considering the soil cover thickness and the climate at the site, the highest expected in-service temperature at the depth of the geomembrane is about 20°C (68°F). According to Koerner et al. (2011), the expected service life of an HDPE geomembrane under these conditions is nearly 450 years.

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Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			In accordance with Section 845.780(c), the monitoring and inspection period for the GMF Pond is at least 30 years.
2.	GMF Pond Liner System	The GMF Pond was built and lined in or around 2010. The liner system beneath the GMF Pond is a very robust, state-of-the-art system. No exceedances of Groundwater Protection Standards (GWPS) related to the GMF Pond have been detected.	Based on information reviewed after the public meeting, the GMF Pond was constructed in 2008 and 2009. The GMF Pond liner system was designed and constructed to meet or exceed the criteria specified in 35 IAC 811 and 40 CFR 257 (Hanson Professional Services Inc., 2016). It has an upper geomembrane and a lower geomembrane with a leak detection system between them. The leak detection system has not detected any leakage. The lower geomembrane has two additional soil barrier layers below it for enhanced containment/redundancy. The issue of geomembrane service life was raised. A significant amount of research has been conducted to evaluate the expected service life of geomembranes under different field conditions. The Geosynthetics Research Institute developed the foremost technical paper on this topic entitled "Geomembrane Lifetime Predictions: Unexposed and Exposed Conditions" (Koerner et al., 2011) to summarize the findings from a 12-year study on this topic and to provide guidance on the expected service life for geomembranes. The expected service life of a geomembrane is dependent on whether it is exposed or unexposed to ultraviolet radiation and other environmental factors, as well as the in-service temperature of the geomembrane. The geomembranes in the liner system beneath the GMF Pond will be unexposed at closure. Considering the depth to the liner system and the measured temperatures of groundwater in the vicinity of the GMF Pond, the highest expected in-service temperature at the depths of the geomembranes is about 20°C (68°F).

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			According to Koerner et al. (2011), the expected service life of an HDPE geomembrane under these conditions is nearly 450 years. As a result of the issue raised by the public, the closure plan for the GMF Pond will be revised slightly to indicate that all areas of the liner system will be covered with soil to prevent geomembrane exposure.
3.	Groundwater Monitoring	At the GMF Pond, there are approximately 52 groundwater monitoring wells. At the BAB, there are approximately 10 groundwater monitoring wells. Maps and tables showing well locations and depths have been provided in the on-line, publicly available materials. Quarterly groundwater monitoring is required for at least 30 years after closure of the GMF Pond (closure in place). Groundwater monitoring is required for at least 3 years after closure of the BAB (closure by removal). Follow-up actions are required if GWPS exceedances are detected, as prescribed in Part 845, but there is no expectation of future impacts associated with the GMF Pond or BAB.	Based on information reviewed after the public meeting, we have confirmed there are 10 monitoring wells around the BAB. There are 36 monitoring wells around the GMF Pond, and 16 monitoring wells located around the GMF Recycle Pond. The proposed Part 845 monitoring well network for the BAB consists of 8 monitoring wells. The proposed Part 845 monitoring well network for the GMF Pond will consist of 10 wells and 1 unit water monitoring location.
4.	Water Handling	Ponded water in the GMF Pond will be removed to facilitate closure; interstitial water (water within pore spaces) will remain. Water will be discharged through an existing NPDES outfall, consistent with permit requirements. Treatment may be required prior to discharge.	No additional response is necessary.

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R003091

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
5.	Risk Assessment	We will provide a written response for this issue due to the level of technical detail involved.	The Duck Creek Power Plant Risk Assessment was conducted to identify potential hazards and evaluate potential risks to human and ecological receptors that may be exposed to CCR constituents in environmental media potentially impacted by the GMF Pond and BAB. The conceptual site model (CSM) provides a basis for understanding the site conditions and exposure pathways for receptors that may be exposed to site-related constituents. Exposure pathways refer to the way a person or animal could come in contact with a constituent. They are generally referred to as either complete or incomplete. The necessary components for a complete exposure pathway consist of: ▪ A source and mechanism of constituent release from the source; ▪ Retention or transport of the constituent through the environmental medium; ▪ A point of contact between the receptor and the environmental medium; and ▪ A route of exposure for the potential receptor at the contact point. Cancer risks are expressed as a unitless probability of an individual developing cancer over a lifetime, above background risk, as a result of site-related exposures. US EPA has established an acceptable target cancer risk range of 1×10^{-6} to 1×10^{-4} (US EPA, 1990, 1991). Non-cancer risks are expressed as a hazard index (HI) and US EPA has established an acceptable target HI of 1 (US EPA, 1997). An HI less than 1 suggests that exposures are not likely to cause an appreciable risk of non-cancer effects during a lifetime. Risks above these US EPA defined target levels are termed potentially "unacceptable risks".

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R003092

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			For the Duck Creek Risk Assessment, we followed processes and protocols provided by US EPA comparing measured and modeled environmental concentrations to screening levels (*e.g.*, surface water quality standards) that have been determined by US EPA to be protective of human health and the environment. If the environmental concentrations were below the health protective screening levels, we concluded that there is no unacceptable risk. Based on the evaluation, no unacceptable risks to human and ecological receptors resulting from CCR exposures associated with either the GMF Pond or the BAB were identified.
6.	Closure Cost Estimation	For this current evaluation cost estimates were not considered. Cost estimates are being prepared and will be included in the construction permit application.	
7.	Financial Assurance/Future Assurances	Part 845 requires that the owner provide financial assurance instruments to cover the cost of closure and post-closure care in the event that the owner is unable to carry out these obligations.	Illinois Power Resources Generating, LLC (IPRG) has complied with the Part 845 financial assurance requirements for each of the CCR surface impoundments it is closing under Part 845. The financial assurance provisions in Part 845 are robust and were constructed based on other established financial assurance program regulations. Financial assurance has already been provided for closure activities, post-closure activities, and to address the need for potential remediation of releases and will be updated in the future as needed. The mechanisms for financial assurance provided for under Part 845 are all ones that have been successfully used in other regulatory contexts and that can be easily accessed by IEPA. For Duck Creek, IPRG is using surety bonds guaranteeing performance as its financial assurance mechanism. In the unlikely event of a default, this form of financial assurance allows the surety to step in to perform the closure, post-closure care, or corrective action or to pay a penal sum that will

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R003093

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			be placed into the CCR Surface Impoundment Financial Assurance Fund within the State Treasury, assuring the work under Part 845 will be performed.
8.	Availability of Information Related to Public Meetings	Slides will not be posted on our publicly available website. Written responses will be provided to all issues raised in the public meetings.	
9.	On-Site Landfill	The landfill has been permitted with IEPA and permit conditions allow disposal of CCR. It has received CCR and will be closed in accordance with the permit after final receipt of waste.	The landfill remains open only for decommissioning activities. There is not capacity in the landfill for disposal of materials from the GMF Pond.
10.	GMF Recycle Pond	The GMF Recycle Pond is regulated under different regulatory provisions (*i.e.*, not Part 845) since it is not a CCR surface impoundment.	No further response is necessary since this question does not pertain to the GMF Pond or Bottom Ash Basin.
11.	Cooling Pond	The cooling pond is not subject to Part 845. Sampling is required for discharges from the cooling pond in accordance with the NPDES permit.	No further response is necessary since this question does not pertain to the GMF Pond or Bottom Ash Basin.
12.	NPDES Permitting	All surface water runoff from the closed GMF Pond and BAB will flow into the cooling pond. Discharges from the cooling pond are regulated by a NPDES permit. The NPDES permit is currently up for reauthorization. The NPDES permit reauthorization is a different issue from the CCR units and the Part 845 requirements.	The ammonia and other constituents are a byproduct of former used air pollution control devices.

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R003094

In accordance with 845.240(f)(4), a list people who requested to be added to the IEPA Listserv for Duck Creek is as follows:

Duck Creek Listserv	
Name	email
Joseph Cooper	bgfarm47@gmail.com
Nancy Long	nclong405@yahoo.com
Joyce Blumanshire	joblumen@yahoo.com
Bob Jorgensen	jestpr@hotmail.com
Russell Shantz	icmfarm@yahoo.com
Bob Gilmore	robert.gilmore67@gmail.com
Andrew Rehn	arehn@prairierivers.org

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APPENDIX M

Training Program Statement

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Dianna Tickner
Dynegy Midwest Generation, LLC
Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

January 14, 2022

Illinois Environmental Protection Agency
DWPC – Permits MC # 15
ATTN: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: 415 ILCS 5/22.59(b)(4) Certification Statement
Duck Power Plant GMF Pond (IEPA ID # W0578010001-04)
Duck Creek Power Plant Bottom Ash Basin (IEPA ID # W0578010001-03)
Hennepin Power Plant East Ash Pond (IEPA ID # W1550100002-05)
Vermilion Power Plant New East Ash Pond (IEPA ID # W1838000002-04)
Vermilion Power Plant North Ash Pond/Old East Ash Pond (IEPA ID # W1838000002- 01,03)

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundments and in accordance with 415 ILCS 5/22.59(b)(4), Dynegy Midwest Generation, LLC and Illinois Power Resources Generating, LLC certify that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment will be participants in a training program that is approved by and registered with the US Department of Labor's Employment and Training Administration and that includes instruction in the following: erosion control, environmental remediation, operation of heavy equipment and excavation.

Sincerely,
Dynegy Midwest Generation, LLC
Illinois Power Resources Generating, LLC

Dianna Tickner
Director, Decommissioning & Demolition

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From: Summers, Michael
To: Hunt, Lauren; Dunaway, Lynn
Cc: Mullenax, Heather; Garee, Matthew J.; Bierwagen, Justin
Subject: RE: Joppa West Adjusted Standard Recommendation Meeting follow up
Date: Wednesday, November 1, 2023 3:31:32 PM

Added to clarify for lawyers in red

From: Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Sent: Wednesday, November 1, 2023 3:22 PM
To: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>; Summers, Michael <Michael.Summers@Illinois.gov>
Cc: Mullenax, Heather <Heather.Mullenax@Illinois.gov>; Garee, Matthew J. <Matthew.Garee@Illinois.gov>; Bierwagen, Justin <Justin.Bierwagen@Illinois.gov>
Subject: RE: Joppa West Adjusted Standard Recommendation Meeting follow up

Final draft for Lynn to pass on:

As filed, the Recommendation allows a 6-year temp. AS to allow sampling (5 years) and modeling/reporting (1 year) to prove monitored natural attenuation (MNA) will work.
USEPA has been very non-receptive to MNA demonstrations at other sites around the country. Therefore, IEPA needs to amend the Rec to withdraw the Alt Standard suggested or not amend in which case Joppa maybe subject to USEPA enforcement. (Note: This was where the upper management decision came in, considering our goal to get primacy)

IEPA also asked for source monitoring, Joppa did install and has been doing total metals monitoring, but is not done yet, so the ask would be:
Please provide the groundwater sampling and analysis results for total metals at site wells listed in the Attachment B from Ramboll and Associates dated December 19, 2022 for 8 quarters of groundwater sampling along with the precipitation, infiltration and leaching analysis. [Note: unlikely that they have completed this at this time since we are just under two years since the submittal of our recommendation]

IEPA also asked for CCR characterization. Joppa provided 6 CCR samples with analysis. The issue is that there are roughly 5 million cubic yards of CCR in Joppa West, so the ask would be:
Please provide further CCR solids sampling and analysis to include a minimum of 1 sample location per 10% of the total cubic yards of CCR, ~~and~~ with ~~one-third of the~~ 3 samples collected from each location: ~~must be~~ one (1) from the upper 1/3 of the CCR by depth from ground surface, ~~one-third collected~~ one (1) from the middle 1/3 of the CCR by depth from ground surface, and ~~one-third collected~~ one (1) from the bottom 1/3 of the CCR by depth from ground surface. This would 30 samples over the entire site. The SPLP analysis in accordance with SW846 using the lowest pH on site of 3.5. ~~the samples must be spread out as follows:~~

Lauren I. Hunt, M.S.
(she/they/he)
Environmental Protection Geologist III

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Illinois Environmental Protection Agency
Bureau of Water
Groundwater Section
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C: 309-361-0037
Lauren.hunt@illinois.gov
Hours: 8:30 am to 5:30 pm Tuesday through Friday
8:30 am to 4 pm Mondays and alternating Mondays off
Working remotely Mondays and Fridays.

From: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>
Sent: Wednesday, November 1, 2023 3:11 PM
To: Summers, Michael <Michael.Summers@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Cc: Mullenax, Heather <Heather.Mullenax@Illinois.gov>; Garee, Matthew J. <Matthew.Garee@Illinois.gov>; Bierwagen, Justin <Justin.Bierwagen@Illinois.gov>
Subject: RE: Joppa West Adjusted Standard Recommendation Meeting follow up

How about something like this:

1 sample per 10% of the volume with one-third of the samples being collected as follows:
upper 1/3 of the CCR by depth from ground surface,
middle 1/3 of the CCR by depth from ground surface, and
bottom 1/3 of the CCR by depth from ground surface.

From: Summers, Michael <Michael.Summers@Illinois.gov>
Sent: Wednesday, November 1, 2023 2:43 PM
To: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Cc: Mullenax, Heather <Heather.Mullenax@Illinois.gov>; Garee, Matthew J. <Matthew.Garee@Illinois.gov>; Bierwagen, Justin <Justin.Bierwagen@Illinois.gov>
Subject: RE: Joppa West Adjusted Standard Recommendation Meeting follow up

Do we have an rational for 50,000 cubic yards? If its 5 million cubic yards and one sample per 50,000 would equal 100 samples. is this an amount we want to look at?

When using a volume are we likely to run into a “disagreement” with the site on how actual large the site is? Would it be more appropriate to base sample on the surface area of the site. Or since we do have volumes (ie depth estimates) we could do a percentage of the entire volume. It is easily quantifiable, no argument on the size of the facility. Something like a shallow, mid-point and deep (3) samples collected per acre? 3 Per every 5 acres of surface area? take a look at what is a reasonable number of samples to characterize the site.

If we to end up asking for a set number of samples, we still need to make sure that various depth are mentioned in the request for samples to adequately characterize the site.

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From: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>
Sent: Wednesday, November 1, 2023 11:54 AM
To: Hunt, Lauren <Lauren.Hunt@Illinois.gov>; Summers, Michael <Michael.Summers@Illinois.gov>
Cc: Mullenax, Heather <Heather.Mullenax@Illinois.gov>; Garee, Matthew J. <Matthew.Garee@Illinois.gov>; Bierwagen, Justin <Justin.Bierwagen@Illinois.gov>
Subject: RE: Joppa West Adjusted Standard Recommendation Meeting follow up

For the attorneys I would break this out more like this:

As filed, the Recommendation allows a 6-year temp. AS to allow sampling (5 years) and modeling/reporting (1 year) to prove monitored natural attenuation (MNA) will work.
USEPA has been very non-receptive to MNA demonstrations at other sites around the country. Therefore, IEPA needs to amend the Rec to withdraw the Alt Standard suggested or not amend in which case Joppa maybe subject to USEPA enforcement. (Note: This was where the upper management decision came in, considering our goal to get primacy)

IEPA also asked for source monitoring, Joppa did install and has been doing total metals monitoring, but is not done yet, so the ask would be:
Please provide the groundwater sampling and analysis results for total metals at site wells listed in the Attachment B from Ramboll and Associates dated December 19, 2022 for 8 quarters of groundwater sampling along with the precipitation, infiltration and leaching analysis. [Note: unlikely that they have completed this at this time since we are just under two years since the submittal of our recommendation]

IEPA also asked for CCR characterization. Joppa provided 6 CCR samples with analysis. The issue is that there are roughly 5 million cubic yards of CCR in Joppa West, so the ask would be:
Please provide further CCR solids sampling and analysis to include a minimum of 1 sample per 50,000? cubic yards of CCR and SPLP analysis in accordance with SW846 using the lowest pH on site of 3.5. [Note: Mike I'll let you weigh in on volume of CCR per sample that is appropriate.

From: Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Sent: Wednesday, November 1, 2023 11:31 AM
To: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>; Summers, Michael <Michael.Summers@Illinois.gov>
Cc: Mullenax, Heather <Heather.Mullenax@Illinois.gov>; Garee, Matthew J. <Matthew.Garee@Illinois.gov>; Bierwagen, Justin <Justin.Bierwagen@Illinois.gov>
Subject: Joppa West Adjusted Standard Recommendation Meeting follow up

Hi Mike and Lynn.
Please review the following for Sara and Stefanie:

1. Please provide the groundwater sampling and analysis results for total metals at site wells listed in the Attachment B from Ramboll and Associates dated December 19, 2022 for 8 quarters of groundwater sampling along with the precipitation, infiltration and leaching analysis. [unlikely that they have completed this at this time since we are just under two years

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since the submittal of our recommendation].

2. Please provide further CCR solids sampling and analysis to include a minimum of 1 sample per 50,000? cubic yards of CCR and SPLP analysis in accordance with SW846 using the lowest pH on site of 3.5. [Current status is 6 total samples for approximately 5 million cubic yards (or 103.5 acres and 30 feet deep).]

Please note: EEI shows that the hydraulic conductivities are downward from the CCR unit through the UCU (Upper confining unit) into the Upper Aquifer (UA). Total solids CCR samples show that the CCR contains all of the constituents in 845.600 whereas the surrounding formations do not contain some of those and generally contain less of the 845.600 constituents than the CCR where present.

Thanks. Lauren

Lauren I. Hunt, M.S.
(she/they/he)
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Hours: 8:30 am to 5:30 pm Tuesday through Friday
8:30 am to 4 pm Mondays and alternating Mondays off
Working remotely Mondays and Fridays.

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Meade, Mallory

From: Diers, Stefanie
Sent: Thursday, November 2, 2023 7:52 AM
To: Dunaway, Lynn; Terranova, Sara
Cc: Summers, Michael; Hunt, Lauren; Bierwagen, Justin; Mullenax, Heather; Garee, Matthew J.; Sofat, Sanjay
Subject: RE: Joppa AS

Thanks. Sara and I will review and follow up with questions we have.

From: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>
Sent: Wednesday, November 1, 2023 3:40 PM
To: Diers, Stefanie <Stefanie.Diers@Illinois.gov>; Terranova, Sara <Sara.Terranova@Illinois.gov>
Cc: Summers, Michael <Michael.Summers@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>; Bierwagen, Justin <Justin.Bierwagen@Illinois.gov>; Mullenax, Heather <Heather.Mullenax@Illinois.gov>; Garee, Matthew J. <Matthew.Garee@Illinois.gov>; Sofat, Sanjay <Sanjay.Sofat@Illinois.gov>
Subject: Joppa AS

Mike and I have both reviewed this and Mike asked me to send this along to you.

As filed, the Recommendation allows a 6-year temp. AS to allow sampling (5 years) and modeling/reporting (1 year) to prove monitored natural attenuation (MNA) will work.
USEPA has been very non-receptive to MNA demonstrations at other sites around the country.
Therefore, IEPA needs to amend the Rec to withdraw the Alt Standard suggested or not amend in which case Joppa maybe subject to USEPA enforcement. (Note: This was where the upper management decision came in, considering our goal to get primacy)

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Please provide further CCR solids sampling and analysis to include a minimum of 1 sample location per 10% of the total cubic yards of CCR, with 3 samples collected from each location: one (1) from the upper 1/3 of the CCR by depth from ground surface, one (1) from the middle 1/3 of the CCR by depth from ground surface, and one (1) from the bottom 1/3 of the CCR by depth from ground surface. This would 30 samples over the entire Joppa West site. The SPLP analysis in accordance with SW846 using the lowest pH on site of 3.5.

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W0578010001

Luminant

Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

November 11, 2023
Illinois Environmental Protection Agency
DWPC – Permits MC#15
Attn: 35 I.A.C. § 845.650(e) Alternative Source Demonstration Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

RECEIVED
NOV 13 2023
IEPA/CAS

Re: Duck Creek GMF Pond; IEPA ID # W0578010001-04

Dear Mr. LeCrone:

In accordance with Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845.650(e), Illinois Power Resources Generating, LLC (IPRG) is submitting this Alternative Source Demonstration (ASD) for exceedances observed from the Quarter 2 2023 sampling event at the Duck Creek GMF Pond, identified by Illinois Environmental Protection Agency (IEPA) ID No. W0578010001-04.

This ASD is being submitted within 60 days from the date of determination of an exceedance of a groundwater protection standard (GWPS) for constituents listed in 35 I.A.C. § 845.600. As required by 35 I.A.C. § 845.650 (e)(1), the ASD was placed on the facility's website within 24 hours of submittal to the agency.

One hard copy is provided with this submittal.

Sincerely,

Dianna Tickner

Dianna Tickner
Sr. Director – Decommission and Demolition

Enclosures
Alternate Source Demonstration, Quarter 2 2023, East Ash Pond Joppa Power Plant, Joppa Illinois

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Intended for
Illinois Power Resources Generating, LLC

Date
November 11, 2023

Project Number
1940103649-005

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IEPA/CC

35 I.A.C. § 845.650(E): ALTERNATIVE SOURCE DEMONSTRATION

DUCK CREEK POWER PLANT
CANTON, ILLINOIS
IEPA ID: W0578010001-04

RAMBOLL Bright ideas. Sustainable change.

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CERTIFICATIONS

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used other than for its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.



Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Ramboll Americas Engineering Solutions, Inc.
Date: November 11, 2023

I, Brian G. Hennings, a professional geologist in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used other than for its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.



Brian G. Hennings
Professional Geologist
196.001482
Illinois
Ramboll Americas Engineering Solutions, Inc.
Date: November 11, 2023

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TABLES (IN TEXT)

Table A Summary of Boron Concentrations in Compliance Wells

FIGURES (ATTACHED)

Figure 1 Sampling Locations and Potentiometric Surface Map – May 8, 2023
Figure 2 CCR Characterization

APPENDICES

Appendix A GMF Pond Liner Hydraulic Conductivity Supporting Information
Appendix B Supporting Aqueous Analytical Data
Appendix C Technical Memorandum: Geochemical Analysis of Duck Creek Groundwater In Support of an Alternative Source Demonstration (ASD)

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ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
ASD	Alternative Source Demonstration
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
DCPP	Duck Creek Power Plant
E001	Event 1
EPRI	Electric Power Research Institute
GCL	geosynthetic clay liner
GMF Pond	Gypsum Management Facility Pond
GWPS	groundwater protection standard
HDPE	high-density polyethylene
IEPA	Illinois Environmental Protection Agency
LOE(s)	line(s) of evidence
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
NRT/OBG	Natural Resource Technology, an OBG Company
oz/yd^2	ounce per square yard
PCA	Principal component analysis
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
TDS	total dissolved solids
UA	Uppermost Aquifer
UTL	Upper Tolerance Limit

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1. INTRODUCTION

Under Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.650(e), within 60 days from the date of determination of an exceedance of a groundwater protection standard (GWPS) for constituents listed in 35 I.A.C. § 845.600, an owner or operator of a coal combustion residuals (CCR) surface impoundment may complete a written demonstration that a source other than the CCR surface impoundment caused the contamination and the CCR surface impoundment did not contribute to the contamination, or that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction (Alternative Source Demonstration [ASD]).

This ASD has been prepared on behalf of Illinois Power Resources Generating, LLC, by Ramboll Americas Engineering Solutions, Inc (Ramboll), to provide pertinent information pursuant to 35 I.A.C. § 845.650(e) for the Duck Creek Power Plant (DCPP) Gypsum Management Facility Pond (GMF Pond) located near Canton, Illinois.

The first quarterly sampling event (Event 1 [E001]) was completed on May 15, 2023, and analytical data were received on July 14, 2023. In accordance with 35 I.A.C. § 845.610(b)(3)(C), comparison of statistically derived values with the GWPSs described in 35 I.A.C. § 845.600 to determine exceedances of the GWPS was completed by September 12, 2023, within 60 days of receipt of the analytical data (Ramboll, 2023a). The statistical determination identified the following GWPS exceedances at compliance groundwater monitoring wells:

- pH at well G60L

Pursuant to 35 I.A.C. § 845.650(e), the lines of evidence (LOEs) presented in **Section 3** demonstrate that sources other than the GMF Pond were the cause of the pH GWPS exceedance listed above and the GMF Pond has not contributed to the exceedance. A localized native peat deposit located upgradient of G60L is an alternative source of the pH exceedance. This ASD was completed by November 11, 2023, within 60 days of determination of the exceedances (September 12, 2023), as required by 35 I.A.C. § 845.650(e). This ASD has been completed in conformance with guidance provided in the Electric Power Research Institute (EPRI) guidance for development of ASDs at CCR sites (EPRI, 2017), and the United States Environmental Protection Agency (USEPA)'s Solid Waste Disposal Facility Criteria: Technical Manual (USEPA, 1993).

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2. BACKGROUND

2.1 Site Location and Description

The DCPP is located in Fulton County, in central Illinois, approximately 9 miles southeast of the town of Canton. Duck Creek Cooling Pond is located east of the power plant and the GMF Pond with agricultural land surrounding the entire property.

2.2 Geology and Hydrogeology

The DCPP geologic and hydrogeologic setting is fully characterized and described in the October 25, 2021 operating permit application (Burns McDonnell, 2021) and January 28, 2022 closure construction permit application (Golder, 2022). Those materials are incorporated herein by reference. The summary below is obtained from published sources, hydrogeologic investigation data, and boring data collected during site investigations conducted from 2005 to 2021 (Natural Resource Technology, an OBG Company [NRT/OBG], 2017; Ramboll, 2021a).

Regionally, the DCPP is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems.

Several large former surface coal mines are present in the vicinity. Strip mining in the region since the 1930s disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit. The strip mining activity produced rough topography from soil piles and depressions, often ponded with water. Unlithified materials are present in the excavated strip mine spoils and have been mixed due to the surface mining activities. Mining operations in the area have ceased.

The uppermost bedrock stratum in the area is the Carbondale Formation of the Kewanee Group of the Pennsylvanian System. The Carbondale Formation consists primarily of shaley siltstone and silty shale and includes the Springfield (No. 5) Coal and other coal units. Bedrock occurs within approximately 50 feet of the ground surface in this area.

Quaternary deposits in the Canton area consist mainly of loess, diamictons, and lacustrine/alluvial deposits that were deposited during Illinoian and Wisconsinan glaciations. Four hydrostratigraphic units have been identified at the DCPP based on stratigraphic relationships and common hydrogeologic characteristics, and are summarized as follows (beginning at the ground surface):

- CCR: This unit is composed of gypsum CCR, present within the GMF Pond at a thickness ranging from less than 1 to 22 feet. The thickest areas of gypsum are to the north and west within the GMF Pond and thin toward the south end of the GMF Pond. This material is considered to be homogeneous because the scrubber operations at the facility have not materially changed over the 10-year operating period (2009-2019).
- Uppermost Aquifer (UA): At the GMF Pond, this unit includes the Peoria/Roxanna Loess, the upper Radnor Till, and shallow sands. These units are hydraulically connected and underlain by a thick till sequence of the Radnor Till. The shallow sand zone is the primary migration pathway within these hydraulically connected formations. The shallow sands are laterally extensive across the site, vary in thickness from less than 1 to 18 feet, and are generally

located at an elevation of 570 to 590 feet North American Vertical Datum of 1988 (NAVD88). The shallow sand is saturated. During construction of the GMF Pond, sand was completely removed everywhere it was encountered (mainly the northeast corner and southwest corner of the pond), putting the base of the liner in contact with clay of the lower Radnor Till. Sand outside the GMF Pond footprint remains in place.

  - The Peoria/Roxanna Loess within the UA has been identified as a potential migration pathway (PMP). While the primary migration pathway (*i.e.*, the UA) is the shallow sand of the UA, impacts have the potential to migrate within groundwater in the overlying Peoria/Roxanna Loess. The PMP is saturated at depths of 3.5 to 11 feet below ground surface (bgs). While the PMP and UA are hydraulically connected, groundwater flow in the PMP is expected to be primarily vertical, with the majority of the horizontal migration expected to occur within the UA.

- Lower Confining Unit: Underlying the UA, the lower Radnor Till is approximately 42 to 58 feet thick. Previous hydrogeologic studies indicate discontinuous sand lenses observed within the till are not hydraulically connected to the UA.
- Bedrock Confining Unit: The bedrock encountered across the site consists of low permeability shaley siltstone, silty shale, and coal beds of the Carbondale Formation, and is estimated to have a thickness of approximately 300 to 400 feet.

Groundwater elevations (referenced to NAVD88) in the UA near the GMF Pond are shown on **Figure 1**. Groundwater elevations were measured on May 8, 2023, prior to a combined sampling event at the DCPP for the three CCR units located there and for multiple monitoring programs required by both federal and state regulatory agencies. Groundwater elevations from UA wells at the GMF Pond ranged from 616.72 to 588.23 feet NAVD88.

2.3 GMF Pond Groundwater and Porewater Monitoring

The monitoring system for the GMF Pond is shown on **Figure 1**. Monitoring wells G02S, G50S, and G51S are used to monitor background groundwater quality for the GMF Pond. These wells are located north (G02S), northwest (G50S), and west (G51S) of the GMF Pond. The compliance monitoring wells screened in the UA are G54S, G57S, G60S, and G64S. The compliance monitoring wells screened in the PMP are G54L, G60L, and G64L (Ramboll, 2021b).

Groundwater samples are collected and analyzed in accordance with the Multi-Site Sampling and Analysis Plan (Ramboll, 2023b). Statistical evaluation of analytical data is performed in accordance with Multi-Site Statistical Analysis Plan (Ramboll, 2022).

GMF Pond source water samples are collected from the GMF Pond at location X301, a riser pipe from the ring drain present above the upper liner that collects gypsum contact water and pond surface water. The most recent pond water sample was collected from X301 on January 16, 2023. Prior to performing hydrogeologic investigations in 2021, Ramboll completed a review of existing data to determine whether sufficient information existed to meet the requirements of 35 I.A.C. § 845. Based on review of the limited extent of gypsum visible through time on aerial photographs, identifying visible differences (color) in surficial materials, and capturing a representative spatial distribution, a single porewater well location was identified (**Figure 2**) with consideration for health & safety risks associated with accessing locations where gypsum was present. Location XTPW02 is a temporary monitoring well installed in the gypsum within the pond for collection of porewater (**Figure 2**). CCR porewater most accurately represents the mobile

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constituents associated with the waste management activity within the CCR SI (EPRI, 2017). XTPW02 was last sampled in June of 2021. In this double lined surface impoundment the samples from the ring drain riser and the porewater well (collectively referred to herein as "source water") are representative of the waters present above the double lined system that could be potential contributions to groundwater observed in compliance monitoring wells.

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3. ALTERNATIVE SOURCE DEMONSTRATION: LINES OF EVIDENCE

As allowed by 35 I.A.C. § 845.650(e), this ASD demonstrates that sources other than the GMF Pond (the CCR unit) caused the pH exceedance at G60L. LOEs supporting this ASD include the following:

1. The GMF Pond has a double geomembrane liner designed to prevent CCR contact with groundwater.
2. Boron concentrations in compliance groundwater monitoring wells do not exceed background groundwater limits.
3. Geochemical analysis and empirical observations at and near G60L demonstrate that a localized pocket of native peat is an alternative source of the pH exceedance.

These LOEs are described and supported in greater detail below.

3.1 LOE #1: The GMF Pond Has a Double Geomembrane Liner Designed to Prevent CCR Contact with Groundwater

Construction of the GMF Pond was in accordance with Water Pollution Control Permit 2017-EO-62336 granted by the Illinois Environmental Protection Agency (IEPA). The GMF Pond liner system includes the following components:

- 60-mil high-density polyethylene (HDPE) geomembrane liner
- Minimum 12-inch soil cushion layer (up to 24 inches thick in select areas on the side slope)
- 4 ounce per square yard (oz/yd^2) non-woven geotextile filter fabric
- 12-inch highly permeable granular drainage sand layer
- 10 oz/yd^2 non-woven geotextile filter fabric
- 60-mil HDPE geomembrane liner
- Geosynthetic clay liner (GCL) with a manufacturer's certified maximum hydraulic conductivity of 5×10^{-9} centimeters per second (cm/s)
- 36-inch compacted clay layer with a maximum hydraulic conductivity of 9×10^{-7} cm/s based upon laboratory testing of samples collected from the site

Supporting information for the hydraulic conductivity of the compacted clay and GCL is provided in **Appendix A**.

The IEPA-approved GMF Pond double geomembrane liner system far exceeds the design criteria for a composite liner for CCR surface impoundments established by 35 I.A.C. § 845.400, suggesting that the GMF Pond is not the source of the pH exceedance.

3.2 LOE #2: Boron Concentrations in Compliance Groundwater Monitoring Wells Do Not Exceed Background Groundwater Limits

Boron is a potential indicator of CCR impacts to groundwater due to its leachability from CCR, low occurrence as an anthropogenic contaminant, and mobility in groundwater (Electric Power Research Institute [EPRI], 2012). If boron concentrations in CCR source water are present above

background groundwater concentrations, then groundwater impacted by CCR would be expected to contain boron concentrations elevated above the background groundwater Upper Tolerance Limit (UTL). The UTL is a statistically derived upper bound on background groundwater concentrations calculated for comparing compliance well results to background groundwater. Source water samples collected from the GMF Pond have elevated boron concentrations, indicating that boron is a site-specific key indicator for CCR (**Appendix B**). Boron concentrations measured in compliance monitoring wells during the first quarterly sampling event (Ramboll, 2023a) are summarized in **Table A** below. All compliance wells had concentrations of boron below the UTL (0.21 milligrams per liter [mg/L]) calculated for background groundwater, indicating that compliance wells have not been affected by CCR in the GMF Pond. Therefore, the GMF Pond is not the source of the pH GWPS exceedance at G60L.

Table A. Summary of Boron Concentrations Measured in Compliance Wells during the first quarterly sampling event.

	G54S	G54L	G57S	G60L	G60S	G64L	G64S
Boron (mg/L) (Background Groundwater UTL=0.21 mg/L)	0.062	0.095	<0.01	0.042	0.030	0.031	0.014

3.3 LOE #3: Geochemical Analysis and Empirical Observations at and Near G60L Demonstrate that a Localized Pocket of Native Peat is an Alternative Source of the pH Exceedance

Multivariate statistical analysis of the groundwater and GMF Pond source water data, review of ionic composition of both, and literature review were performed by Life Cycle Geo, LLC (2023) to support the conclusion that the pH exceedance at G60L is due to the influence of a localized, native peat deposit located upgradient of the well. Details of the analysis are included as **Appendix C**. The following conclusions were made based on the results of the evaluation:

- Principal component analysis (PCA) shows that the groundwater signature at G60L is similar to background and compliance well groundwater signatures and distinct from the source water signature.
- The major ion composition of groundwater at G60L is inconsistent with influence from source water due to a low proportion of chloride, an indicator of CCR impacts in groundwater, and is similar to the major ion composition of nearby groundwater.
- A localized native peat deposit located upgradient of G60L is an alternative source of the pH exceedance based on literature review of peat influence on groundwater conditions, evaluation of other wells downgradient of the peat deposit (including hydraulic gradients and aqueous and solid-phase geochemistry), and the absence of CCR indicators boron and chloride.

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4. CONCLUSIONS

Based on the three LOEs below, it has been demonstrated that the GMF Pond is not the source of the pH exceedance at G60L and the GMF Pond has not contributed to the exceedance.

1. The GMF Pond has a double geomembrane liner designed to prevent CCR contact with groundwater.
2. Boron concentrations in compliance groundwater monitoring wells do not exceed background groundwater limits.
3. Geochemical analysis and empirical observations at and near G60L demonstrate that a localized pocket of native peat is an alternative source of the pH exceedance.

This information serves as the written ASD prepared in accordance with 35 I.A.C. § 845.650(e), demonstrating that the pH exceedance observed at G60L during the first quarterly sampling event was not due to the GMF Pond and is attributable to local peat deposits. Therefore, assessment of corrective measures is not required for pH at the GMF Pond.

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5. REFERENCES

Burns McDonnell, 2021. Initial Operating Permit, Duck Creek GMF Pond, October 25, 2021.

Electric Power Research Institute [EPRI], 2012. Groundwater Quality Signatures for Assessing Potential Impacts from Coal Combustion Product Leachate, Report 1017923. October 2012.

Electric Power Research Institute (EPRI), 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. EPRI, Palo Alto, CA. 3002010920.

Golder Associates USA, Inc., 2022, Part 845 Construction Permit Application for the Gypsum Management Facility Pond, Duck Creek Power Plant, January 25, 2022.

Life Cycle Geo, LLC, 2023. Technical Memorandum: Geochemical Analysis of Duck Creek Groundwater In Support of an Alternate Source Demonstration (ASD). October 10, 2023.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017. *Hydrogeologic Monitoring Plan. Duck Creek GMF Pond – CCR Unit ID 203, Duck Creek Landfill – CCR Unit ID 204. Duck Creek Power Station, Canton, Illinois.* Illinois Power Resources Generating, LLC. October 17, 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021a. *Hydrogeologic Site Characterization Report. Duck Creek Power Plant, Gypsum Management Facility Pond, Canton, Illinois.* Illinois Power Generating Company. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021b. Groundwater Monitoring Plan for the Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Illinois. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2022. *Multi-Site Statistical Analysis Plan.* December 28, 2022.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2023a. *35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances: 2023 Quarter 2. Gypsum Management Facility (GMF) Pond, Duck Creek Power Plant, Canton, Illinois.* September 12, 2023.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2023b. *Multi-Site Sampling and Analysis Plan, Revision 1*. October 10, 2023.

United States Environmental Protection Agency (USEPA), 1993. Solid Waste Disposal Facility Criteria: Technical Manual EPA530-R-93-017. Solid Waste and Emergency Response (5305). November 1993.

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FIGURES

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COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
PORE WATER WELL
CCR SOURCE WATER SAMPLE
MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION

0 150 300 Feet

NOTES:
1. PARENTHESES INDICATES WELL NOT USED FOR CONTOURING
2.ELEVATION CONTOURS SHOWN IN FEET NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

SAMPLING LOCATIONS AND POTENTIOMETRIC SURFACE MAP MAY 8, 2023

FIGURE 1

ALTERNATIVE SOURCE DEMONSTRATION
GMF POND
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS INC.

RAMBOLL

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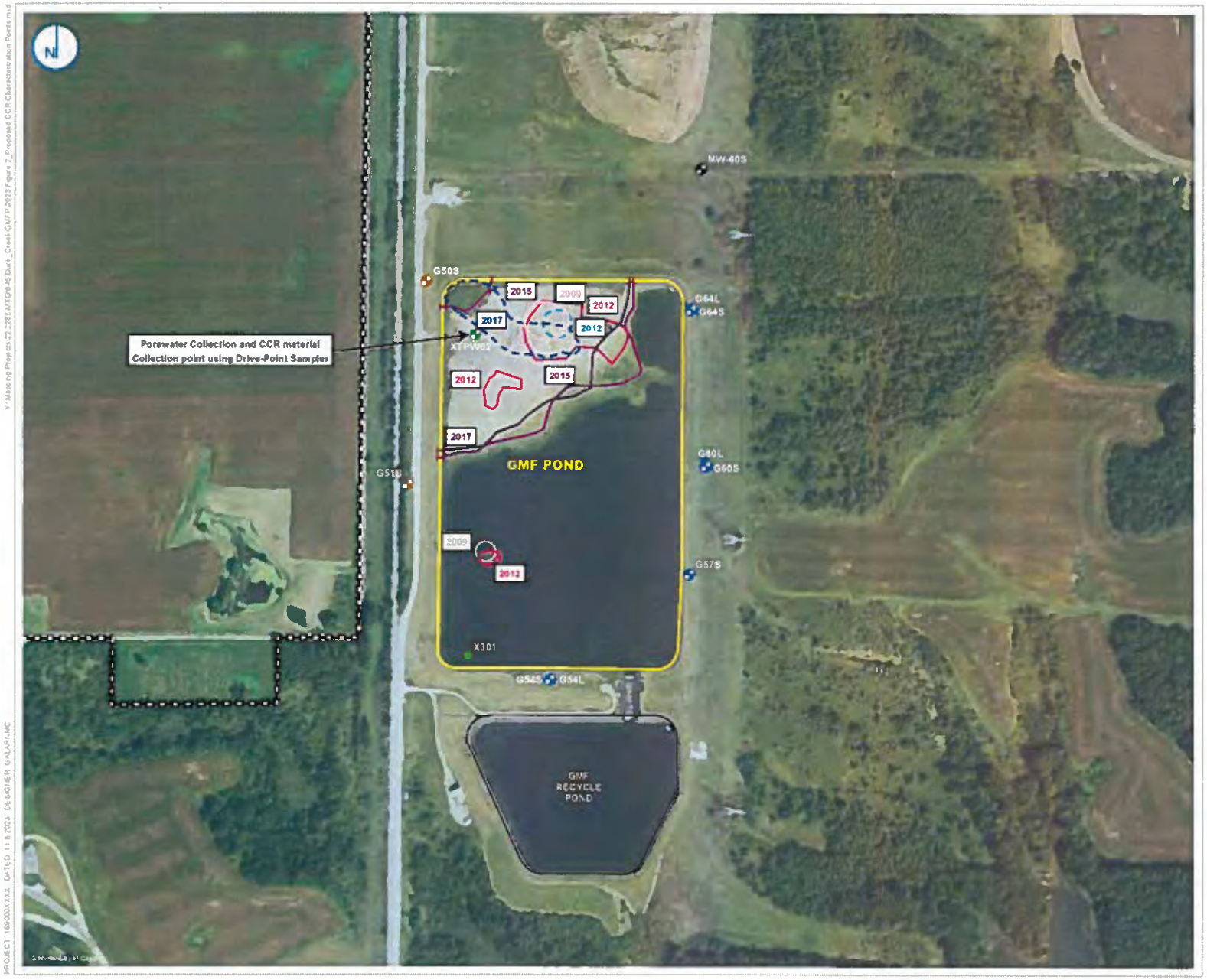

CCR CHARACTERIZATION

ALTERNATIVE SOURCE DEMONSTRATION
DUCK CREEK POWER STATION
CANTON, ILLINOIS

FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS INC

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APPENDIX A
GMF POND LINER HYDRAULIC CONDUCTIVITY SUPPORTING INFORMATION

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COMPACTED CLAY PERMEABILITY TESTING SUMMARY AND SAMPLE LOCATIONS

R003127

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Full Scale Soil Liner Permeability Testing Summary

Gypsum Stack Acceptance Report
Gypsum Management Facility
AERG Duck Creek Power Generating Station
Fulton County, Illinois

Date	Sample No.	Easting	Northing	Design Elevation - Top of Soil Liner	Top of Sample Elevation	Permeability Result (1.0×10^{-4} cm/sec max.)	Pass/ Fail	Lift
7/28/2008	ST-07	69.21	15533.46	610.98	608.68	3.9×10^{-8}	PASS	1
8/1/2008	ST-11	913.80	15609.93	602.03	601.21	9.8×10^{-7}	PASS	3
8/1/2008	ST-12	850.80	16161.49	614.17	612.23	2.5×10^{-8}	PASS	2
9/10/2008	ST-13	737.41	15927.94	593.51	593.87	1.9×10^{-7}	PASS	3/4
9/10/2008	ST-14	579.64	16027.96	594.50	594.92	2.3×10^{-7}	PASS	4/5
9/10/2008	ST-15	457.62	15795.25	592.68	591.59	5.0×10^{-7}	PASS	3
9/27/2008	ST-20	775.12	15796.90	592.67	592.88	2.3×10^{-7}	PASS	4
9/27/2008	ST-21	899.66	15801.58	597.38	597.05	1.0×10^{-7}	PASS	3
10/5/2008	ST-24	517.60	15517.36	588.92	588.99	4.6×10^{-7}	PASS	4
10/5/2008	ST-25	717.24	15661.41	590.85	591.20	1.6×10^{-7}	PASS	4
10/13/2008	ST-26	286.74	15381.59	587.11	587.47	4.4×10^{-8}	PASS	4/5
10/13/2008	ST-27	705.94	15365.23	586.78	587.10	9.0×10^{-8}	PASS	5
10/22/2008	ST-34	710.76	15163.62	585.18	585.26	1.8×10^{-7}	PASS	4
10/22/2008	ST-35	343.17	15138.39	584.81	584.93	1.2×10^{-7}	PASS	5
10/23/2008	ST-36	711.00	14792.60	589.17	588.30	7.6×10^{-7}	PASS	3
10/23/2008	ST-37	311.60	14806.40	585.21	584.41	2.1×10^{-7}	PASS	3
11/2/2008	ST-38	630.45	14953.47	583.52	583.79	8.6×10^{-9}	PASS	4
11/2/2008	ST-39	390.91	14942.74	583.41	583.58	1.1×10^{-7}	PASS	4

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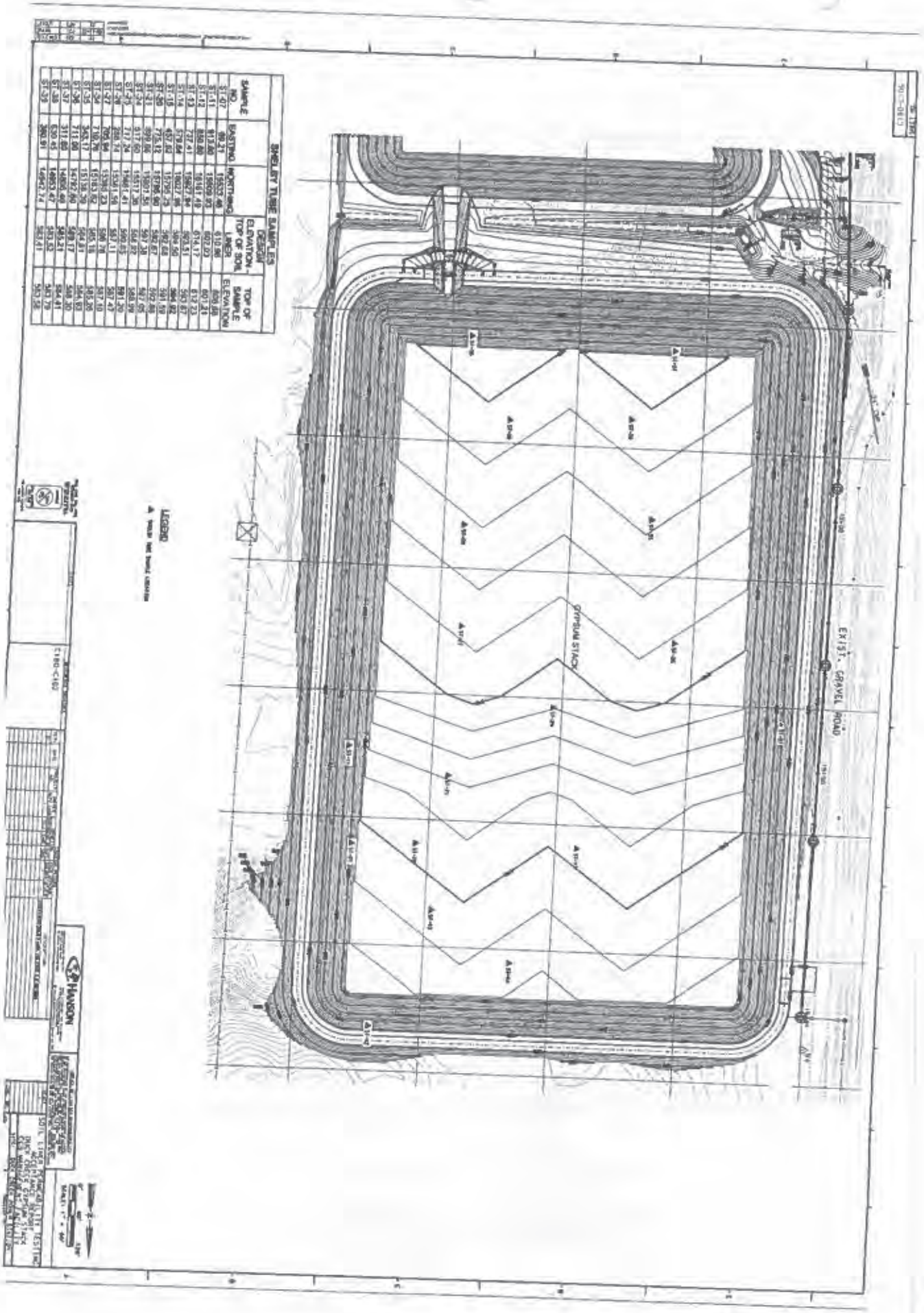

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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	8/1/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-7-1
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy clayey silt (tr. c. sand & sm. gravel).	DEPTH (FT):	0.0-0.5

SPECIMEN WEIGHT (G)	1032.24
SPECIMEN HEIGHT (IN)	4.530
DIAMETER (IN)	2.877
AREA (SQ IN)	6.501
VOLUME (CU IN)	29.449
WET DENSITY (PCF)	133.53
DRY DENSITY (PCF)	115.93
WT. DRY SOIL (G)	896.18
VOLUME DRY SOIL (CU	20.255
SP.GR. (ASSUMED)	2.7
POROSITY (%)	31.22
HEIGHT OF HEAD (PSI)	4.9
HYDRAULIC GRADIANT	29.9
1/4 PORE VOLUME	37.66
Initial Degree of Saturation	90.31
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	128.36	1085.01
TARE + DRY SOIL (G)	111.93	938.43
TARE (G)	3.71	50.13
WATER (G)	16.43	146.58
DRY SOIL (G)	108.22	888.30
WATER CONTENT (%)	15.18	16.50

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	344.56
PANEL NUMBER	5
PERMEANT USED:	Tap Water

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 8/7/2008
BORING #: N/A
SAMPLE #: ST-7-1
DEPTH (FT): 0.0-0.5

SPECIMEN HEIGHT (IN) 4.530
DIAMETER (IN) 2.877
AREA (SQ IN) 6.501

HEIGHT OF HEAD (PSI) 4.9
PRESSURE HEAD (CM H2O) 344.555064
PANEL NUMBER 5

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
8/7/2008	12:53:30	8/8/2008	8:37:00	6.90	6.9000	1183.50	1183.50	7.74E-08	7.74E-08
8/8/2008	16:34:00	8/11/2008	8:59:00	18.30	25.2000	3865.00	5048.50	6.28E-08	7.01E-08
8/11/2008	9:01:30	8/11/2008	16:35:25	2.00	27.2000	453.92	5502.42	5.85E-08	6.62E-08
8/11/2008	16:35:25	8/13/2008	13:14:20	10.00	37.2000	2678.92	8181.33	4.95E-08	5.69E-08
8/13/2008	13:14:20	8/14/2008	8:31:50	3.60	40.8000	1157.50	9338.83	4.13E-08	4.98E-08
8/14/2008	8:31:50	8/15/2008	8:21:15	4.10	44.9000	1429.42	10768.25	3.81E-08	4.30E-08
8/15/2008	8:23:30	8/15/2008	15:36:00	1.40	46.3000	432.50	11200.75	4.30E-08	4.08E-08
8/19/2008	10:17:05	8/20/2008	8:59:45	3.70	50.0000	1362.67	12563.42	3.60E-08	3.90E-08
8/20/2008	8:59:45	8/21/2008	9:03:15	3.80	53.8000	1443.50	14006.92	3.49E-08	3.80E-08

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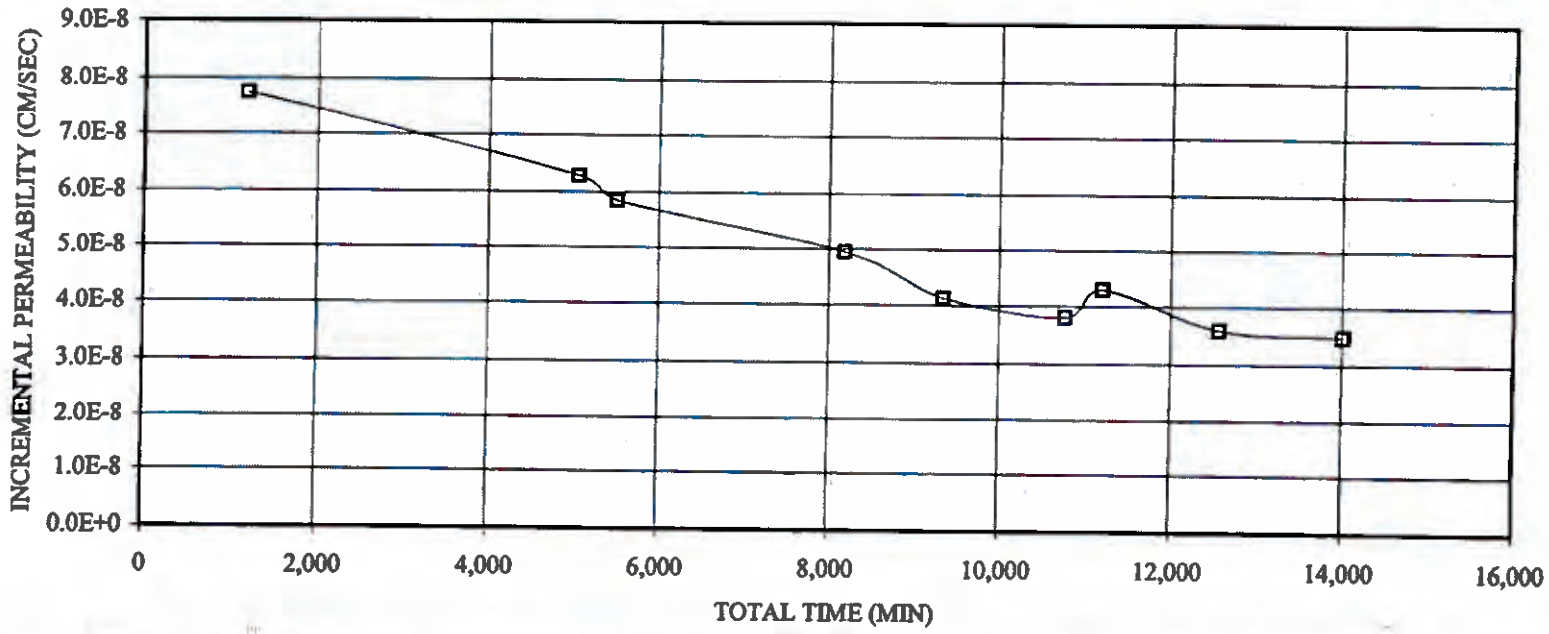
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	8/7/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-7-1
		DEPTH (FT):	0.0-0.5

SPECIMEN HEIGHT (IN)	4.530	HEIGHT OF HEAD (PSI)	4.9
DIAMETER (IN)	2.877	PRESSURE HEAD (CM H2O)	344.555064
AREA (SQ IN)	6.501	PANEL NUMBER	5



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Chain of Custody Record

(Form CQAP 6.1, Revision 0)

Gypsum Management and CCB Landfill Facilities

Ameren

Client	Ameren Duck Creek Generating Station
Address	17751 North Cilco Road
City, State Zip Code	Canton, IL 61520
Phone / Facsimile No.	(309) 668-2236 / (217) 347-3106
Client Project	Gypsum Stack
Location	Fulton Co IL
Sampler(s) / Phone	Ryne Finnito 1217-414-4056
Turnaround Time	Standard [ ] Rush [X] Date Required: 08/06/08
P.O. # or Invoice To	Ameren Energy
Contact Person	Dave Bryce Ameren Construction Mgr.

Sample Description	Sampling Date	Sampling Time	Sample Type[1]	# of Containers	Analysis and/or Method Requested: Permeab: liner spec.	Remarks or Observations
ST-07	07/28/08		S	1	X	
Shelby Tube						
of clay liner						

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
Ryne Finnito	07/28/08	17:20		7/28/08	19:26	
	07/29/08	08:00		7/29/08	08:00	

Special Instructions:

 Copies: White – CQA Officer Yellow – Testing Firm Pink – Sampler

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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	8/13/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST11-2
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy silt / so. clay & sm. gr.	DEPTH (FT):	0.5-1.0

SPECIMEN WEIGHT (G)	829.20
SPECIMEN HEIGHT (IN)	3.844
DIAMETER (IN)	2.833
AREA (SQ IN)	6.304
VOLUME (CU IN)	24.231
WET DENSITY (PCF)	130.37
DRY DENSITY (PCF)	115.77
WT. DRY SOIL (G)	736.39
VOLUME DRY SOIL (CU IN)	16.643
SP.GR. (ASSUMED)	2.7
POROSITY (%)	31.313
HEIGHT OF HEAD (PSI)	4.1
HYDRAULIC GRADIANT	29.5
1/4 PORE VOLUME	31.08
Initial Degree of Saturation	74.65
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	162.38	899.17
TARE + DRY SOIL (G)	144.62	772.92
TARE (G)	3.71	50.01
WATER (G)	17.76	126.25
DRY SOIL (G)	140.91	722.91
WATER CONTENT (%)	12.60	17.46

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	288.301176
PANEL NUMBER	4
PERMEANT USED:	Tap Water

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 8/13/2008
BORING #: N/A
SAMPLE #: ST11-2
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.844
DIAMETER (IN) 2.833
AREA (SQ IN) 6.304

HEIGHT OF HEAD (PSI) 4.1
PRESSURE HEAD (CM H2O) 288.301176
PANEL NUMBER 4

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
8/14/2008	13:37:50	8/14/2008	16:24:45	14.80	14.8000	166.92	166.92	1.23E-06	1.23E-06
8/15/2008	8:56:00	8/15/2008	15:42:10	40.33	55.1300	406.17	573.08	1.38E-06	1.30E-06
8/19/2008	10:55:50	8/20/2008	6:52:10	91.02	146.1500	1196.33	1769.42	1.06E-06	1.22E-06
8/20/2008	6:54:20	8/20/2008	17:24:40	46.99	193.1400	630.33	2399.75	1.03E-06	1.16E-06
8/20/2008	17:25:40	8/21/2008	9:09:10	62.90	256.0400	943.50	3343.25	9.25E-07	1.01E-06
8/21/2008	9:12:15	8/21/2008	17:16:00	29.60	285.6400	483.75	3827.00	8.49E-07	9.36E-07
8/21/2008	17:16:50	8/22/2008	8:31:45	69.19	354.8300	914.92	4741.92	1.05E-06	9.41E-07

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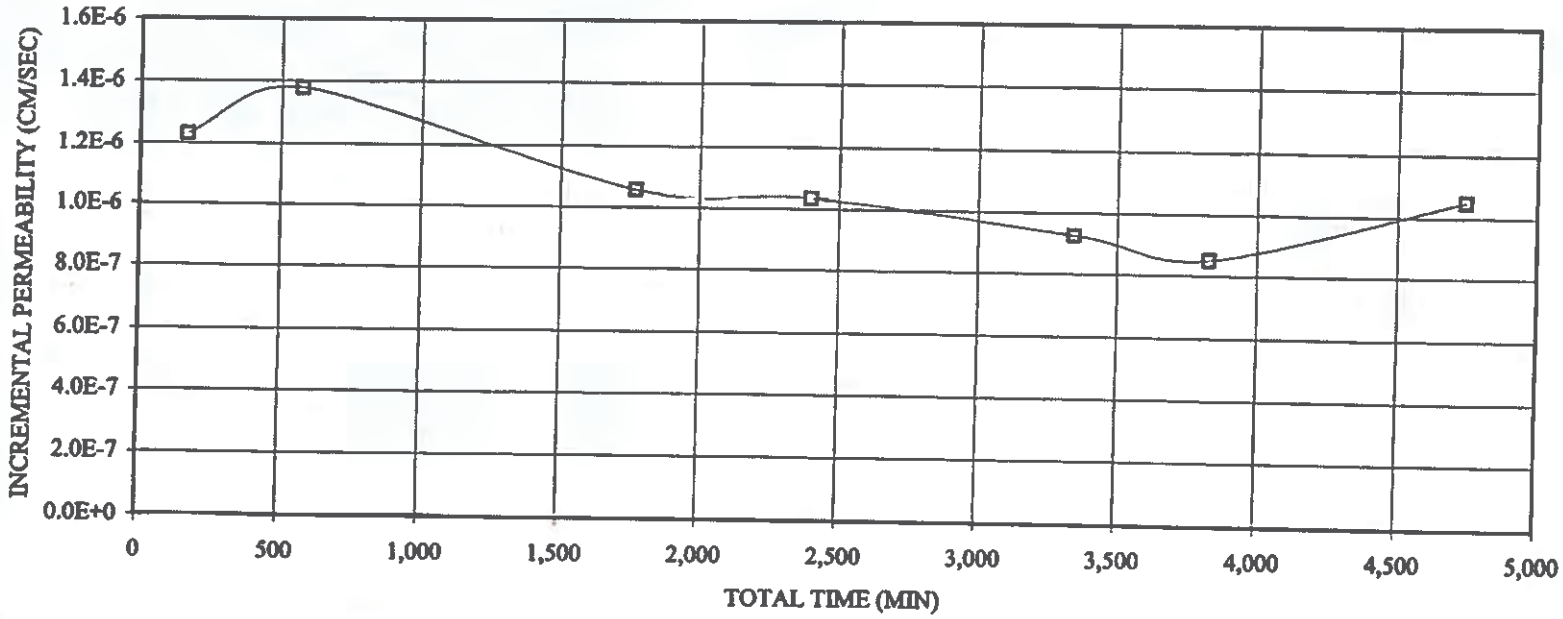
Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	8/13/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST11-2
		DEPTH (FT):	0.5-1.0

SPECIMEN HEIGHT (IN)	3.844	HEIGHT OF HEAD (PSI)	4.1
DIAMETER (IN)	2.833	PRESSURE HEAD (CM H2O)	288.301176
AREA (SQ IN)	6.304	PANEL NUMBER	4



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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	8/13/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST12-1
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy silt / so. clay & sm. gravel.	DEPTH (FT):	0.0-0.5

SPECIMEN WEIGHT (G)	1036.96
SPECIMEN HEIGHT (IN)	4.586
DIAMETER (IN)	2.874
AREA (SQ IN)	6.487
VOLUME (CU IN)	29.751
WET DENSITY (PCF)	132.78
DRY DENSITY (PCF)	117.72
WT. DRY SOIL (G)	919.31
VOLUME DRY SOIL (CU IN)	20.778
SP.GR. (ASSUMED)	2.7
POROSITY (%)	30.16071313
HEIGHT OF HEAD (PSI)	4.9
HYDRAULIC GRADIANT	29.6
1/4 PORE VOLUME	36.76
Initial Degree of Saturation	80.01
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	173.55	1059.87
TARE + DRY SOIL (G)	154.28	912.57
TARE (G)	3.71	3.68
WATER (G)	19.27	147.3
DRY SOIL (G)	150.57	908.89
WATER CONTENT (%)	12.80	16.21

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	344.555064
PANEL NUMBER	8
PERMEANT USED:	Tap Water

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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 6/23/2008
BORING #: N/A
SAMPLE #: ST12-1
DEPTH (FT): 0.0-0.5

SPECIMEN HEIGHT (IN) 4.586
DIAMETER (IN) 2.874
AREA (SQ IN) 6.487

HEIGHT OF HEAD (PSI) 4.9
PRESSURE HEAD (CM H2O) 344.555064
PANEL NUMBER 8

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
8/14/2008	9:20:45	8/15/2008	8:57:30	2.80	2.8000	1416.75	1416.75	2.66E-08	2.66E-08
8/15/2008	8:57:30	8/15/2008	15:43:50	0.90	3.7000	406.33	1823.08	2.98E-08	2.82E-08
8/19/2008	11:01:30	8/20/2008	9:06:30	3.20	6.9000	1325.00	3148.08	3.25E-08	3.12E-08
8/20/2008	9:06:30	8/21/2008	9:13:10	3.00	9.9000	1446.67	4594.75	2.79E-08	3.02E-08
8/21/2008	9:13:10	8/22/2008	8:35:00	2.70	12.6000	1401.83	5996.58	2.59E-08	2.69E-08
8/22/2008	8:35:00	8/25/2008	9:04:15	8.30	20.9000	4349.25	10345.83	2.57E-08	2.58E-08
8/25/2008	9:07:15	8/26/2008	8:37:00	2.80	23.7000	1409.75	11755.58	2.67E-08	2.62E-08
8/26/2008	8:37:00	8/27/2008	10:41:30	3.00	26.7000	1564.50	13320.08	2.58E-08	2.63E-08
8/27/2008	10:41:30	8/28/2008	8:14:15	2.40	29.1000	1292.75	14612.83	2.50E-08	2.54E-08
8/28/2008	8:14:15	8/29/2008	8:24:45	2.60	31.7000	1450.50	16063.33	2.41E-08	2.46E-08
8/29/2008	8:24:45	9/2/2008	10:09:10	10.30	42.0000	5864.42	21927.75	2.36E-08	2.39E-08
9/2/2008	10:06:10	9/3/2008	8:18:00	2.10	44.1000	1331.83	23259.58	2.12E-08	2.24E-08
9/3/2008	8:19:15	9/4/2008	8:25:10	2.80	46.9000	1445.92	24705.50	2.61E-08	2.36E-08
9/4/2008	8:25:10	9/5/2008	9:19:45	2.80	49.7000	1494.58	26200.08	2.52E-08	2.56E-08
9/5/2008	9:19:45	9/8/2008	8:32:00	7.30	57.0000	4272.25	30472.33	2.30E-08	2.41E-08

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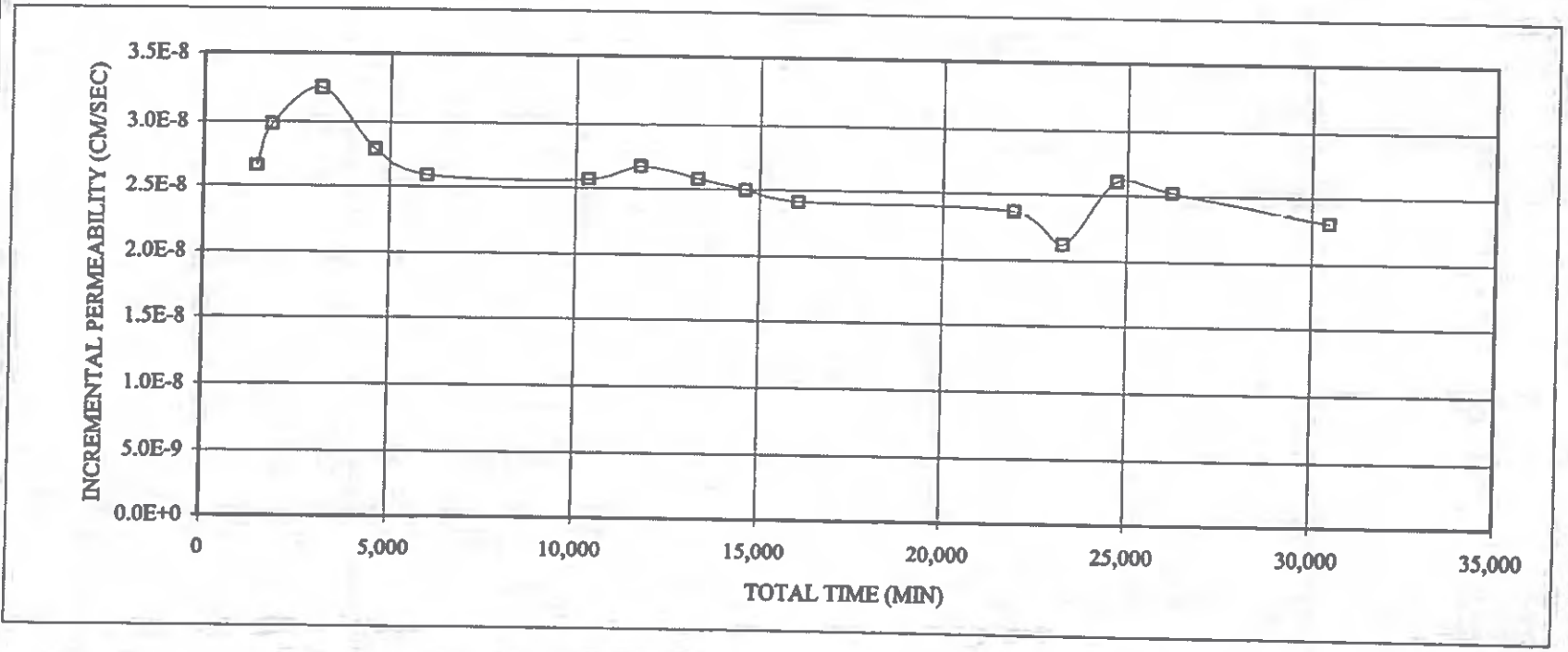
Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	6/23/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST12-1
		DEPTH (FT):	0.0-0.5

SPECIMEN HEIGHT (IN)	4.586	HEIGHT OF HEAD (PSI)	4.9
DIAMETER (IN)	2.874	PRESSURE HEAD (CM H2O)	344.555064
AREA (SQ IN)	6.487	PANEL NUMBER	8



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Chain of Custody Record

(Form CQAP 6.1, Revision 0)

Gypsum Management and CCB Landfill Facilities

Ameren

Client	Ameren Duck Creek Generating Station
Address	17751 North Cilco Road
City, State Zip Code	Canton, IL 61520
Phone / Facsimile No.	(309) 668-2236 / (217) 347-3106
Client Project	Gypsum Stack
Location	Fulton County, IL
Sampler(s) / Phone	Runefiorito 217-414-4056
Turnaround Time	Standard [ ] Rush [X] Date Required:
P.O. # or Invoice To	Ameren Energy
Contact Person	Dave Boyce, Ameren Construction Mgr.

Analysis and/or Method Requested

Permeability per clay liner spec.

Remarks or Observations

Sample Description	Sampling Date	Sampling Time	Sample Type[1]	# of Containers
ST-11	08/01/08	15:15	S	1
Clay Liner				
Lift 4				
ST-12	08/01/08	15:30	S	1
Clay Liner				
Lift 2				

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

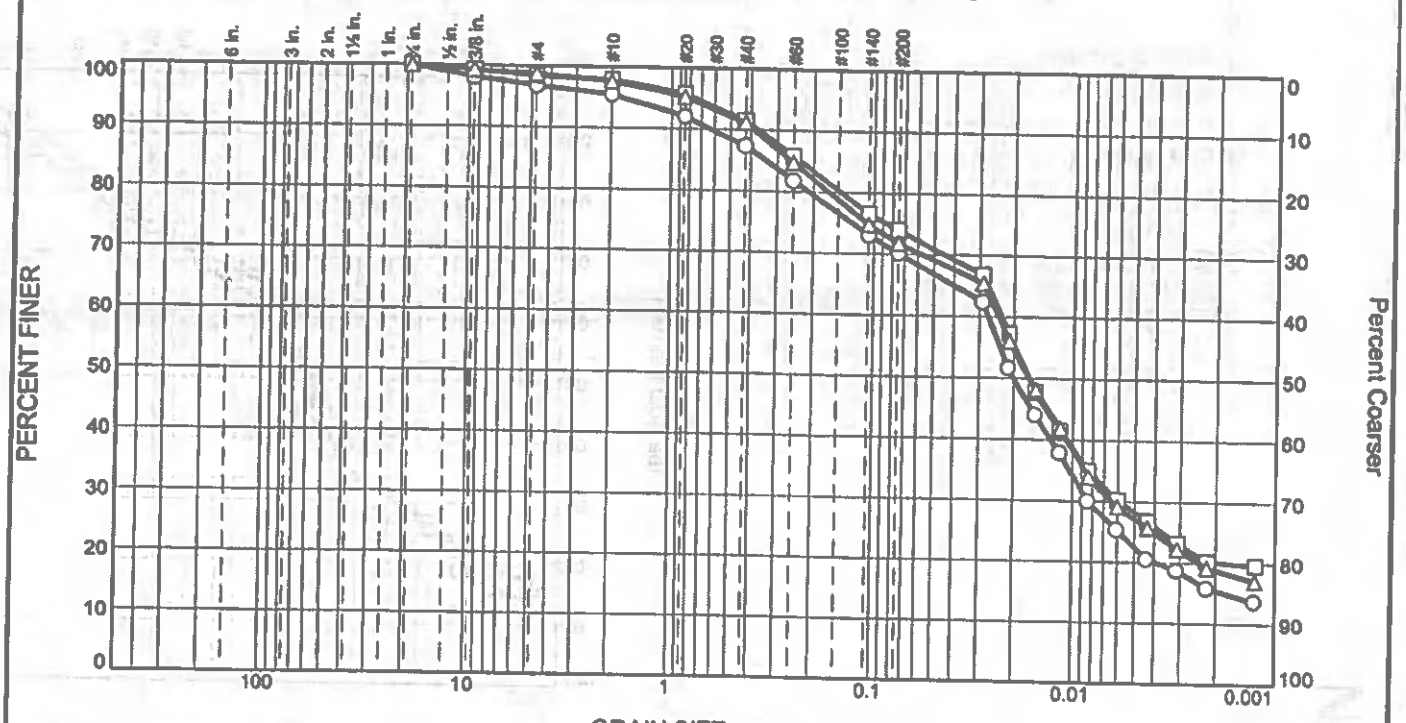
Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
	8/1/08	16:12		8/1/08	4:12	HAND
	8/1/08	18:09		8/1/08	18:09	"

Special Instructions:

 Copies: White – CQA Officer Yellow – Testing Firm Pink – Sampler

Electronic Filing: Received, Clerk's Office 06/20/2024

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	3.1	1.4	8.1	17.2	47.6	22.6
□	0.0	0.0	1.6	0.5	6.4	17.6	45.6	28.3
△	0.0	0.0	1.3	1.1	6.5	19.3	44.6	27.2

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	24	16	0.3388	0.0271	0.0200	0.0084	0.0018			
□	28	14	0.2337	0.0231	0.0167	0.0059				
△	28	14	0.2585	0.0241	0.0167	0.0064				

	Material Description	USCS	AASHTO
○		CL	A-4(3)
□		CL	
△		CL	A-6(7)

Project No. 03S5010 **Client:** Ameren

Project: Duck Creek Gypsum Stack CQA

○ **Sample Source:** CL ST-7,11 & 12 **Depth:** 0.00' - 0.50' **Sample No.:** ST7-1

□ **Sample Source:** CL ST-7,11 & 12 **Depth:** 0.50' - 1.00' **Sample No.:** ST11-2

△ **Sample Source:** CL ST-7,11 & 12 **Depth:** 0.00' - 0.50' **Sample No.:** ST12-1

Remarks:

○ F.M.=0.66

□ F.M.=0.46

△ F.M.=0.49

HANSON

Hanson Professional Services Inc.

Figure

Tested By: TCJ **Checked By:** RIN

Electronic Filing: Received, Clerk's Office 06/20/2024

GRAIN SIZE DISTRIBUTION TEST DATA

9/30/2008

Client: Ameren
Project: Duck Creek Gypsum Stack CQA
Project Number: 03S5010
Location: CL ST-7,11 & 12
Depth: 0.00' - 0.50'
Sample Number: ST7-1
Liquid Limit: 24
Plastic Limit: 16
USCS Classification: CL
AASHTO Classification: A-4(3)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
327.74	0.00	0.00	3			
			2			
			1.5			
			1			
			.75	0.00	100.0	0.0
			.375	6.27	98.1	1.9
			#4	10.32	96.9	3.1
			#10	14.74	95.5	4.5
49.46	0.00	0.00	#20	1.80	92.0	8.0
			#40	4.20	87.4	12.6
			#60	7.10	81.8	18.2
			#140	11.60	73.1	26.9
			#200	13.10	70.2	29.8

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 95.5
Weight of hydrometer sample =50.00
Hygroscopic moisture correction:
- **Moist weight and tare =** 48.49
- **Dry weight and tare =** 48.13
- **Tare weight =** 16.01
- **Hygroscopic moisture =** 1.1%

Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-4.4	-2.0

Meniscus correction only = 0.0
Specific gravity of solids = 2.70
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
2.00	23.2	1.0235	1.0203	0.0129	23.5	10.1	0.0290	62.4	37.6
4.00	23.2	1.0200	1.0168	0.0129	20.0	11.0	0.0214	51.7	48.3
8.00	23.2	1.0175	1.0143	0.0129	17.5	11.7	0.0156	44.0	56.0
15.00	23.2	1.0155	1.0123	0.0129	15.5	12.2	0.0117	37.9	62.1
30.00	23.1	1.0130	1.0098	0.0129	13.0	12.9	0.0085	30.1	69.9
60.00	23.0	1.0115	1.0083	0.0130	11.5	13.3	0.0061	25.5	74.5
120.00	22.7	1.0100	1.0067	0.0130	10.0	13.6	0.0044	20.6	79.4
240.00	22.3	1.0095	1.0061	0.0131	9.5	13.8	0.0031	18.8	81.2
480.00	22.5	1.0085	1.0052	0.0130	8.5	14.0	0.0022	15.9	84.1
1465.00	23.7	1.0075	1.0045	0.0129	7.5	14.3	0.0013	13.7	86.3

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Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	3.1	3.1	1.4	8.1	17.2	26.7	47.6	22.6	70.2

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0018	0.0039	0.0084	0.0200	0.0271	0.2094	0.3388	0.6277	1.7673

Fineness Modulus
0.66

LIQUID AND PLASTIC LIMITS TEST REPORT

Electronic Filing: Received, Clerk's Office 06/20/2024

GRAIN SIZE DISTRIBUTION TEST DATA

9/30/2008

Client: Ameren
Project: Duck Creek Gypsum Stack CQA
Project Number: 03S5010
Location: CL ST-7,11 & 12
Depth: 0.50' - 1.00'
Sample Number: ST11-2
Liquid Limit: 28
Plastic Limit: 14
USCS Classification: CL

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
449.83	0.00	0.00	3			
			2			
			1.5			
			1			
			.75	0.00	100.0	0.0
			.375	3.33	99.3	0.7
			#4	7.19	98.4	1.6
			#10	9.42	97.9	2.1
49.02	0.00	0.00	#20	1.10	95.7	4.3
			#40	3.20	91.5	8.5
			#60	6.10	85.7	14.3
			#140	10.70	76.5	23.5
			#200	12.00	73.9	26.1

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 97.9
Weight of hydrometer sample =50.00
Hygroscopic moisture correction:
- **Moist weight and tare =** 55.81
- **Dry weight and tare =** 55.21
- **Tare weight =** 15.47
- **Hygroscopic moisture =** 1.5%

Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-4.4	-1.5

Meniscus correction only = 0.0
Specific gravity of solids = 2.70
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
2.00	23.3	1.0240	1.0211	0.0129	24.0	9.9	0.0288	66.7	33.3
4.00	23.3	1.0210	1.0181	0.0129	21.0	10.7	0.0212	57.3	42.7
8.00	23.2	1.0180	1.0151	0.0129	18.0	11.5	0.0155	47.7	52.3
15.00	23.2	1.0160	1.0131	0.0129	16.0	12.1	0.0116	41.4	58.6
30.00	23.1	1.0140	1.0111	0.0129	14.0	12.6	0.0084	35.0	65.0
60.00	23.1	1.0125	1.0096	0.0129	12.5	13.0	0.0060	30.2	69.8
120.00	22.7	1.0115	1.0085	0.0130	11.5	13.3	0.0043	26.7	73.3
240.00	22.3	1.0105	1.0073	0.0131	10.5	13.5	0.0031	23.2	76.8
480.00	22.5	1.0095	1.0064	0.0130	9.5	13.8	0.0022	20.2	79.8
1468.00	23.6	1.0090	1.0062	0.0129	9.0	13.9	0.0013	19.6	80.4

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Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.6	1.6	0.5	6.4	17.6	24.5	45.6	28.3	73.9

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0018	0.0059	0.0167	0.0231	0.1465	0.2337	0.3699	0.7560

Fineness Modulus
0.46

Electronic Filing: Received, Clerk's Office 06/20/2024

GRAIN SIZE DISTRIBUTION TEST DATA

9/30/2008

Client: Ameren
Project: Duck Creek Gypsum Stack CQA
Project Number: 03S5010
Location: CL ST-7,11 & 12
Depth: 0.00' - 0.50'
Sample Number: ST12-1
Liquid Limit: 28
Plastic Limit: 14
USCS Classification: CL
AASHTO Classification: A-6(7)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
523.35	0.00	0.00	3			
			2			
			1.5			
			1			
			.75	0.00	100.0	0.0
			.375	4.31	99.2	0.8
			#4	6.73	98.7	1.3
			#10	12.55	97.6	2.4
49.50	0.00	0.00	#20	1.20	95.2	4.8
			#40	3.30	91.1	8.9
			#60	6.60	84.6	15.4
			#140	11.60	74.7	25.3
			#200	13.10	71.8	28.2

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 97.6
Weight of hydrometer sample =50.00
Hygroscopic moisture correction:
- **Moist weight and tare =** 42.60
- **Dry weight and tare =** 42.24
- **Tare weight =** 16.13
- **Hygroscopic moisture =** 1.4%

Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-4.5	-2.0

Meniscus correction only = 0.0
Specific gravity of solids = 2.70
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
2.00	23.3	1.0240	1.0208	0.0129	24.0	9.9	0.0288	65.5	34.5
4.00	23.3	1.0210	1.0178	0.0129	21.0	10.7	0.0212	56.0	44.0
8.00	23.2	1.0185	1.0153	0.0129	18.5	11.4	0.0154	48.1	51.9
15.00	23.2	1.0165	1.0133	0.0129	16.5	11.9	0.0115	41.8	58.2
30.00	23.2	1.0140	1.0108	0.0129	14.0	12.6	0.0084	33.9	66.1
60.00	23.0	1.0125	1.0093	0.0130	12.5	13.0	0.0060	29.1	70.9
120.00	22.7	1.0115	1.0082	0.0130	11.5	13.3	0.0043	25.7	74.3
240.00	22.3	1.0105	1.0071	0.0131	10.5	13.5	0.0031	22.2	77.8
480.00	22.4	1.0095	1.0061	0.0131	9.5	13.8	0.0022	19.2	80.8
1469.00	23.7	1.0085	1.0054	0.0129	8.5	14.0	0.0013	17.1	82.9

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Fractional Components

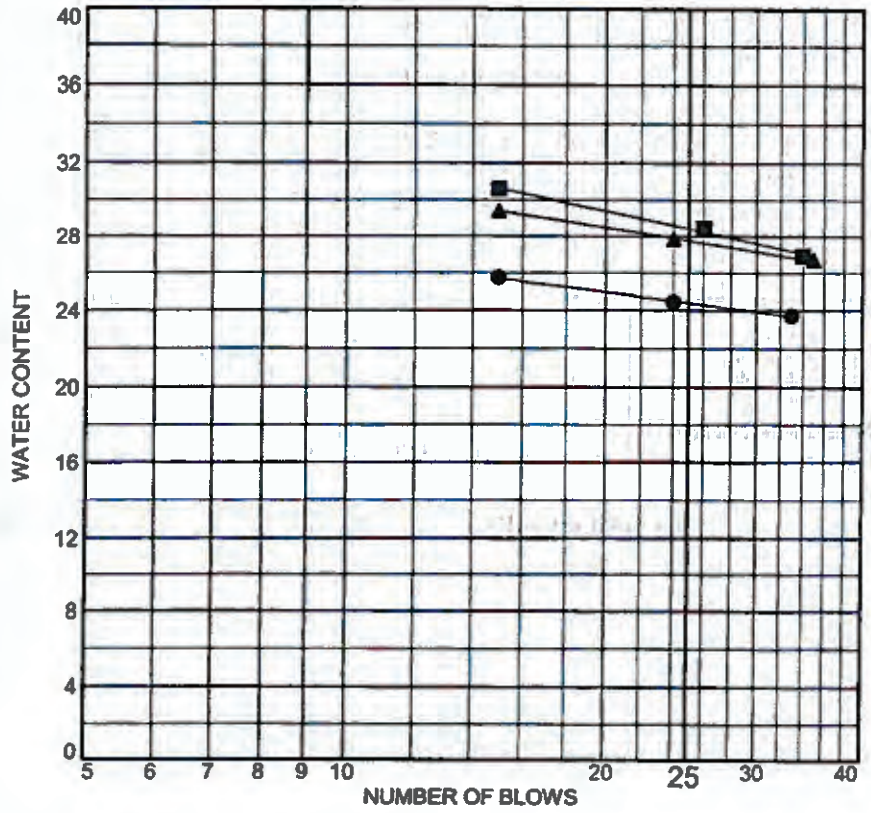
Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.3	1.3	1.1	6.5	19.3	26.9	44.6	27.2	71.8

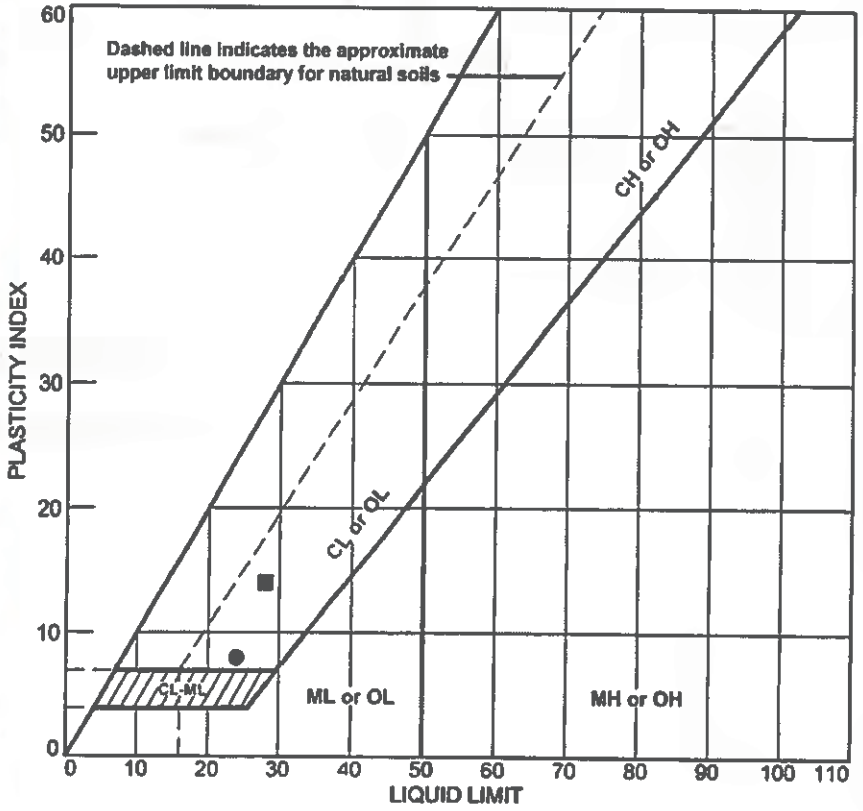
D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0024	0.0064	0.0167	0.0241	0.1677	0.2585	0.3887	0.8171

Fineness Modulus
0.49

Electronic Filing: Received, Clerk's Office 06/20/2024

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	CL ST-7,11 & 12	ST7-1	0.00' - 0.50'	09-23-08	CL			24	8
■	CL ST-7,11 & 12	ST11-2	0.50' - 1.00'	09-23-08	CL			28	14
▲	CL ST-7,11 & 12	ST12-1	0.00' - 0.50'	09-23-08	CL			28	14

Client Ameren

Project Duck Creek Gypsum Stack CQA

Project No. 03S5010 | Figure

HANSON
Hanson Professional Services Inc.

Tested By: ○ JCC □ KDE △ JCC **Checked By:** RIN

Electronic Filing: Received, Clerk's Office 06/20/2024

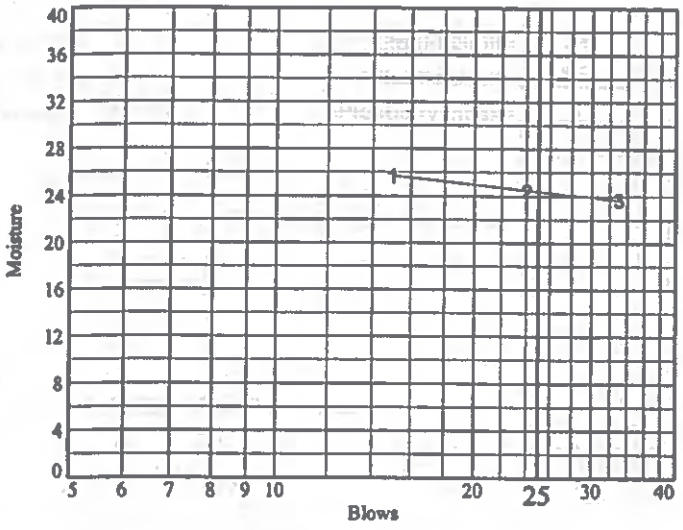
LIQUID AND PLASTIC LIMIT TEST DATA

9/30/2008

Client: Ameren
Project: Duck Creek Gypsum Stack CQA
Project Number: 03S5010
Location: CL ST-7,11 & 12
Depth: 0.00' - 0.50'
Sample Number: ST7-1
Date: 09-23-08
USCS Class.: CL
AASHTO Class.: A-4(3)
Tested by: JCC
Checked by: RIN

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.75	28.96	27.08			
Dry+Tare	26.96	26.30	24.86			
Tare	16.12	15.42	15.50			
# Blows	15	24	33			
Moisture	25.7	24.4	23.7			



Liquid Limit= 24
Plastic Limit= 16
Plasticity Index= 8

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.56	23.37			
Dry+Tare	21.59	22.38			
Tare	15.46	16.01			
Moisture	15.8	15.5			

Electronic Filing: Received, Clerk's Office 06/20/2024

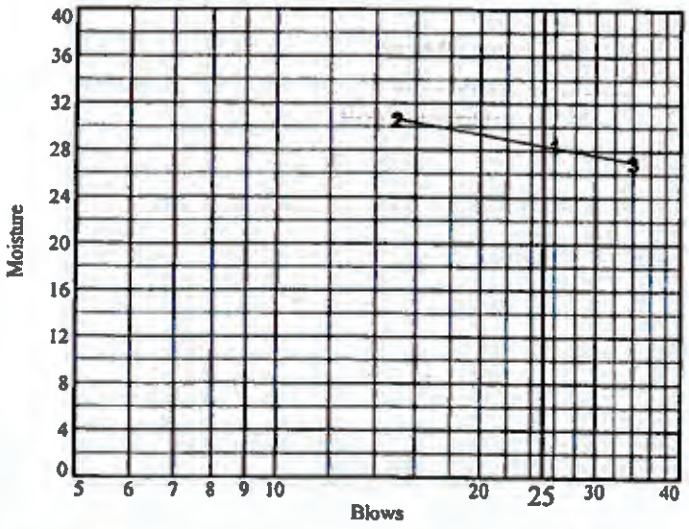
LIQUID AND PLASTIC LIMIT TEST DATA

9/30/2008

Client: Ameren
Project: Duck Creek Gypsum Stack CQA
Project Number: 03S5010
Location: CL ST-7,11 & 12
Depth: 0.50' - 1.00'
Sample Number: ST11-2
Date: 09-23-08
USCS Class.: CL
Tested by: KDE
Checked by: RIN

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	23.60	23.57	23.14			
Dry+Tare	21.95	21.76	21.58			
Tare	16.15	15.84	15.79			
# Blows	26	15	34			
Moisture	28.4	30.6	26.9			



Liquid Limit= 28
Plastic Limit= 14
Plasticity Index= 14

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.66	23.53			
Dry+Tare	21.79	22.53			
Tare	15.42	15.44			
Moisture	13.7	14.1			

Electronic Filing: Received, Clerk's Office 06/20/2024

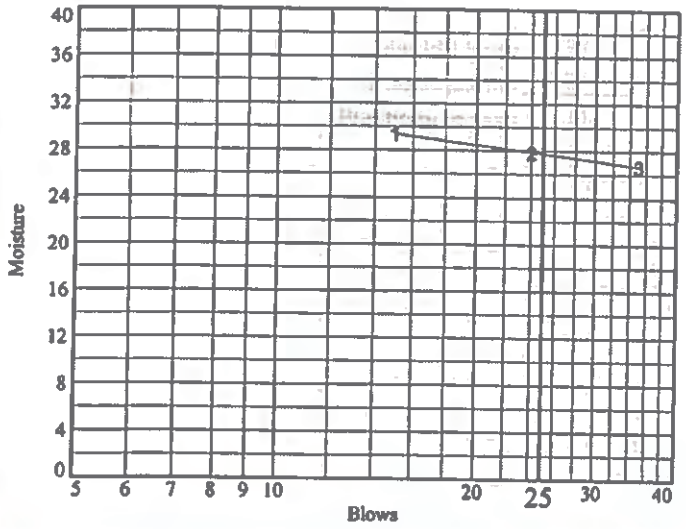
LIQUID AND PLASTIC LIMIT TEST DATA

9/30/2008

Client: Ameren
Project: Duck Creek Gypsum Stack CQA
Project Number: 03S5010
Location: CL ST-7,11 & 12
Depth: 0.00' - 0.50'
Sample Number: ST12-1
Date: 09-23-08
USCS Class.: CL
AASHTO Class.: A-6(7)
Tested by: JCC
Checked by: RIN

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.85	28.84	27.60			
Dry+Tare	26.71	26.09	25.12			
Tare	16.03	16.22	15.84			
# Blows	15	24	35			
Moisture	29.4	27.9	26.7			



Liquid Limit= 28
Plastic Limit= 14
Plasticity Index= 14

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.57	24.16			
Dry+Tare	21.68	23.07			
Tare	15.31	15.47			
Moisture	14.0	14.3			

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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/9/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-13-3 Lift 5
SAMPLE DESCRIPTION:	Yel. brn. & gray vf. sandy silt / so. clay	DEPTH (FT):	1.2-1.5

SPECIMEN WEIGHT (G)	888.28	WATER CONTENT OF TRIMMINGS	BEFORE TEST	AFTER TEST
SPECIMEN HEIGHT (IN)	3.798			
DIAMETER (IN)	2.859	TARE + WET SOIL (G)	49.12	951.45
AREA (SQ IN)	6.420	TARE + DRY SOIL (G)	44.00	845.08
VOLUME (CU IN)	24.382	TARE (G)	3.71	50.23
WET DENSITY (PCF)	138.79	WATER (G)	5.12	106.37
DRY DENSITY (PCF)	123.14	DRY SOIL (G)	40.29	794.85
WT. DRY SOIL (G)	788.13	WATER CONTENT (%)	12.71	13.38
VOLUME DRY SOIL (CU	17.813			
SP.GR. (ASSUMED)	2.7			
POROSITY (%)	26.94	STD. MAX. DEN.(LBS/CU.FT.)	N/A	
HEIGHT OF HEAD (PSI)	4.1	OPTIMUM MOISTURE (%)	N/A	
HYDRAULIC GRADIANT	29.9	% COMPACTION	N/A	
1/4 PORE VOLUME	26.91	PRESSURE HEAD (CM H2O)	288.30	
Initial Degree of Saturation	93.03	PANEL NUMBER	5	
TEST METHOD USED:	IEPA ASTM D5084	PERMEANT USED:	Tap Water	

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 10/9/2008
BORING #: N/A
SAMPLE #: ST-13-3 Lift 5
DEPTH (FT): 1.2-1.5

SPECIMEN HEIGHT (IN) 3.798
DIAMETER (IN) 2.859
AREA (SQ IN) 6.420

HEIGHT OF HEAD (PSI) 4.1
PRESSURE HEAD (CM H2O) 288.301176
PANEL NUMBER 5

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/9/2008	8:54:45	10/9/2008	16:36:30	7.70	7.7000	461.75	461.75	2.25E-07	2.25E-07
10/9/2008	16:39:00	10/10/2008	7:00:45	13.80	21.5000	861.75	1323.50	2.16E-07	2.20E-07
10/10/2008	7:03:00	10/11/2008	9:31:00	24.00	45.5000	1588.00	2911.50	2.04E-07	2.15E-07
10/11/2008	9:34:00	10/12/2008	10:40:00	20.35	65.8500	1506.00	4417.50	1.82E-07	2.00E-07
10/12/2008	10:40:00	10/13/2008	7:52:00	16.65	82.5000	1272.00	5689.50	1.76E-07	1.87E-07
10/13/2008	7:52:00								

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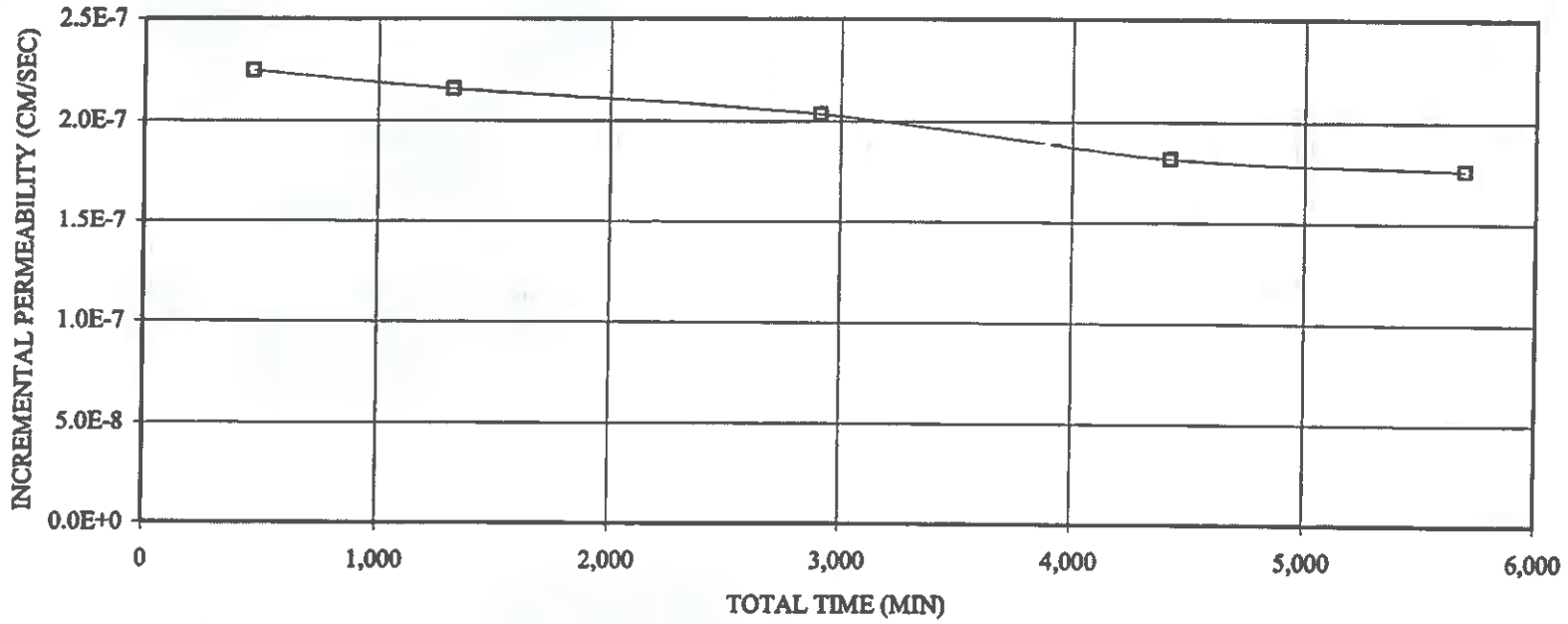
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/9/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-13-3 Lift 5
		DEPTH (FT):	1.2-1.5

SPECIMEN HEIGHT (IN)	3.798	HEIGHT OF HEAD (PSI)	4.1
DIAMETER (IN)	2.859	PRESSURE HEAD (CM H2O)	288.301176
AREA (SQ IN)	6.420	PANEL NUMBER	5



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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/3/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-14-2
SAMPLE DESCRIPTION:	Yel. brn. & gray vf. sandy silt / so. clay.	DEPTH (FT):	0.5-1.0

SPECIMEN WEIGHT (G)	957.23
SPECIMEN HEIGHT (IN)	4.162
DIAMETER (IN)	2.863
AREA (SQ IN)	6.436
VOLUME (CU IN)	26.788
WET DENSITY (PCF)	136.13
DRY DENSITY (PCF)	122.28
WT. DRY SOIL (G)	859.89
VOLUME DRY SOIL (CU IN)	19.435
SP.GR. (ASSUMED)	2.7
POROSITY (%)	27.45
HEIGHT OF HEAD (PSI)	4.5
HYDRAULIC GRADIANT	29.9
1/4 PORE VOLUME	30.13
Initial Degree of Saturation	80.78
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	42.76	1022.46
TARE + DRY SOIL (G)	38.79	900.13
TARE (G)	3.72	50.14
WATER (G)	3.97	122.33
DRY SOIL (G)	35.07	849.99
WATER CONTENT (%)	11.32	14.39

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	316.42812
PANEL NUMBER	4
PERMEANT USED:	Tap Water

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 10/10/2008
BORING #: N/A
SAMPLE #: ST-14-2
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 4.162
DIAMETER (IN) 2.863
AREA (SQ IN) 6.436

HEIGHT OF HEAD (PSI) 4.5
PRESSURE HEAD (CM H2O) 316.43
PANEL NUMBER 4

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/10/2008	6:57:00	10/11/2008	9:37:00	25.00	25.00	1600.00	1600.00	2.10E-07	2.10E-07
10/11/2008	9:39:00	10/12/2008	10:36:30	27.95	52.95	1497.50	3097.50	2.50E-07	2.30E-07
10/12/2008	10:36:30	10/13/2008	8:06:45	22.79	75.74	1290.25	4387.75	2.37E-07	2.32E-07
10/13/2008	8:06:45	10/13/2008	16:05:00	8.17	83.91	478.25	4866.00	2.29E-07	2.39E-07
10/13/2008	16:05:00	10/14/2008	7:36:00	14.62	98.53	931.00	5797.00	2.11E-07	2.26E-07
10/14/2008	7:36:00	10/14/2008	16:16:15	8.60	107.13	520.25	6317.25	2.22E-07	2.20E-07
10/14/2008	16:37:00	10/15/2008	7:58:00	16.77	123.90	921.00	7238.25	2.44E-07	2.25E-07
10/15/2008	8:17:00	10/16/2008	8:12:00	24.08	147.98	1435.00	8673.25	2.25E-07	2.30E-07

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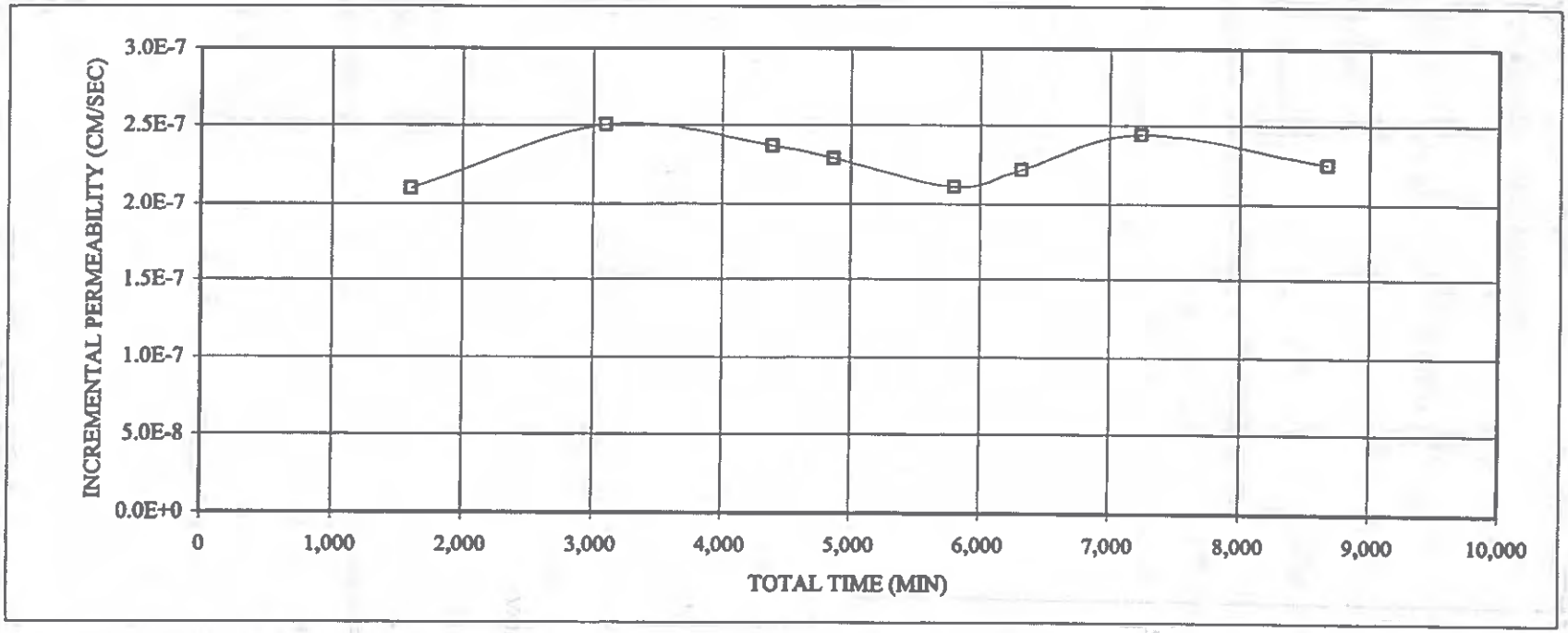
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/10/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-14-2
		DEPTH (FT):	0.5-1.0
SPECIMEN HEIGHT (IN)	4.162	HEIGHT OF HEAD (PSI)	4.5
DIAMETER (IN)	2.863	PRESSURE HEAD (CM H2O)	316.43
AREA (SQ IN)	6.436	PANEL NUMBER	4



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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/3/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST15-1 Lift 3
SAMPLE DESCRIPTION:	Yel. brn. & gray vf. sandy silt / so. clay.	DEPTH (FT):	0.0-0.5

SPECIMEN WEIGHT (G)	968.10
SPECIMEN HEIGHT (IN)	4.274
DIAMETER (IN)	2.856
AREA (SQ IN)	6.408
VOLUME (CU IN)	27.385
WET DENSITY (PCF)	134.67
DRY DENSITY (PCF)	119.91
WT. DRY SOIL (G)	861.95
VOLUME DRY SOIL (CU IN)	19.481
SP.GR. (ASSUMED)	2.7
POROSITY (%)	28.861
HEIGHT OF HEAD (PSI)	4.6
HYDRAULIC GRADIANT	29.8
1/4 PORE VOLUME	32.38
Initial Degree of Saturation	81.96
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	52.95	1029.49
TARE + DRY SOIL (G)	47.55	905.81
TARE (G)	3.7	49.33
WATER (G)	5.4	123.68
DRY SOIL (G)	43.85	856.48
WATER CONTENT (%)	12.31	14.44

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	323.46
PANEL NUMBER	8
PERMEANT USED:	Tap Water

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 10/9/2008
BORING #: N/A
SAMPLE #: ST15-1 Lift 3
DEPTH (FT): 0.0-0.5

SPECIMEN HEIGHT (IN) 4.274
DIAMETER (IN) 2.856
AREA (SQ IN) 6.408

HEIGHT OF HEAD (PSI) 4.6
PRESSURE HEAD (CM H2O) 323.459856
PANEL NUMBER 8

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/9/2008	8:33:00	10/9/2008	12:42:00	16.90	16.9000	249.00	249.00	9.18E-07	9.18E-07
10/9/2008	12:44:15	10/9/2008	16:40:00	12.50	29.4000	235.75	484.75	7.17E-07	8.18E-07
10/9/2008	16:48:00	10/10/2008	7:15:15	40.40	69.8000	867.25	1352.00	6.30E-07	7.55E-07
10/10/2008	7:18:15	10/11/2008	9:39:40	57.60	127.4000	1581.42	2933.42	4.93E-07	6.90E-07
10/11/2008	9:41:10	10/12/2008	10:34:35	49.20	176.6000	1493.42	4426.83	4.46E-07	5.72E-07
10/12/2008	10:36:10	10/13/2008	8:13:00	40.00	216.6000	1296.83	5723.67	4.17E-07	4.97E-07
10/13/2008	8:13:00								

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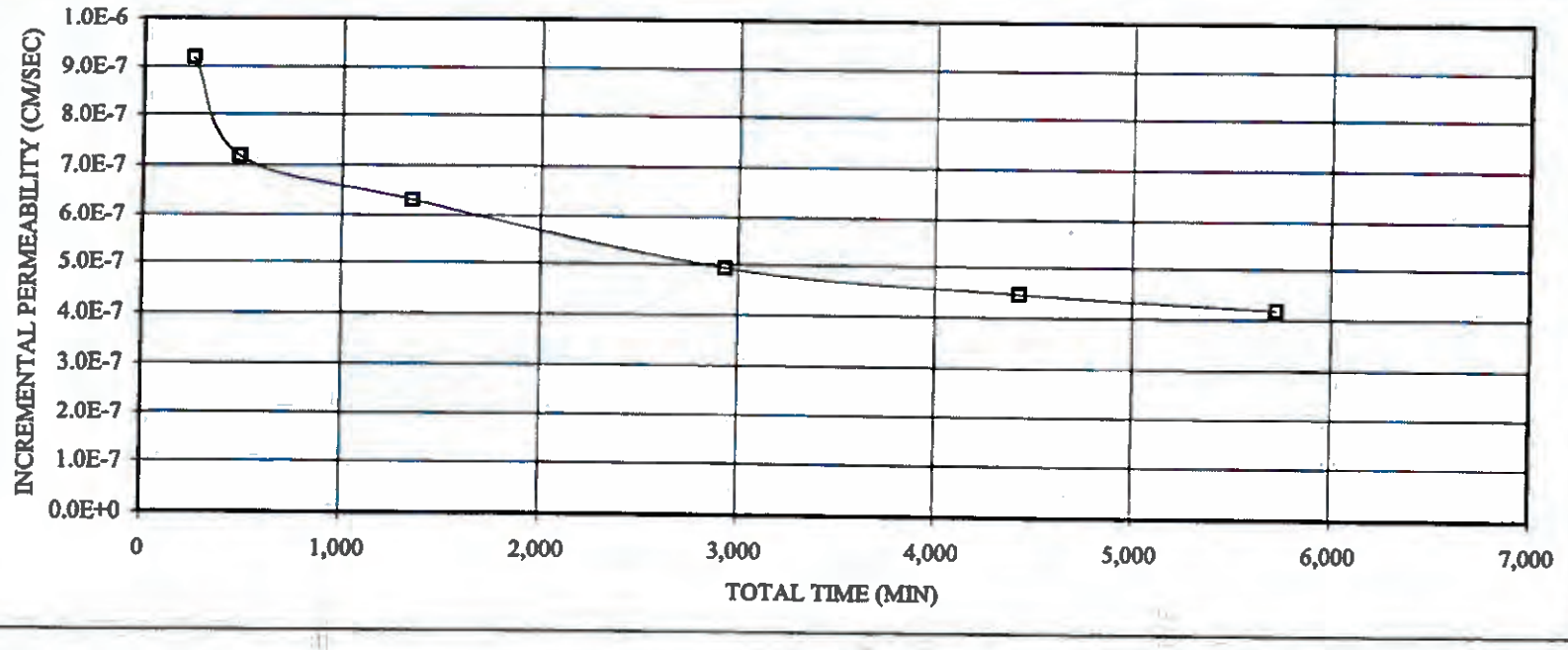
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/9/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST15-1 Lift 3
		DEPTH (FT):	0.0-0.5

SPECIMEN HEIGHT (IN)	4.274	HEIGHT OF HEAD (PSI)	4.6
DIAMETER (IN)	2.856	PRESSURE HEAD (CM H2O)	323.459856
AREA (SQ IN)	6.408	PANEL NUMBER	8



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Chain of Custody Record

(Form CQAP 6.1, Revision 0)

Gypsum Management and CCB Landfill Facilities **Ameren**

Client	Ameren Duck Creek Generating Station
Address	17751 North Cilco Road
City, State Zip Code	Canton, IL 61520
Phone / Facsimile No.	(309) 668-2236 / (217) 347-3106
Client Project	Gypsum Stack
Location	Canton, IL.
Sampler(s) / Phone	John Mansker/D. Lamb 309-635-0268
Turnaround Time	Standard [ ] Rush [ ] Date Required: 1-Week
P.O. # or Invoice To	~~[illegible]~~ Ameren ENERGY
Contact Person	J. Mansker 309-635-0268/Dave Boyce - 309-668-3857

Analysis and/or Method Requested: Per Specifications Table A-1

Sample Description	Sampling Date	Sampling Time	Sample Type[1]	# of Containers	Analysis and/or Method Requested	Remarks or Observations
ST-014	9-10-08	18:30	S	1	X	Clay Liner Material
ST-013	9-10-08	18:00	S	1	X	" "
ST-015	9-10-08	19:00	S	1	X	" "

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
Dave Lamb	9-20-08	1:15pm	Thomas Ruholl	9-20-08	1:13 pm	HAND
Thomas Ruholl	9-20-08	3:10pm	[signature]	9-20-08	3:10	Hand.

Special Instructions:

Page ____ of ____ Copies: White – CQA Officer Yellow – Testing Firm Pink – Sampler

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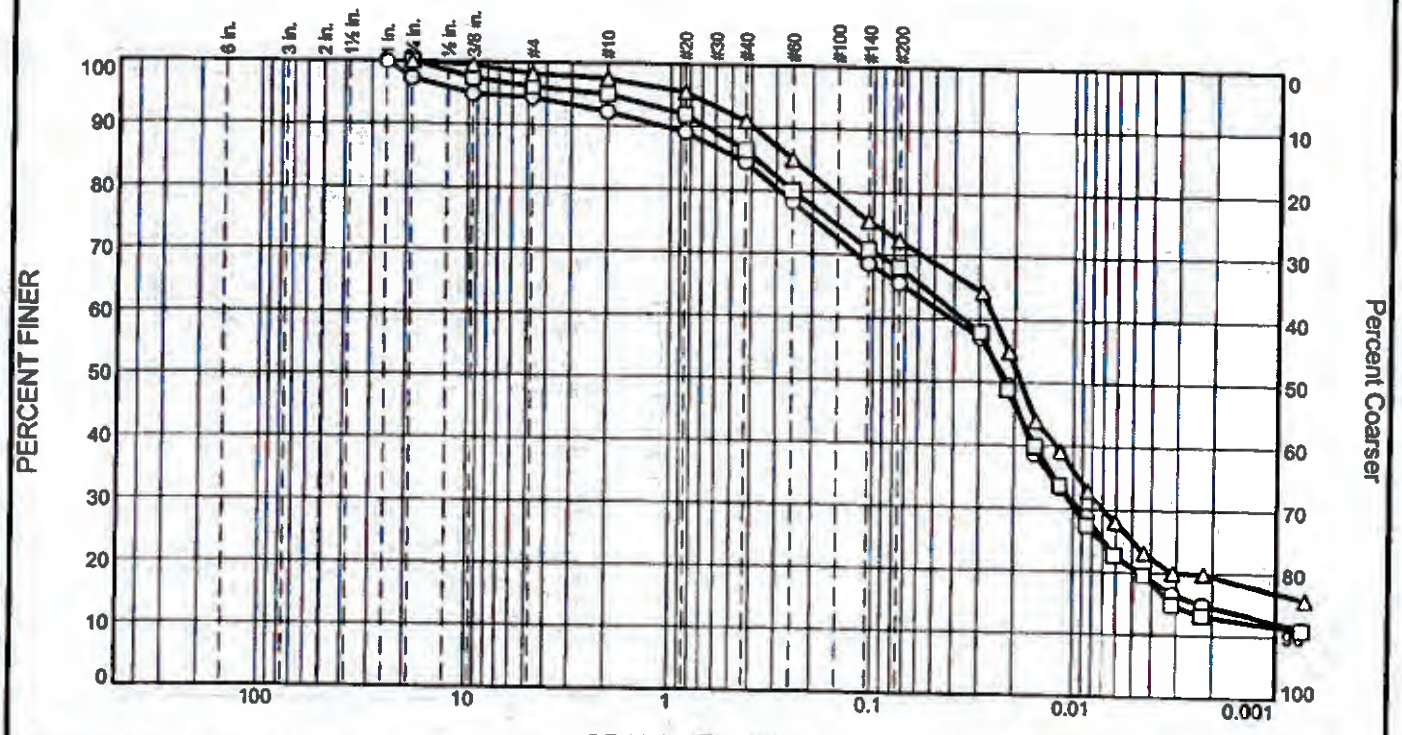
Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	2.7	2.9	2.1	7.8	18.9	44.7	20.9
□	0.0	0.0	3.9	1.1	8.6	18.3	47.3	20.8
△	0.0	0.0	1.8	0.6	6.5	18.8	47.1	25.2

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	23	16	0.4557	0.0408	0.0219	0.0092	0.0023			
□	21	16	0.3776	0.0360	0.0226	0.0098	0.0032			
△	25	15	0.2484	0.0253	0.0186	0.0069				

Material Description	USCS	AASHTO
○ Brn. & gray vf. sandy silt w/so. clay.	CL-ML	A-4(2)
□ Brn. & gray vf. sandy silt w/so. clay.	CL-ML	A-4(1)
△ Brn. & gray vf. sandy silt w/so. clay.	CL	A-4(5)

Project No. 03S5010 **Client:** Ameren
Project: Duck Creek CQA

○ **Sample Source:** Clay Liner **Depth:** 0.70' - 1.20' **Sample No.:** ST13-2 Lift 5
□ **Sample Source:** Clay Liner **Depth:** 0.50' - 1.00' **Sample No.:** ST14-2
△ **Sample Source:** Clay Liner **Depth:** 0.00' - 0.50' **Sample No.:** ST15-1 Lift 3

Remarks:
○F.M.=0.91
□F.M.=0.72
△F.M.=0.49

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Figure

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GRAIN SIZE DISTRIBUTION TEST DATA

10/8/2008

Client: Ameren
Project: Duck Creek CQA
Project Number: 03S5010
Location: Clay Liner
Depth: 0.70' - 1.20'
Sample Number: ST13-2 Lift 5
Material Description: Brn. & gray vf. sandy silt w/so. clay.
Liquid Limit: 23
Plastic Limit: 16
USCS Classification: CL-ML
AASHTO Classification: A-4(2)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
502.80	0.00	0.00	3			
			2			
			1.5			
			1	0.00	100.0	0.0
			.75	13.40	97.3	2.7
			.375	25.70	94.9	5.1
			#4	28.10	94.4	5.6
			#10	38.90	92.3	7.7
49.56	0.00	0.00	#20	1.68	89.1	10.9
			#40	4.15	84.5	15.5
			#60	7.52	78.3	21.7
			#140	12.71	68.6	31.4
			#200	14.33	65.6	34.4

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 92.3
Weight of hydrometer sample =50
Hygroscopic moisture correction:
- **Moist weight and tare =** 46.64
- **Dry weight and tare =** 46.26
- **Tare weight =** 3.72
- **Hygroscopic moisture = 0.9%**

Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-4.5	-2.0

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
2.00	23.1	1.0225	1.0193	0.0129	22.5	10.3	0.0294	57.0	43.0
4.00	23.0	1.0200	1.0168	0.0130	20.0	11.0	0.0215	49.5	50.5
8.00	23.1	1.0163	1.0131	0.0129	16.3	12.0	0.0158	38.7	61.3
15.00	23.1	1.0145	1.0113	0.0129	14.5	12.5	0.0118	33.3	66.7
30.00	23.0	1.0130	1.0098	0.0130	13.0	12.9	0.0085	28.8	71.2
60.00	22.8	1.0110	1.0077	0.0130	11.0	13.4	0.0061	22.8	77.2
120.00	22.6	1.0100	1.0067	0.0130	10.0	13.6	0.0044	19.7	80.3
240.00	22.5	1.0090	1.0056	0.0130	9.0	13.9	0.0031	16.6	83.4
480.00	22.2	1.0085	1.0051	0.0131	8.5	14.0	0.0022	14.9	85.1
4343.00	23.2	1.0070	1.0038	0.0129	7.0	14.4	0.0007	11.2	88.8

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Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	2.7	2.9	5.6	2.1	7.8	18.9	28.8	44.7	20.9	65.6

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0023	0.0046	0.0092	0.0219	0.0408	0.2895	0.4557	1.0767	9.8304

Fineness Modulus
0.91

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GRAIN SIZE DISTRIBUTION TEST DATA

10/8/2008

Client: Ameren
Project: Duck Creek CQA
Project Number: 03S5010
Location: Clay Liner
Depth: 0.50' - 1.00'
Sample Number: ST14-2
Material Description: Brn. & gray vf. sandy silt w/so. clay.
Liquid Limit: 21
Plastic Limit: 16
USCS Classification: CL-ML
AASHTO Classification: A-4(1)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
520.40	0.00	0.00	3			
			2			
			1.5			
			1			
			.75	0.00	100.0	0.0
			.375	13.40	97.4	2.6
			#4	20.20	96.1	3.9
			#10	25.90	95.0	5.0
49.68	0.00	0.00	#20	1.62	91.9	8.1
			#40	4.50	86.4	13.6
			#60	7.82	80.1	19.9
			#140	12.61	70.9	29.1
			#200	14.07	68.1	31.9

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 95.0
Weight of hydrometer sample =50
Hygroscopic moisture correction:
- **Moist weight and tare =** 43.01
- **Dry weight and tare =** 42.76
- **Tare weight =** 3.71
- **Hygroscopic moisture = 0.6%**

Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-4.4	-1.5

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
2.00	23.0	1.0220	1.0191	0.0130	22.0	10.5	0.0297	57.9	42.1
4.00	23.1	1.0190	1.0161	0.0129	19.0	11.3	0.0217	48.8	51.2
8.00	23.2	1.0160	1.0131	0.0129	16.0	12.1	0.0159	39.8	60.2
15.00	23.1	1.0140	1.0111	0.0129	14.0	12.6	0.0119	33.7	66.3
30.00	22.9	1.0120	1.0090	0.0130	12.0	13.1	0.0086	27.4	72.6
60.00	22.8	1.0105	1.0075	0.0130	10.5	13.5	0.0062	22.8	77.2
120.00	22.7	1.0095	1.0065	0.0130	9.5	13.8	0.0044	19.6	80.4
240.00	22.5	1.0080	1.0049	0.0130	8.0	14.2	0.0032	14.9	85.1
480.00	22.3	1.0075	1.0043	0.0131	7.5	14.3	0.0023	13.2	86.8
4342.00	23.2	1.0065	1.0036	0.0129	6.5	14.6	0.0007	11.0	89.0

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Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	3.9	3.9	1.1	8.6	18.3	28.0	47.3	20.8	68.1

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0032	0.0046	0.0098	0.0226	0.0360	0.2485	0.3776	0.6672	1.9873

Fineness Modulus
0.72

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GRAIN SIZE DISTRIBUTION TEST DATA

10/8/2008

Client: Ameren
Project: Duck Creek CQA
Project Number: 03S5010
Location: Clay Liner
Depth: 0.00' - 0.50'
Sample Number: ST15-1 Lift 3
Material Description: Brn. & gray vf. sandy silt w/so. clay.
Liquid Limit: 25
Plastic Limit: 15
USCS Classification: CL
AASHTO Classification: A-4(5)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
343.80	0.00	0.00	3			
			2			
			1.5			
			1			
			.75	0.00	100.0	0.0
			.375	1.80	99.5	0.5
			#4	6.20	98.2	1.8
			#10	8.40	97.6	2.4
49.47	0.00	0.00	#20	1.05	95.5	4.5
			#40	3.29	91.1	8.9
			#60	6.33	85.1	14.9
			#140	11.24	75.4	24.6
			#200	12.79	72.3	27.7

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 97.6
Weight of hydrometer sample =50
Hygroscopic moisture correction:
- **Moist weight and tare =** 22.65
- **Dry weight and tare =** 22.45
- **Tare weight =** 3.64
- **Hygroscopic moisture =** 1.1%

Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-4.0	-2.0

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
2.00	23.1	1.0235	1.0205	0.0129	23.5	10.1	0.0291	64.3	35.7
4.00	23.1	1.0205	1.0175	0.0129	20.5	10.9	0.0213	54.9	45.1
8.00	23.1	1.0170	1.0140	0.0129	17.0	11.8	0.0157	43.9	56.1
15.00	23.0	1.0155	1.0125	0.0130	15.5	12.2	0.0117	39.1	60.9
30.00	22.9	1.0135	1.0105	0.0130	13.5	12.7	0.0084	32.8	67.2
60.00	22.8	1.0120	1.0090	0.0130	12.0	13.1	0.0061	28.1	71.9
120.00	22.6	1.0105	1.0074	0.0130	10.5	13.5	0.0044	23.2	76.8
240.00	22.5	1.0095	1.0064	0.0130	9.5	13.8	0.0031	20.0	80.0
480.00	22.2	1.0095	1.0063	0.0131	9.5	13.8	0.0022	19.9	80.1
4534.00	23.2	1.0080	1.0050	0.0129	8.0	14.2	0.0007	15.8	84.2

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Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.8	1.8	0.6	6.5	18.8	25.9	47.1	25.2	72.3

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0029	0.0069	0.0186	0.0253	0.1595	0.2484	0.3866	0.7876

Fineness Modulus
0.49

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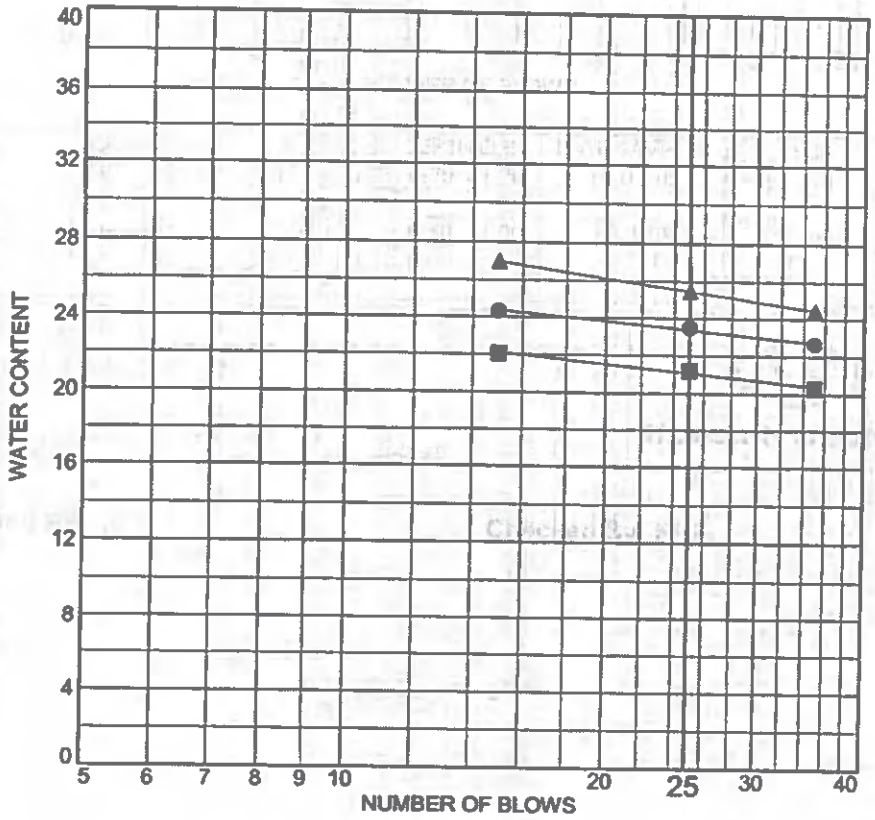
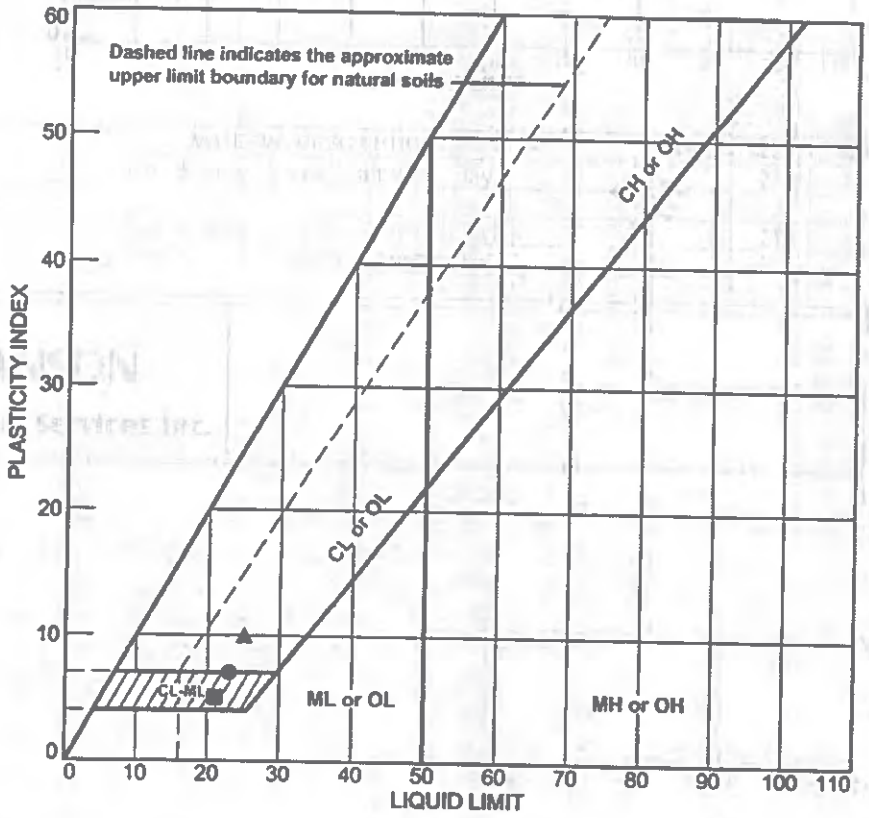
LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	Clay Liner	ST13-2 Lift 5	0.70' - 1.20'	10-03-08	CL-ML	Brn. & gray vf. sandy silt w/so. clay.		23	7
■	Clay Liner	ST14-2	0.50' - 1.00'	10-3-08	CL-ML	Brn. & gray vf. sandy silt w/so. clay.		21	5
▲	Clay Liner	ST15-1 Lift 3	0.00' - 0.50'	10-03-08	CL	Brn. & gray vf. sandy silt w/so. clay.		25	10

Client Ameren

Project Duck Creek CQA

Project No. 03S5010 | Figure

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Tested By: JCC **Checked By:** RIN

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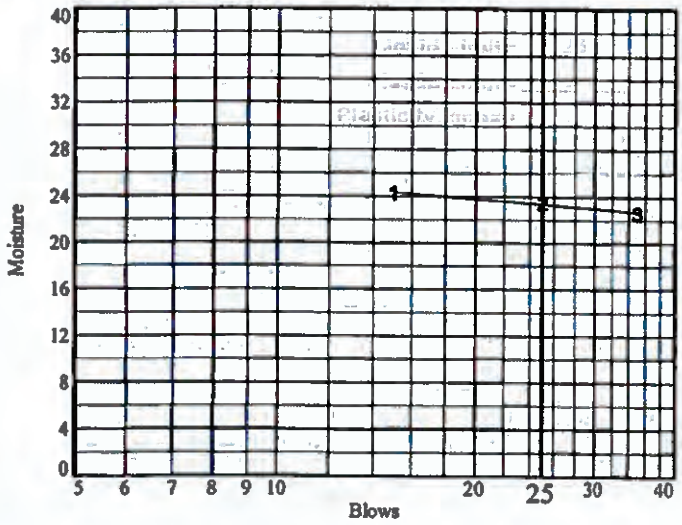
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2008

Client: Ameren
Project: Duck Creek CQA
Project Number: 03S5010
Location: Clay Liner
Depth: 0.70' - 1.20'
Sample Number: ST13-2 Lift 5
Material Description: Brn. & gray vf. sandy silt w/so. clay.
Date: 10-03-08
USCS Class.: CL-ML
AASHTO Class.: A-4(2)
Tested by: JCC
Checked by: RIN

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	30.11	29.08	28.05			
Dry+Tare	27.37	26.48	25.74			
Tare	16.10	15.42	15.54			
# Blows	15	25	35			
Moisture	24.3	23.5	22.6			



Liquid Limit= 23
Plastic Limit= 16
Plasticity Index= 7

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	25.55	25.33			
Dry+Tare	24.14	24.02			
Tare	15.44	15.99			
Moisture	16.2	16.3			

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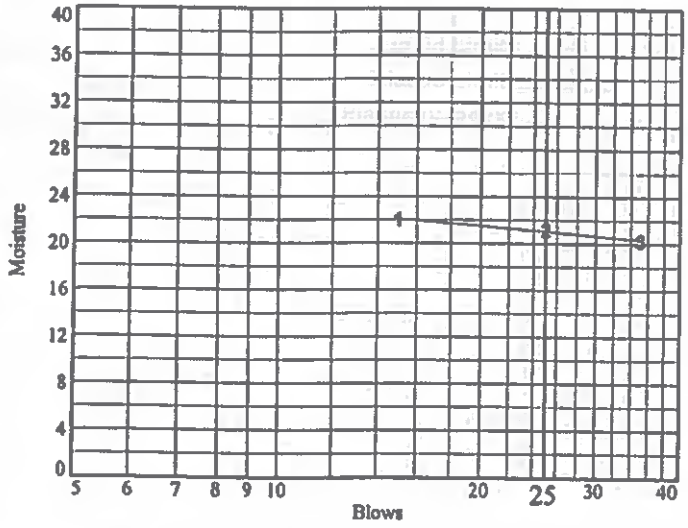
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2008

Client: Ameren
Project: Duck Creek CQA
Project Number: 03S5010
Location: Clay Liner
Depth: 0.50' - 1.00'
Sample Number: ST14-2
Material Description: Brn. & gray vf. sandy silt w/so. clay.
Date: 10-3-08
USCS Class.: CL-ML
AASHTO Class.: A-4(1)
Tested by: JCC
Checked by: RIN

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	30.28	29.31	28.37			
Dry+Tare	27.56	26.90	26.21			
Tare	15.22	15.53	15.56			
# Blows	15	25	35			
Moisture	22.0	21.2	20.3			



Liquid Limit= 21
Plastic Limit= 16
Plasticity Index= 5

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	23.23	23.72			
Dry+Tare	22.17	22.66			
Tare	15.54	16.08			
Moisture	16.0	16.1			

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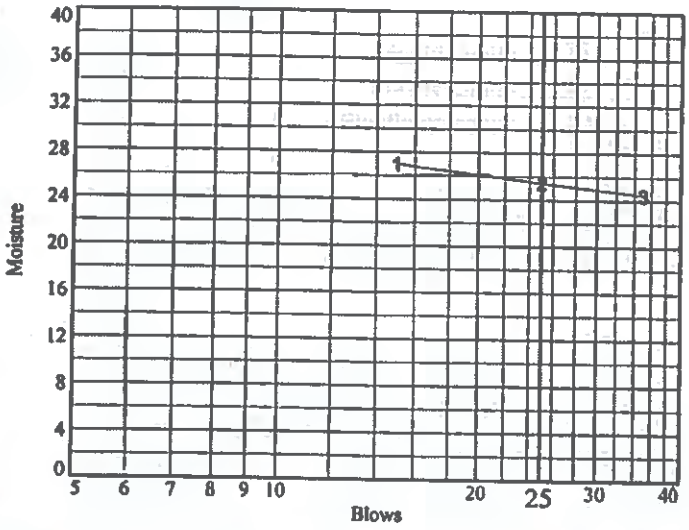
LIQUID AND PLASTIC LIMIT TEST DATA

10/10/2008

Client: Ameren
Project: Duck Creek CQA
Project Number: 03S5010
Location: Clay Liner
Depth: 0.00' - 0.50'
Sample Number: ST15-1 Lift 3
Material Description: Brn. & gray vf. sandy silt w/so. clay.
Date: 10-03-08
USCS Class.: CL
AASHTO Class.: A-4(5)
Tested by: JCC
Checked by: RIN

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	30.20	29.00	28.14			
Dry+Tare	27.10	26.26	25.79			
Tare	15.61	15.50	16.18			
# Blows	15	25	35			
Moisture	27.0	25.5	24.5			



Liquid Limit= 25
Plastic Limit= 15
Plasticity Index= 10

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.45	22.76			
Dry+Tare	21.56	21.83			
Tare	15.89	15.61			
Moisture	15.7	15.0			

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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER: 03S5010 TEST DATE: 10/13/2008

CLIENT: Ameren Duck Creek BORING #: N/A

JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor) SAMPLE #: ST-020-2 Lift 5

SAMPLE DESCRIPTION: Brn. gray vf. sandy silt (tr. clay, c. sand & sm. gravel). DEPTH (FT): 0.8-1.2

SPECIMEN WEIGHT (G)	833.63			
SPECIMEN HEIGHT (IN)	3.548			
DIAMETER (IN)	2.832			
AREA (SQ IN)	6.299			
VOLUME (CU IN)	22.349			
WET DENSITY (PCF)	142.10			
DRY DENSITY (PCF)	128.00			
WT. DRY SOIL (G)	750.93			
VOLUME DRY SOIL (CU	16.972			
SP.GR. (ASSUMED)	2.7			
POROSITY (%)	24.06			
HEIGHT OF HEAD (PSI)	3.8			
HYDRAULIC GRADIANT	29.7			
1/4 PORE VOLUME	22.03			
Initial Degree of Saturation	93.86			
TEST METHOD USED:	IEPA ASTM D5084			

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	361.96	893.13
TARE + DRY SOIL (G)	326.42	807.76
TARE (G)	3.71	50.17
WATER (G)	35.54	85.37
DRY SOIL (G)	322.71	757.59
WATER CONTENT (%)	11.01	11.27

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	267.21
PANEL NUMBER	5
PERMEANT USED:	Tap Water

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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor)

TEST DATE: 10/18/2008
BORING #: N/A
SAMPLE #: ST-020-2 Lift 5
DEPTH (FT): 0.8-1.2

SPECIMEN HEIGHT (IN) 3.548
DIAMETER (IN) 2.832
AREA (SQ IN) 6.299

HEIGHT OF HEAD (PSI) 3.8
PRESSURE HEAD (CM H2O) 267.205968
PANEL NUMBER 5

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/18/2008	9:31:00	10/18/2008	11:39:30	3.00	3.0000	128.50	128.50	3.23E-07	3.23E-07
10/18/2008	11:41:30	10/19/2008	11:56:30	25.90	28.9000	1455.00	1583.50	2.46E-07	2.85E-07
10/19/2008	11:56:30	10/20/2008	8:15:00	19.61	48.5100	1218.50	2802.00	2.23E-07	2.64E-07
10/20/2008	8:15:00	10/20/2008	13:39:00	4.81	53.3200	324.00	3126.00	2.05E-07	2.25E-07
10/20/2008	13:39:00	10/20/2008	16:42:25	2.96	56.2800	183.42	3309.42	2.23E-07	2.17E-07
10/20/2008	16:44:15	10/21/2008	8:17:30	14.80	71.0800	933.25	4242.67	2.19E-07	2.16E-07
10/21/2008	8:17:30	10/21/2008	13:18:15	5.18	76.2600	300.75	4543.42	2.38E-07	2.27E-07

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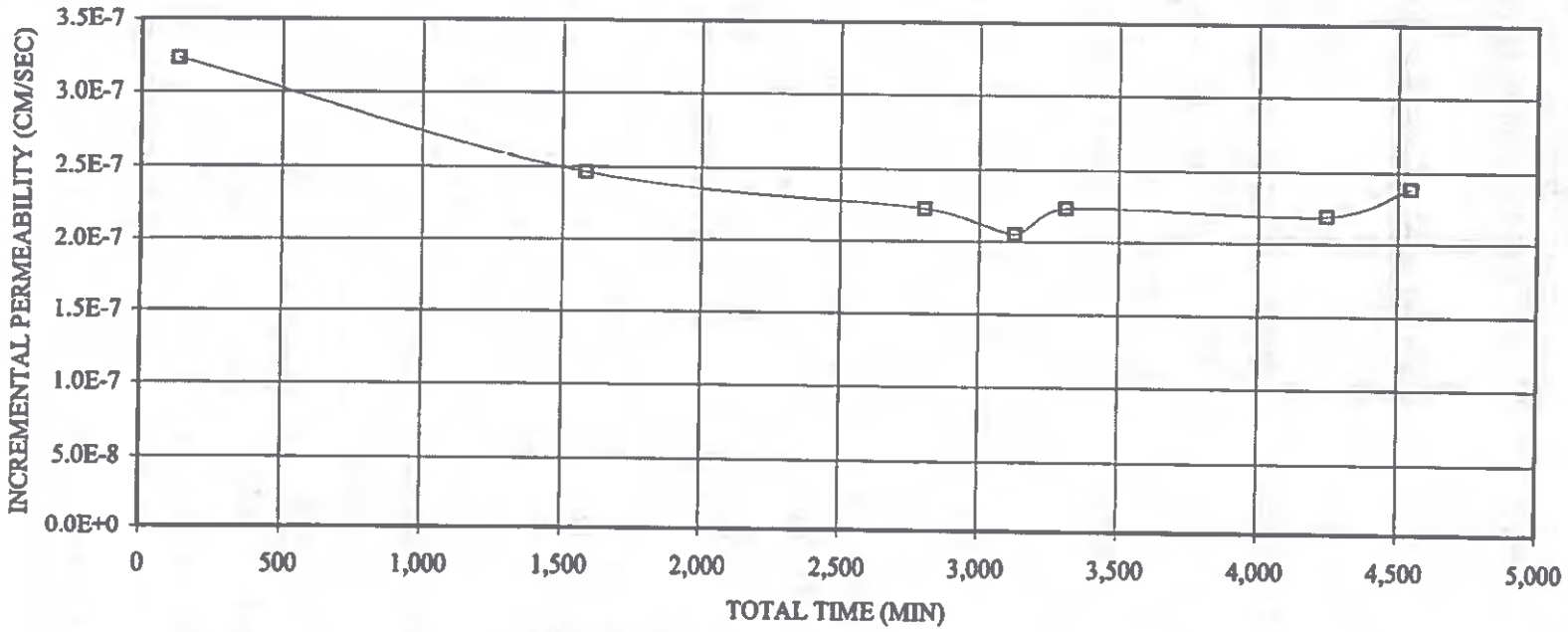
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/18/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Floor)	SAMPLE #:	ST-020-2 Lift 5
		DEPTH (FT):	0.8-1.2
SPECIMEN HEIGHT (IN)	3.548	HEIGHT OF HEAD (PSI)	3.8
DIAMETER (IN)	2.832	PRESSURE HEAD (CM H2O)	267.205968
AREA (SQ IN)	6.299	PANEL NUMBER	5



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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/13/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Slope)	SAMPLE #:	ST-021-3 Lift 4
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy silt / so clay (tr. sm. gravel).	DEPTH (FT):	1.0-1.5

			WATER CONTENT OF TRIMMINGS	
			BEFORE TEST	AFTER TEST
SPECIMEN WEIGHT (G)	760.63			
SPECIMEN HEIGHT (IN)	3.471			
DIAMETER (IN)	2.877	TARE + WET SOIL (G)	131.29	820.24
AREA (SQ IN)	6.501	TARE + DRY SOIL (G)	111.7	691.69
VOLUME (CU IN)	22.564	TARE (G)	3.75	49.98
WET DENSITY (PCF)	128.42	WATER (G)	19.59	128.55
DRY DENSITY (PCF)	108.69	DRY SOIL (G)	107.95	641.71
WT. DRY SOIL (G)	643.80	WATER CONTENT (%)	18.15	20.03
VOLUME DRY SOIL (CU IN)	14.551			
SP.GR. (ASSUMED)	2.7			
POROSITY (%)	35.51	STD. MAX. DEN.(LBS/CU.FT.)	N/A	
HEIGHT OF HEAD (PSI)	3.7	OPTIMUM MOISTURE (%)	N/A	
HYDRAULIC GRADIANT	29.5	% COMPACTION	N/A	
1/4 PORE VOLUME	32.83	PRESSURE HEAD (CM H2O)	260.174232	
Initial Degree of Saturation	88.97	PANEL NUMBER	6	
TEST METHOD USED:	IEPA ASTM D5084	PERMEANT USED:	Tap Water	

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (Slope)

TEST DATE: 10/18/2008
BORING #: N/A
SAMPLE #: ST-021-3 Lift 4
DEPTH (FT): 1.0-1.5

SPECIMEN HEIGHT (IN) 3.471
DIAMETER (IN) 2.877
AREA (SQ IN) 6.501

HEIGHT OF HEAD (PSI) 3.7
PRESSURE HEAD (CM H2O) 260.17
PANEL NUMBER 6

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/18/2008	9:33:45	10/19/2008	11:57:00	12.30	12.30	1583.25	1583.25	1.05E-07	1.05E-07
10/19/2008	11:58:00	10/20/2008	8:15:45	9.50	21.80	1217.75	2801.00	1.05E-07	1.05E-07
10/20/2008	8:15:45	10/20/2008	13:41:00	2.30	24.10	325.25	3126.25	9.52E-08	1.00E-07
10/20/2008	13:41:00	10/20/2008	16:44:40	1.30	25.40	183.67	3309.92	9.53E-08	9.53E-08
10/20/2008	16:46:45	10/21/2008	8:21:30	7.20	32.60	934.75	4244.67	1.04E-07	9.95E-08
10/21/2008	8:21:30	10/21/2008	13:02:35	2.00	34.60	281.08	4525.75	9.58E-08	9.98E-08

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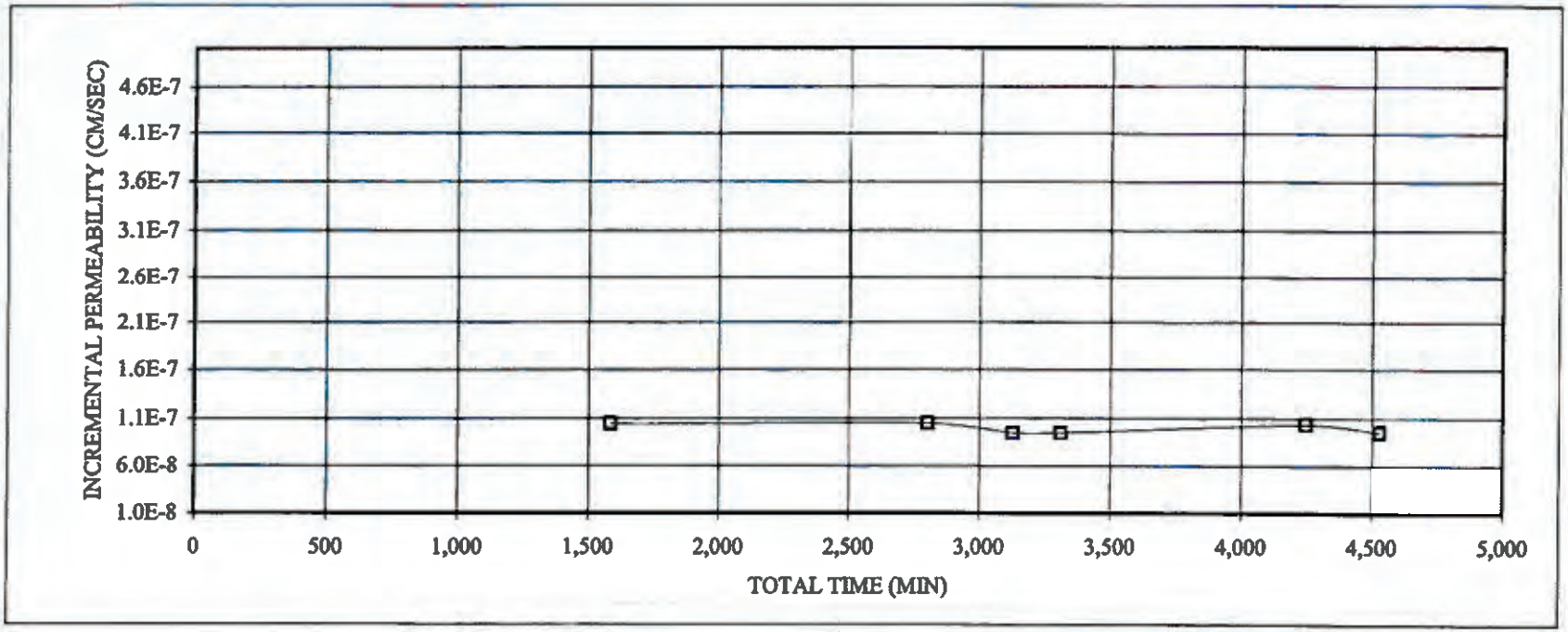
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/18/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Slope)	SAMPLE #:	ST-021-3 Lift 4
		DEPTH (FT):	1.0-1.5

SPECIMEN HEIGHT (IN)	3.471	HEIGHT OF HEAD (PSI)	3.7
DIAMETER (IN)	2.877	PRESSURE HEAD (CM H2O)	260.17
AREA (SQ IN)	6.501	PANEL NUMBER	6



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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/13/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-024-2 Lift 5
SAMPLE DESCRIPTION:	Gray vf. sandy silt (tr. clay, c. sand & sm. gravel).	DEPTH (FT):	0.5-1.0

SPECIMEN WEIGHT (G)	838.06
SPECIMEN HEIGHT (IN)	3.756
DIAMETER (IN)	2.821
AREA (SQ IN)	6.250
VOLUME (CU IN)	23.476
WET DENSITY (PCF)	136.00
DRY DENSITY (PCF)	120.87
WT. DRY SOIL (G)	744.82
VOLUME DRY SOIL (CU IN)	16.834
SP.GR. (ASSUMED)	2.7
POROSITY (%)	28.292
HEIGHT OF HEAD (PSI)	4
HYDRAULIC GRADIANT	29.5
1/4 PORE VOLUME	27.21
Initial Degree of Saturation	85.67
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	156.96	889.79
TARE + DRY SOIL (G)	139.91	783.23
TARE (G)	3.71	49.34
WATER (G)	17.05	106.56
DRY SOIL (G)	136.2	733.89
WATER CONTENT (%)	12.52	14.52

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	281.269
PANEL NUMBER	8
PERMEANT USED:	Tap Water

Electronic Filing: Received, Clerk's Office 06/20/2024

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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 10/18/2008
BORING #: N/A
SAMPLE #: ST-024-2 Lift 5
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.756
DIAMETER (IN) 2.821
AREA (SQ IN) 6.250

HEIGHT OF HEAD (PSI) 4
PRESSURE HEAD (CM H2O) 281.26944
PANEL NUMBER 8

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/18/2008	9:42:30	10/18/2008	11:43:45	6.30	6.3000	121.25	121.25	7.28E-07	7.28E-07
10/18/2008	11:45:30	10/19/2008	12:01:30	61.60	67.9000	1456.00	1577.25	5.93E-07	6.61E-07
10/19/2008	12:02:20	10/20/2008	8:18:40	45.20	113.1000	1216.33	2793.58	5.21E-07	6.14E-07
10/20/2008	8:18:40	10/20/2008	13:43:30	10.80	123.9000	324.83	3118.42	4.66E-07	5.27E-07
10/20/2008	13:43:30	10/20/2008	16:53:00	5.60	129.5000	189.50	3307.92	4.14E-07	4.67E-07
10/20/2008	16:57:25	10/21/2008	8:29:30	30.80	160.3000	932.08	4240.00	4.63E-07	4.48E-07
10/21/2008	8:29:30	10/21/2008	13:31:00	9.20	169.5000	301.50	4541.50	4.28E-07	4.35E-07

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Hanson Professional Services Inc.

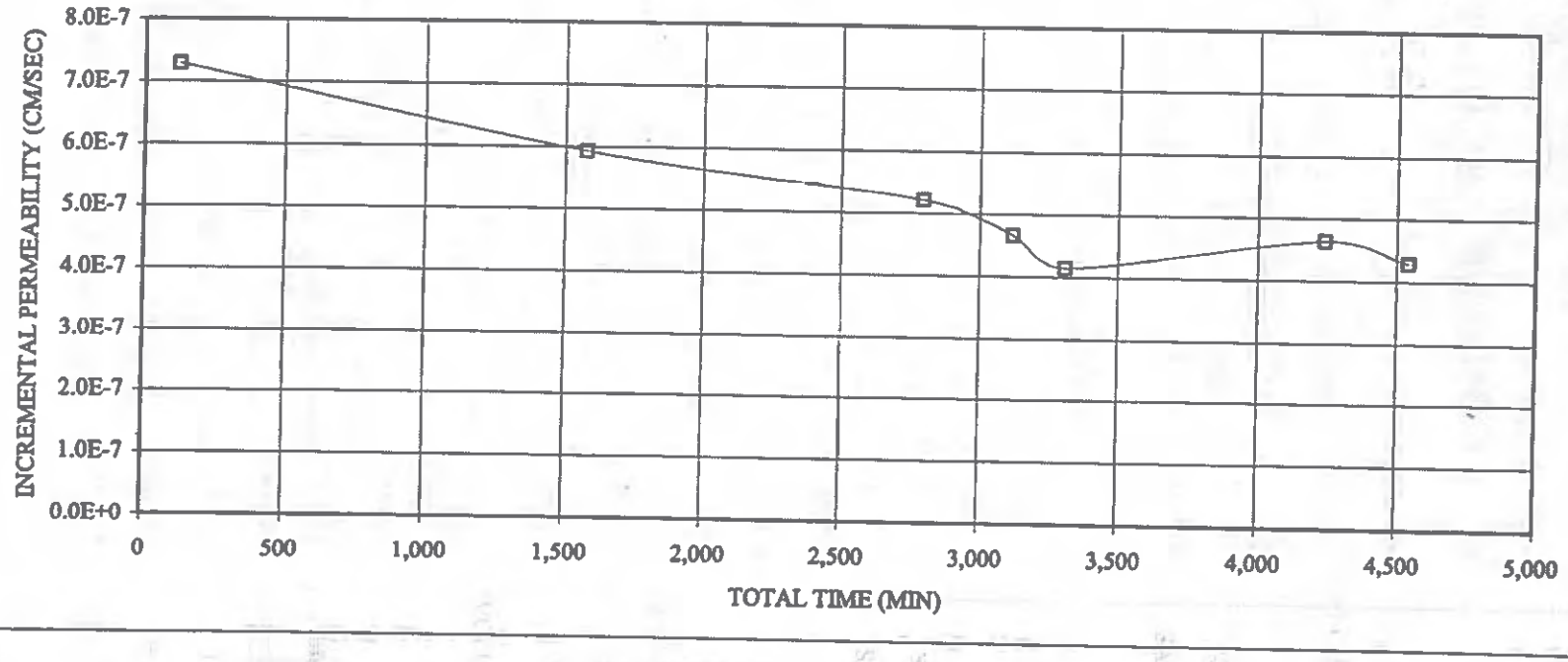
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 10/18/2008
BORING #: N/A
SAMPLE #: ST-024-2 Lift 5
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.756
DIAMETER (IN) 2.821
AREA (SQ IN) 6.250

HEIGHT OF HEAD (PSI) 4
PRESSURE HEAD (CM H2O) 281.26944
PANEL NUMBER 8



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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/13/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-025-3 Lift 5
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy silt (tr. clay, c. sand & sm. gravel).	DEPTH (FT):	1.0-1.5

SPECIMEN WEIGHT (G)	851.83
SPECIMEN HEIGHT (IN)	3.563
DIAMETER (IN)	2.879
AREA (SQ IN)	6.510
VOLUME (CU IN)	23.195
WET DENSITY (PCF)	139.91
DRY DENSITY (PCF)	124.98
WT. DRY SOIL (G)	760.95
VOLUME DRY SOIL (CU IN)	17.199
SP.GR. (ASSUMED)	2.7
POROSITY (%)	25.851
HEIGHT OF HEAD (PSI)	3.8
HYDRAULIC GRADIANT	29.5
1/4 PORE VOLUME	24.56
Initial Degree of Saturation	92.49
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	218.83	907.69
TARE + DRY SOIL (G)	195.88	815.28
TARE (G)	3.71	50.04
WATER (G)	22.95	92.41
DRY SOIL (G)	192.17	765.24
WATER CONTENT (%)	11.94	12.08

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	267.21
PANEL NUMBER	1
PERMEANT USED:	Tap Water

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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 10/18/2008
BORING #: N/A
SAMPLE #: ST-025-3 Lift 5
DEPTH (FT): 1.0-1.5

SPECIMEN HEIGHT (IN): 3.563
DIAMETER (IN): 2.879
AREA (SQ IN): 6.510

HEIGHT OF HEAD (PSI): 3.8
PRESSURE HEAD (CM H2O): 267.205968
PANEL NUMBER: 1

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/18/2008	9:44:45	10/18/2008	11:46:30	1.70	1.7000	121.75	121.75	1.88E-07	1.88E-07
10/18/2008	11:48:15	10/19/2008	12:03:00	18.80	20.5000	1454.75	1576.50	1.74E-07	1.81E-07
10/19/2008	12:04:00	10/20/2008	8:20:00	14.80	35.3000	1216.00	2792.50	1.64E-07	1.69E-07
10/20/2008	8:20:00	10/20/2008	13:34:30	3.60	38.9000	314.50	3107.00	1.54E-07	1.59E-07
10/20/2008	13:34:30	10/20/2008	16:58:10	2.40	41.3000	203.67	3310.67	1.58E-07	1.56E-07
10/20/2008	17:00:20	10/21/2008	8:34:15	10.40	51.7000	933.92	4244.58	1.50E-07	1.54E-07
10/21/2008	8:34:15	10/21/2008	13:52:00	3.60	55.3000	317.75	4562.33	1.52E-07	1.51E-07

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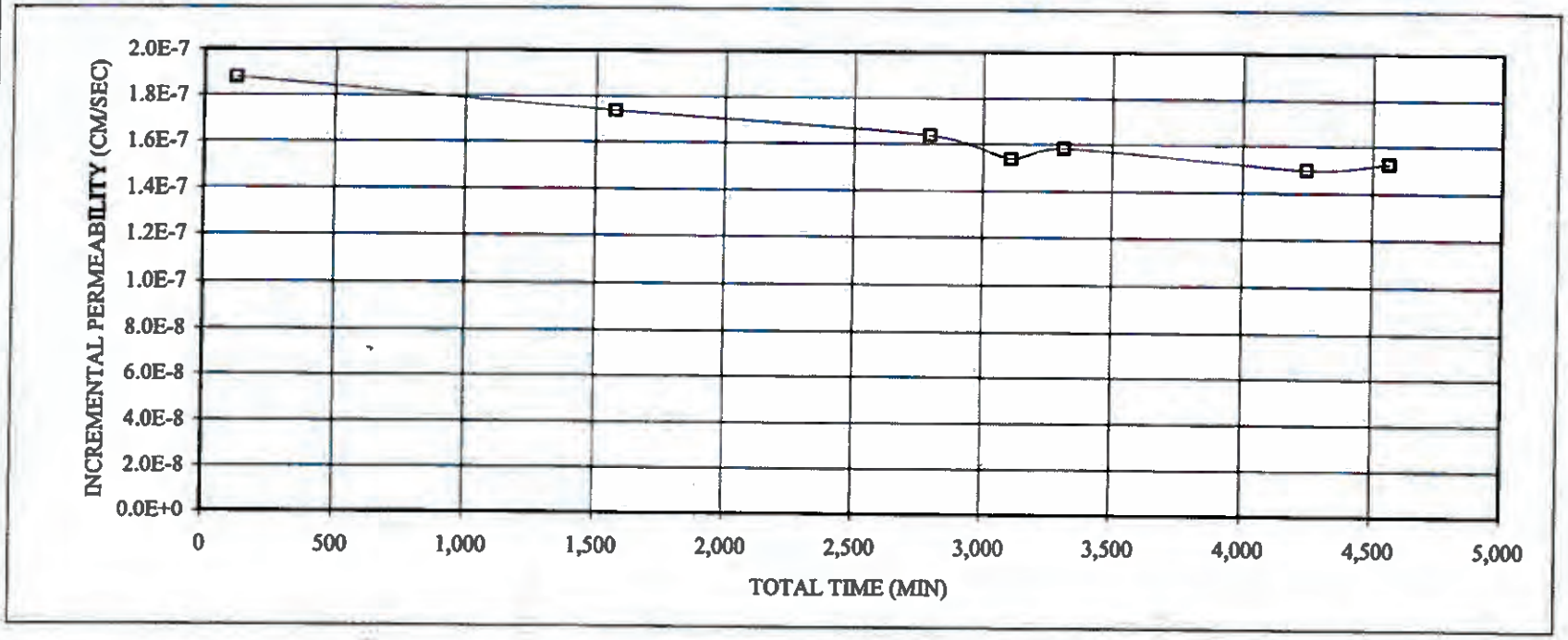
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/18/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-025-3 Lift 5
		DEPTH (FT):	1.0-1.5

SPECIMEN HEIGHT (IN)	3.563	HEIGHT OF HEAD (PSI)	3.8
DIAMETER (IN)	2.879	PRESSURE HEAD (CM H2O)	267.205968
AREA (SQ IN)	6.510	PANEL NUMBER	1



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Chain of Custody Record

(Form CQAP 6.1, Revision 0)

Gypsum Management and CCB Landfill Facilities

Ameren

Client	Ameren Duck Creek Generating Station
Address	17751 North Cilco Road
City, State Zip Code	Canton, IL 61520
Phone / Facsimile No.	(309) 668-2236 / (217) 347-3106
Client Project	GYPSUM STACK
Location	FULTON COUNTY, IL
Sampler(s) / Phone	JOHN MANSKER & DIANNE LAMBI (309) 635-0268
Turnaround Time	Standard [ ] Rush [X] Date Required:
P.O. # or Invoice To	AMEREN ENERGY
Contact Person	DANE BOYCE AMEREN CONST. MGR.

Sample Description	Sampling Date	Sampling Time	Sample Type[1]	# of Containers	Analysis and/or Method Requested: TEST PER SPECIFICATIONS	Remarks or Observations
ST 24	10/5/08	15:20	O	1	X	CLAY LINER
~~ST-022~~	~~10/5/08~~	~~14:00~~	~~O~~	~~1~~		
ST-025	10/5/08	16:00	O	1	X	CLAY LINER
ST-021	9/27/08	14:00	O	1	X	CLAY LINER
ST-020	9/27/08	13:00	O	1	X	CLAY LINER

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
[signature]	10/7/08	14:40	[signature]	10-7-08	14:40	

Special Instructions:

 Copies: White – CQA Officer Yellow – Testing Firm Pink – Sampler

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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER: 03S5010 TEST DATE: 10/21/2008

CLIENT: Ameren Duck Creek BORING #: N/A

JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor) SAMPLE #: ST-026-2

SAMPLE DESCRIPTION: Brn. gray vf. sandy silt (tr. clay, c. sand & sm. gravel). DEPTH (FT): 0.5-1.0

SPECIMEN WEIGHT (G)	864.61
SPECIMEN HEIGHT (IN)	3.700
DIAMETER (IN)	2.860
AREA (SQ IN)	6.424
VOLUME (CU IN)	23.770
WET DENSITY (PCF)	138.57
DRY DENSITY (PCF)	123.28
WT. DRY SOIL (G)	769.20
VOLUME DRY SOIL (CU	17.385
SP.GR. (ASSUMED)	2.7
POROSITY (%)	26.86
HEIGHT OF HEAD (PSI)	4.0
HYDRAULIC GRADIANT	29.9
1/4 PORE VOLUME	26.16
Initial Degree of Saturation	91.19
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	136.05	916.72
TARE + DRY SOIL (G)	121.45	813.46
TARE (G)	3.75	49.97
WATER (G)	14.60	103.26
DRY SOIL (G)	117.70	763.49
WATER CONTENT (%)	12.40	13.52

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	281.27
PANEL NUMBER	5
PERMEANT USED:	Tap Water

Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON.

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor)

TEST DATE: 10/23/2008
BORING #: N/A
SAMPLE #: ST-026-2
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.700
DIAMETER (IN) 2.860
AREA (SQ IN) 6.424

HEIGHT OF HEAD (PSI) 4
PRESSURE HEAD (CM H2O) 281.26944
PANEL NUMBER 5

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/23/2008	8:23:00	10/24/2008	8:13:15	11.90	11.9000	1430.25	1430.25	1.12E-07	1.12E-07
10/24/2008	16:27:30	10/25/2008	7:58:00	3.30	15.2000	930.50	2360.75	4.77E-08	7.97E-08
10/25/2008	7:58:00	10/25/2008	16:25:30	1.70	16.9000	507.50	2868.25	4.50E-08	4.63E-08
10/25/2008	16:25:30	10/26/2008	7:25:10	2.90	19.8000	899.67	3767.92	4.33E-08	4.42E-08
10/26/2008	7:25:10	10/26/2008	16:15:00	1.60	21.4000	529.83	4297.75	4.06E-08	4.19E-08
10/26/2008	16:15:00	10/27/2008	8:13:30	3.10	24.5000	958.50	5256.25	4.35E-08	4.20E-08
10/27/2008	8:15:00	10/28/2008	7:50:00	4.60	29.1000	1415.00	6671.25	4.37E-08	4.36E-08

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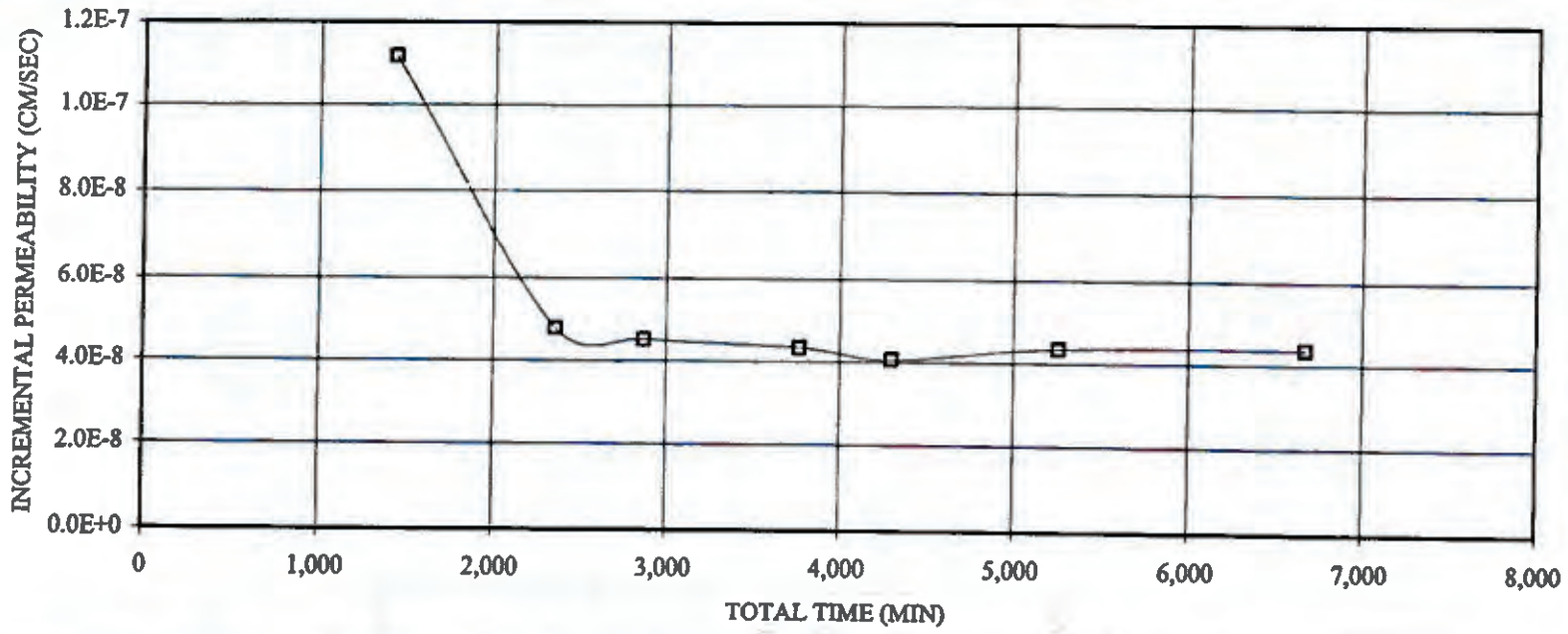
Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/23/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Floor)	SAMPLE #:	ST-026-2
		DEPTH (FT):	0.5-1.0

SPECIMEN HEIGHT (IN)	3.700	HEIGHT OF HEAD (PSI)	4
DIAMETER (IN)	2.860	PRESSURE HEAD (CM H2O)	281.26944
AREA (SQ IN)	6.424	PANEL NUMBER	5



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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/21/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Floor)	SAMPLE #:	ST-027-1
SAMPLE DESCRIPTION:	Yel. brn. & brn. vf. sandy silt / so. clay (tr. gravel).	DEPTH (FT):	0.0-0.5

			WATER CONTENT OF TRIMMINGS	
SPECIMEN WEIGHT (G)	798.21		BEFORE TEST	AFTER TEST
SPECIMEN HEIGHT (IN)	3.604			
DIAMETER (IN)	2.887	TARE + WET SOIL (G)	353.7	858.81
AREA (SQ IN)	6.546	TARE + DRY SOIL (G)	304.91	723.83
VOLUME (CU IN)	23.592	TARE (G)	3.71	50.19
WET DENSITY (PCF)	128.89	WATER (G)	48.79	134.98
DRY DENSITY (PCF)	110.92	DRY SOIL (G)	301.2	673.64
WT. DRY SOIL (G)	686.94	WATER CONTENT (%)	16.20	20.04
VOLUME DRY SOIL (CU IN)	15.526			
SP.GR. (ASSUMED)	2.7			
POROSITY (%)	34.19	STD. MAX. DEN.(LBS/CU.FT.)	N/A	
HEIGHT OF HEAD (PSI)	3.8	OPTIMUM MOISTURE (%)	N/A	
HYDRAULIC GRADIANT	29.2	% COMPACTION	N/A	
1/4 PORE VOLUME	33.05	PRESSURE HEAD (CM H2O)	267.205968	
Initial Degree of Saturation	84.18	PANEL NUMBER	6	
TEST METHOD USED:	IEPA ASTM D5084	PERMEANT USED:	Tap Water	

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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor)

TEST DATE: 10/23/2008
BORING #: N/A
SAMPLE #: ST-027-1
DEPTH (FT): 0.0-0.5

SPECIMEN HEIGHT (IN): 3.604
DIAMETER (IN): 2.887
AREA (SQ IN): 6.546

HEIGHT OF HEAD (PSI): 3.8
PRESSURE HEAD (CM H2O): 267.21
PANEL NUMBER: 6

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/23/2008	8:59:45	10/23/2008	15:54:00	7.70	7.70	414.25	414.25	2.51E-07	2.51E-07
10/23/2008	15:56:00	10/24/2008	8:14:30	16.50	24.20	978.50	978.50	2.28E-07	2.28E-07
10/24/2008	8:16:50	10/24/2008	16:17:45	1.40	25.60	480.92	1459.42	3.94E-08	1.34E-07
10/24/2008	16:20:00	10/25/2008	7:54:45	6.50	32.10	934.75	2394.17	9.40E-08	6.67E-08
10/25/2008	7:54:45	10/25/2008	16:21:30	3.50	35.60	506.75	2900.92	9.34E-08	9.37E-08
10/25/2008	16:21:30	10/26/2008	7:23:30	5.90	41.50	902.00	3802.92	8.84E-08	9.09E-08
10/26/2008	7:23:30	10/26/2008	16:12:15	3.40	44.90	528.75	4331.67	8.69E-08	8.77E-08
10/26/2008	16:14:15	10/27/2008	8:15:00	6.40	51.30	960.75	5292.42	9.01E-08	8.85E-08

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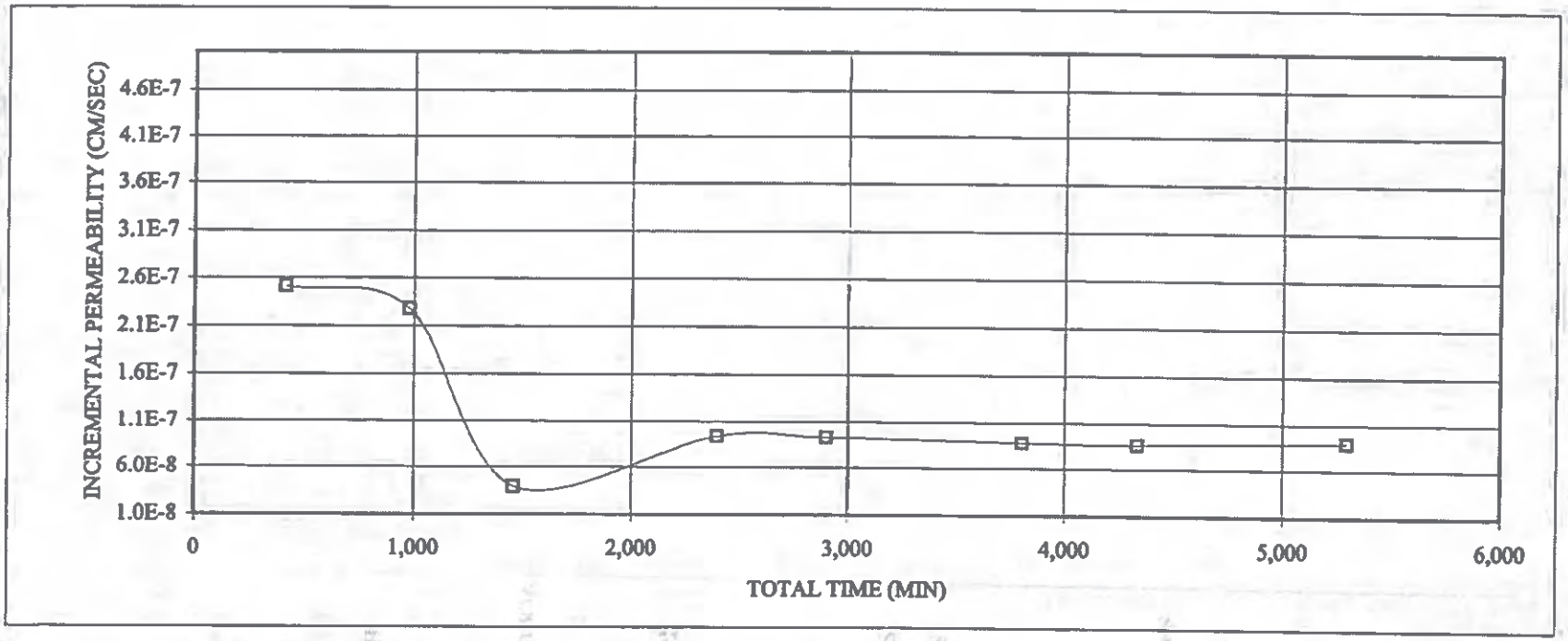
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/23/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Floor)	SAMPLE #:	ST-027-1
		DEPTH (FT):	0.0-0.5

SPECIMEN HEIGHT (IN)	3.604	HEIGHT OF HEAD (PSI)	3.8
DIAMETER (IN)	2.887	PRESSURE HEAD (CM H2O)	267.21
AREA (SQ IN)	6.546	PANEL NUMBER	6



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Chain of Custody Record

(Form CQAP 6.1, Revision 0)

Gypsum Management and CCB Landfill Facilities

Ameren

Client	Ameren Duck Creek Generating Station
Address	17751 North Cilco Road
City, State Zip Code	Canton, IL 61520
Phone / Facsimile No.	(309) 668-2236 / (217) 347-3106
Client Project	GYPSUM STACK
Location	FULTON COUNTY, IL
Sampler(s) / Phone	JOHN MANSKER 1(309)635-0268
Turnaround Time	Standard [ ] Rush [X] Date Required:
P.O. # or Invoice To	AMEREN ENERGY
Contact Person	DAVE

Analysis and/or Method Requested

Sample Description	Sampling Date	Sampling Time	Sample Type[1]	# of Containers	TEST PER CLAY LINER SPECIFICATIONS						Remarks or Observations
ST-026	10/13/08	08:00	O	1	X						
ST-027	10/13/08	08:30	O	1	X						

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
John M Mansker	10/17/08	14:00		10-17-08	2:00	Car.
	10-17-08	3:52PM		10-17-08	3:52	"

Special Instructions:

Electronic Filing: Received, Clerk's Office 06/20/2024

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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER: 03S5010 TEST DATE: 10/28/2008

CLIENT: Ameren Duck Creek BORING #: N/A

JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor) SAMPLE #: ST-034-2 Lift 5

SAMPLE DESCRIPTION: Yel. brn. & brn. vf. sandy clayey silt DEPTH (FT): 0.5-1.0

SPECIMEN WEIGHT (G)	772.66	WATER CONTENT OF TRIMMINGS		
SPECIMEN HEIGHT (IN)	3.508		BEFORE TEST	AFTER TEST
DIAMETER (IN)	2.882	TARE + WET SOIL (G)	225.04	833.84
AREA (SQ IN)	6.523	TARE + DRY SOIL (G)	188.52	702.67
VOLUME (CU IN)	22.884	TARE (G)	3.70	49.35
WET DENSITY (PCF)	128.62	WATER (G)	36.52	131.17
DRY DENSITY (PCF)	107.40	DRY SOIL (G)	184.82	653.32
WT. DRY SOIL (G)	645.17	WATER CONTENT (%)	19.76	20.08
VOLUME DRY SOIL (CU	14.582			
SP.GR. (ASSUMED)	2.7			
POROSITY (%)	36.28	STD. MAX. DEN.(LBS/CU.FT.)	N/A	
HEIGHT OF HEAD (PSI)	3.8	OPTIMUM MOISTURE (%)	N/A	
HYDRAULIC GRADIANT	30.0	% COMPACTION	N/A	
1/4 PORE VOLUME	34.01	PRESSURE HEAD (CM H2O)	267.21	
Initial Degree of Saturation	93.70	PANEL NUMBER	5	

TEST METHOD USED: IEPA ASTM D5084 PERMEANT USED: Tap Water

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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor)

TEST DATE: 10/30/2008
BORING #: N/A
SAMPLE #: ST-034-2 Lift 5
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.508
DIAMETER (IN) 2.882
AREA (SQ IN) 6.523

HEIGHT OF HEAD (PSI) 3.8
PRESSURE HEAD (CM H2O) 267.205968
PANEL NUMBER 5

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/30/2008	9:48:30	10/31/2008	8:04:00	19.30	19.3000	1335.50	1335.50	1.91E-07	1.91E-07
10/31/2008	8:06:30	11/1/2008	7:42:00	19.90	39.2000	1415.50	2751.00	1.86E-07	1.88E-07
11/1/2008	7:44:30	11/2/2008	8:06:45	19.80	59.0000	1462.25	4213.25	1.79E-07	1.82E-07
11/2/2008	7:08:15	11/3/2008	8:43:50	21.00	80.0000	1535.58	5748.83	1.81E-07	1.80E-07
11/3/2008	8:45:25	11/4/2008	8:05:00	17.70	97.7000	1399.58	7148.42	1.67E-07	1.74E-07

Electronic Filing: Received, Clerk's Office 06/20/2024

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Hanson Professional Services Inc.

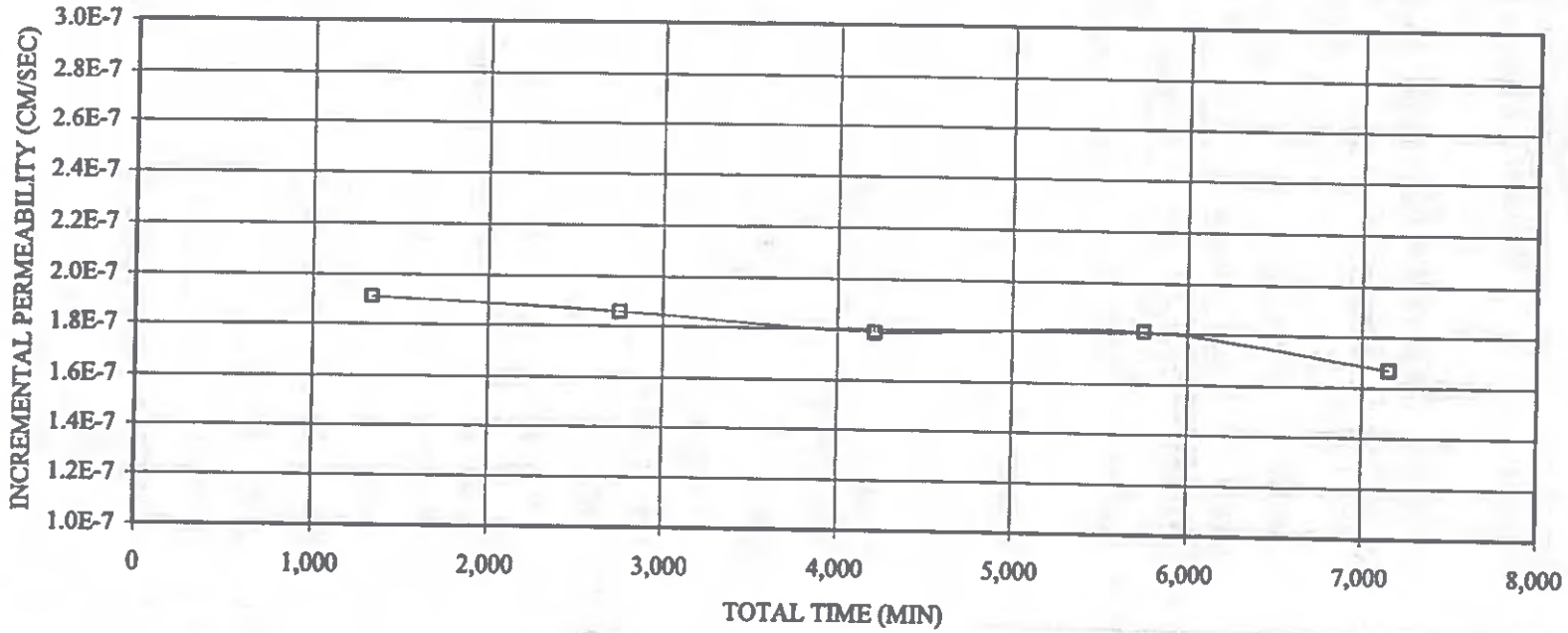
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor)

TEST DATE: 10/30/2008
BORING #: N/A
SAMPLE #: ST-034-2 Lift 5
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.508
DIAMETER (IN) 2.882
AREA (SQ IN) 6.523

HEIGHT OF HEAD (PSI) 3.8
PRESSURE HEAD (CM H2O) 267.205968
PANEL NUMBER 5



Electronic Filing: Received, Clerk's Office 06/20/2024

HANSON.

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/28/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Floor)	SAMPLE #:	ST-035-1 Lift 5
SAMPLE DESCRIPTION:	Yel. brn. & brn. vf. sandy silt / so. clay.	DEPTH (FT):	0.0-0.5

SPECIMEN WEIGHT (G)	726.97
SPECIMEN HEIGHT (IN)	3.291
DIAMETER (IN)	2.867
AREA (SQ IN)	6.456
VOLUME (CU IN)	21.246
WET DENSITY (PCF)	130.35
DRY DENSITY (PCF)	109.48
WT. DRY SOIL (G)	610.59
VOLUME DRY SOIL (CU IN)	13.800
SP.GR. (ASSUMED)	2.7
POROSITY (%)	35.04
HEIGHT OF HEAD (PSI)	3.5
HYDRAULIC GRADIANT	29.4
1/4 PORE VOLUME	30.50
Initial Degree of Saturation	95.38
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	187.05	782.91
TARE + DRY SOIL (G)	157.7	659.31
TARE (G)	3.71	50.18
WATER (G)	29.35	123.6
DRY SOIL (G)	153.99	609.13
WATER CONTENT (%)	19.06	20.29

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	246.11076
PANEL NUMBER	1
PERMEANT USED:	Tap Water

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (Floor)

TEST DATE: 10/30/2008
BORING #: N/A
SAMPLE #: ST-035-1 Lift 5
DEPTH (FT): 0.0-0.5

SPECIMEN HEIGHT (IN): 3.291
DIAMETER (IN): 2.867
AREA (SQ IN): 6.456

HEIGHT OF HEAD (PSI): 3.5
PRESSURE HEAD (CM H2O): 246.11
PANEL NUMBER: 1

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
10/30/2008	9:55:00	10/31/2008	8:17:30	11.10	11.10	1342.50	1342.50	1.12E-07	1.12E-07
10/31/2008	8:17:30	10/31/2008	16:00:45	4.50	15.60	463.25	1805.75	1.32E-07	1.32E-07
10/31/2008	16:03:00	11/1/2008	7:57:15	10.00	25.60	954.25	2760.00	1.42E-07	1.37E-07
11/1/2008	7:57:15	11/2/2008	8:24:30	13.30	38.90	1467.25	4227.25	1.23E-07	1.33E-07
11/2/2008	7:26:30	11/3/2008	9:19:20	14.60	53.50	1552.83	5780.08	1.28E-07	1.25E-07
11/3/2008	9:19:20	11/3/2008	16:08:20	3.50	57.00	409.00	6189.08	1.16E-07	1.22E-07
11/3/2008	16:09:15	11/4/2008	8:22:30	8.90	65.90	973.25	7162.33	1.24E-07	1.20E-07

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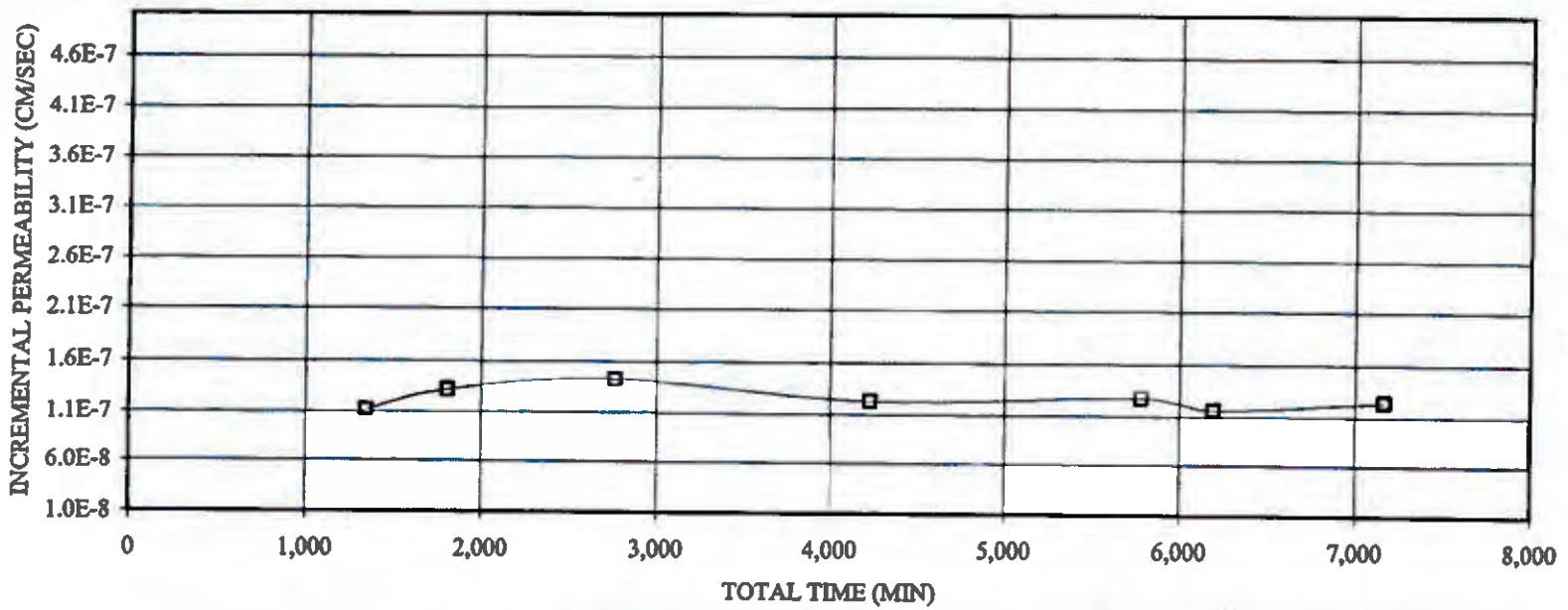
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	10/30/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (Floor)	SAMPLE #:	ST-035-1 Lift 5
		DEPTH (FT):	0.0-0.5

SPECIMEN HEIGHT (IN)	3.291	HEIGHT OF HEAD (PSI)	3.5
DIAMETER (IN)	2.867	PRESSURE HEAD (CM H2O)	246.11
AREA (SQ IN)	6.456	PANEL NUMBER	1



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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	10/31/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner (south slope)	SAMPLE #:	ST-036-2 Lift 4 (S. Slope)
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy silt (tr. clay, c. sand & Sm. gravel).	DEPTH (FT):	0.5-1.0

SPECIMEN WEIGHT (G)	727.24
SPECIMEN HEIGHT (IN)	3.209
DIAMETER (IN)	2.857
AREA (SQ IN)	6.411
VOLUME (CU IN)	20.572
WET DENSITY (PCF)	134.67
DRY DENSITY (PCF)	118.85
WT. DRY SOIL (G)	641.81
VOLUME DRY SOIL (CU IN)	14.506
SP.GR. (ASSUMED)	2.7
POROSITY (%)	29.488
HEIGHT OF HEAD (PSI)	3.4
HYDRAULIC GRADIANT	29.3
1/4 PORE VOLUME	24.85
Initial Degree of Saturation	85.94
TEST METHOD USED:	IEPA ASTM D5084

WATER CONTENT OF TRIMMINGS

	BEFORE TEST	AFTER TEST
TARE + WET SOIL (G)	222.39	783.22
TARE + DRY SOIL (G)	196.7	688.95
TARE (G)	3.71	49.97
WATER (G)	25.69	94.27
DRY SOIL (G)	192.99	638.98
WATER CONTENT (%)	13.31	14.75

STD. MAX. DEN.(LBS/CU.FT.)	N/A
OPTIMUM MOISTURE (%)	N/A
% COMPACTION	N/A
PRESSURE HEAD (CM H2O)	239.08
PANEL NUMBER	7
PERMEANT USED:	Tap Water

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (south slope)

TEST DATE: 11/3/2008
BORING #: N/A
SAMPLE #: ST-036-2 Lift 4 (S. Slope)
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.209
DIAMETER (IN) 2.857
AREA (SQ IN) 6.411

HEIGHT OF HEAD (PSI) 3.4
PRESSURE HEAD (CM H2O) 239.079024
PANEL NUMBER 7

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
11/3/2008	9:30:40	11/3/2008	13:10:15	20.50	20.5000	219.58	219.58	1.28E-06	1.28E-06
11/3/2008	13:12:00	11/3/2008	16:10:00	15.20	35.7000	178.00	397.58	1.17E-06	1.23E-06
11/3/2008	16:12:00	11/4/2008	8:09:45	69.54	105.2400	957.75	1355.33	9.98E-07	1.09E-06
11/4/2008	8:12:00	11/4/2008	16:27:00	32.30	137.5400	495.00	1850.33	8.96E-07	9.47E-07
11/4/2008	16:28:15	11/5/2008	8:12:15	49.02	186.5600	944.00	2794.33	7.13E-07	8.05E-07
11/5/2008	8:14:30	11/5/2008	14:58:40	19.76	206.3200	404.17	3198.50	6.72E-07	6.93E-07

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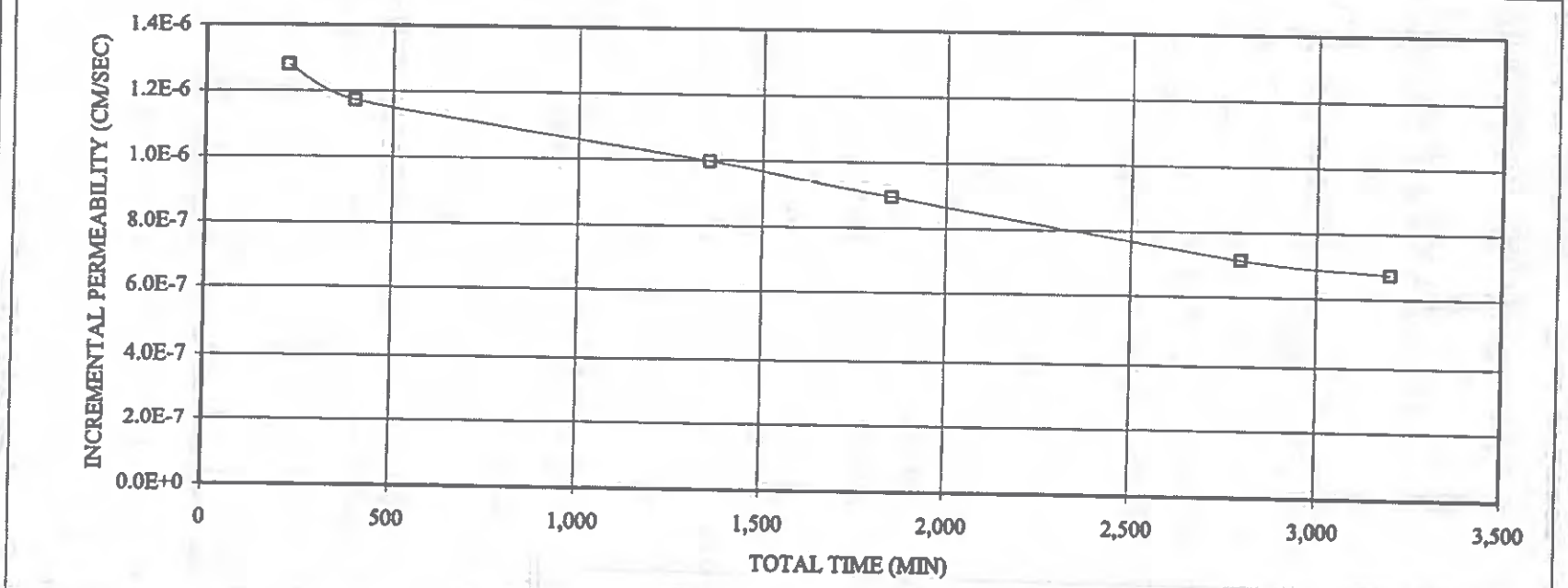
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner (south slope)

TEST DATE: 11/3/2008
BORING #: N/A
SAMPLE #: ST-036-2 Lift 4 (S. Slope)
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.209
DIAMETER (IN) 2.857
AREA (SQ IN) 6.411

HEIGHT OF HEAD (PSI) 3.4
PRESSURE HEAD (CM H2O) 239.079024
PANEL NUMBER 7



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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	11/4/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-037-2 Lift 4
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy clayey silt.	DEPTH (FT):	0.5-1.0

			WATER CONTENT OF TRIMMINGS	
SPECIMEN WEIGHT (G)	728.73		BEFORE TEST	AFTER TEST
SPECIMEN HEIGHT (IN)	3.442			
DIAMETER (IN)	2.883	TARE + WET SOIL (G)	311.18	781.31
AREA (SQ IN)	6.528	TARE + DRY SOIL (G)	248.48	637.09
VOLUME (CU IN)	22.469	TARE (G)	3.75	50.16
WET DENSITY (PCF)	123.55	WATER (G)	62.7	144.22
DRY DENSITY (PCF)	98.35	DRY SOIL (G)	244.73	586.93
WT. DRY SOIL (G)	580.11	WATER CONTENT (%)	25.62	24.57
VOLUME DRY SOIL (CU IN)	13.111			
SP.GR. (ASSUMED)	2.7			
POROSITY (%)	41.65	STD. MAX. DEN.(LBS/CU.FT.)	N/A	
HEIGHT OF HEAD (PSI)	3.7	OPTIMUM MOISTURE (%)	N/A	
HYDRAULIC GRADIANT	29.8	% COMPACTION	N/A	
1/4 PORE VOLUME	38.34	PRESSURE HEAD (CM H2O)	260.17	
Initial Degree of Saturation	96.92	PANEL NUMBER	5	
TEST METHOD USED:	IEPA ASTM D5084	PERMEANT USED:	Tap Water	

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 11/10/2008
BORING #: N/A
SAMPLE #: ST-037-2 Lift 4
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN): 3.442
DIAMETER (IN): 2.883
AREA (SQ IN): 6.528
1/4 PORE VOLUME: 38.338

HEIGHT OF HEAD (PSI): 3.7
PRESSURE HEAD (CM H2O): 260.174232
PANEL NUMBER: 5

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
11/10/2008	8:27:00	11/10/2008	16:17:10	7.60	7.60	470.17	470.17	2.15E-07	2.15E-07
11/10/2008	16:17:10	11/11/2008	7:47:00	16.10	23.70	929.83	1400.00	2.30E-07	2.23E-07
11/10/2008	7:50:15	11/11/2008	16:24:30	10.80	34.50	1954.25	3354.25	7.35E-08	1.52E-07
11/11/2008	16:25:40	11/12/2008	8:01:20	17.70	52.20	935.67	4289.92	2.52E-07	1.63E-07
11/12/2008	8:01:20	11/12/2008	13:30:00	7.50	59.70	328.67	4618.58	3.03E-07	2.78E-07

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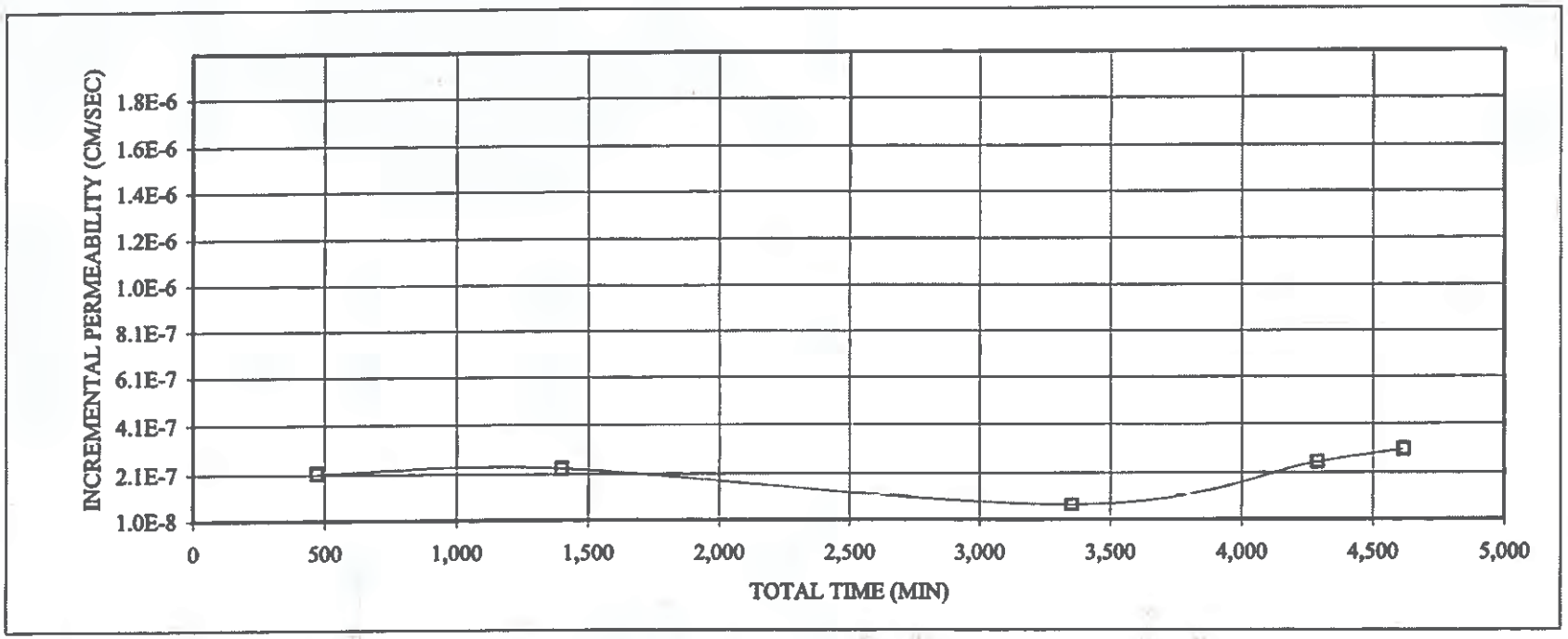
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	11/10/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-037-2 Lift 4
		DEPTH (FT):	0.5-1.0

SPECIMEN HEIGHT (IN)	3.442	HEIGHT OF HEAD (PSI)	3.7
DIAMETER (IN)	2.883	PRESSURE HEAD (CM H2O)	260.174232
AREA (SQ IN)	6.528	PANEL NUMBER	5
1/4 PORE VOLUME	38.338		



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Chain of Custody Record

(Form CQAP 6.1, Revision 0)

Gypsum Management and CCB Landfill Facilities

Ameren

Client	Ameren Duck Creek Generating Station
Address	17751 North Cilco Road
City, State Zip Code	Canton, IL 61520
Phone / Facsimile No.	(309) 668-2236 / (217) 347-3106
Client Project	GYPSUM STACK
Location	FULTON COUNTY, IL
Sampler(s) / Phone	JOHN MANSKER 1309-635-0268
Turnaround Time	Standard [ ] Rush [X] Date Required:
P.O. # or Invoice To	AMEREN ENERGY
Contact Person	DAVE BOYKE - AMEREN CONSTRUCTION MGR. 815-970-1771

Analysis and/or Method Requested

Sample Description	Sampling Date	Sampling Time	Sample Type[1]	# of Containers	TEST PER SPECIFICATIONS FOR CLAY LINER						Remarks or Observations
ST-034	10/22/08	10:00	O	1	X						
ST-035	10/22/08	17:00	O	1	X						
ST-036	10/23/08	09:30	O	1	X						
ST-037	10/23/08	10:00	O	1	X						

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
[signature]	10/23/08	16:45	[signature]	10-23-08	16:45	

Special Instructions:

 Copies: White – CQA Officer Yellow – Testing Firm Pink – Sampler

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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	11/12/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-038-2 Lift 5
SAMPLE DESCRIPTION:	Brn. & gray vf. sandy silt / so. clay (tr. sm. gravel).	DEPTH (FT):	0.5-1.0

FOR ESTIMATING PORE VOLUME ONLY

				WATER CONTENT	
				TRIMMINGS BEFORE TEST	SAMPLE AFTER TEST
SPECIMEN WEIGHT (G)	733.03				
SPECIMEN HEIGHT (IN)	3.302				
DIAMETER (IN)	2.877		TARE + WET SOIL (G)	200.09	785.11
AREA (SQ IN)	6.501		TARE + DRY SOIL (G)	170.46	665.73
VOLUME (CU IN)	21.466		TARE (G)	3.71	50.13
WET DENSITY (PCF)	130.09		WATER (G)	29.63	119.38
DRY DENSITY (PCF)	110.46	*	DRY SOIL (G)	166.75	615.60
WT. DRY SOIL (G)	622.43	*	WATER CONT.(%)	17.77	19.39
VOLUME DRY SOIL (CU IN	14.068	*			
SP.GR. (ASSUMED)	2.70				
POROSITY (%)	34.46	*	STD. MAX. DEN.(LBS/CU.FT.)	N/A	
HEIGHT OF HEAD (PSI)	3.50		OPTIMUM MOISTURE (%)	N/A	
HYDRAULIC GRADIANT	29.3		% COMPACTION	N/A	
1/4 PORE VOLUME	30.31	*	PRESSURE HEAD (CM H2O)	246.11	
Initial Degree of Saturation	91.23	*	PANEL NUMBER	8	

TEST METHOD USED: IEPA ASTM D5084 PERMEANT USED: Tap Water

* **Estimates Only**

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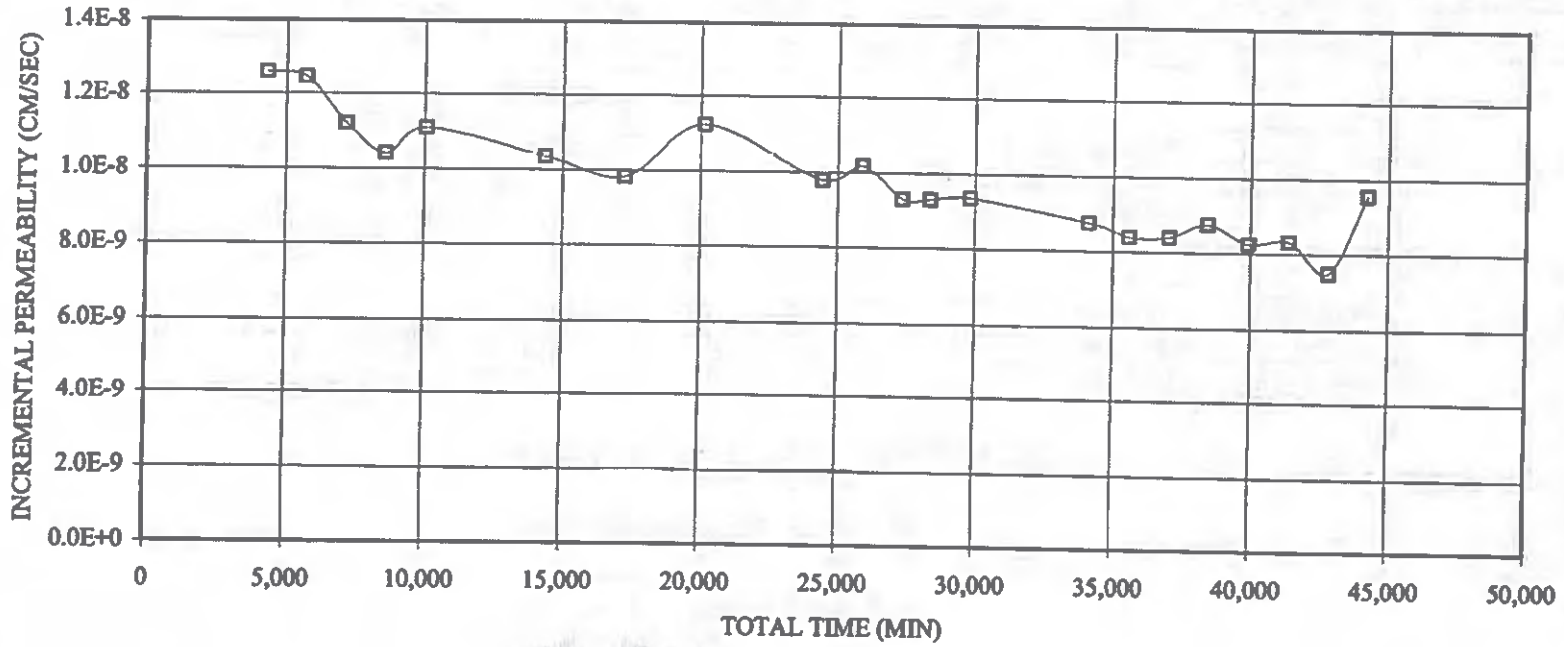
CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	11/14/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-038-2 Lift 5
		DEPTH (FT):	0.5-1.0

SPECIMEN HEIGHT (IN)	3.302	HEIGHT OF HEAD (PSI)	3.50
DIAMETER (IN)	2.877	PRESSURE HEAD (CM H2O)	246.11
AREA (SQ IN)	6.501	PANEL NUMBER	8
1/4 PORE VOLUME	30.31		



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Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 11/14/2008
BORING #: N/A
SAMPLE #: ST-038-2 Lift 5
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN): 3.302
DIAMETER (IN): 2.877
AREA (SQ IN): 6.501
1/4 PORE VOLUME: 30.31

HEIGHT OF HEAD (PSI): 3.50
PRESSURE HEAD (CM H2O): 246.11
PANEL NUMBER: 8

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
11/14/2008	8:23:00	11/17/2008	8:11:15	4.00	4.0000	4308.25	4308.25	1.26E-08	1.26E-08
11/17/2008	8:11:15	11/18/2008	7:45:45	1.30	5.3000	1414.50	5722.75	1.24E-08	1.25E-08
11/18/2008	7:45:45	11/19/2008	7:56:45	1.20	6.5000	1451.00	7173.75	1.12E-08	1.18E-08
11/19/2008	7:56:45	11/20/2008	7:47:00	1.10	7.6000	1430.25	8604.00	1.04E-08	1.08E-08
11/20/2008	7:47:00	11/21/2008	8:11:30	1.20	8.8000	1464.50	10068.50	1.11E-08	1.08E-08
11/21/2008	8:11:30	11/24/2008	8:02:45	3.30	12.1000	4311.25	14379.75	1.04E-08	1.07E-08
11/24/2008	8:02:45	11/26/2008	8:17:00	2.10	14.2000	2894.25	17274.00	9.83E-09	1.01E-08
11/26/2008	8:20:15	11/28/2008	8:33:30	2.40	16.6000	2893.25	20167.25	1.12E-08	1.05E-08
11/28/2008	8:33:30	12/1/2008	8:03:00	3.10	19.7000	4289.50	24456.75	9.79E-09	1.05E-08
12/1/2008	8:03:00	12/2/2008	8:26:15	1.10	20.8000	1463.25	25920.00	1.02E-08	9.98E-09
12/2/2008	8:26:15	12/3/2008	8:40:00	1.00	21.8000	1453.75	27373.75	9.32E-09	9.75E-09
12/3/2008	14:59:00	12/4/2008	7:57:45	0.70	22.5000	1018.75	28392.50	9.31E-09	9.31E-09
12/4/2008	7:57:45	12/5/2008	8:04:30	1.00	23.5000	1446.75	29839.25	9.36E-09	9.33E-09
12/5/2008	8:04:30	12/8/2008	8:13:00	2.80	26.3000	4328.50	34167.75	8.76E-09	9.06E-09
12/8/2008	8:13:00	12/9/2008	8:25:45	0.90	27.2000	1452.75	35620.50	8.39E-09	8.57E-09
12/9/2008	8:25:45	12/10/2008	8:37:00	0.90	28.1000	1451.25	37071.75	8.40E-09	8.39E-09
12/10/2008	8:37:00	12/11/2008	7:50:00	0.90	29.0000	1393.00	38464.75	8.75E-09	8.57E-09
12/11/2008	7:50:00	12/12/2008	8:29:00	0.90	29.9000	1479.00	39943.75	8.24E-09	8.50E-09

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CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE: 11/14/2008
BORING #: N/A
SAMPLE #: ST-038-2 Lift 5
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.302
DIAMETER (IN) 2.877
AREA (SQ IN) 6.501
1/4 PORE VOLUME 30.31

HEIGHT OF HEAD (PSI) 3.50
PRESSURE HEAD (CM H2O) 246.11
PANEL NUMBER 8

12/12/2008	8:29:00	12/13/2008	8:56:00	0.90	30.8000	1467.00	41410.75	8.31E-09	8.27E-09
12/13/2008	8:56:00	12/14/2008	9:02:30	0.80	31.6000	1446.50	42857.25	7.49E-09	7.90E-09
12/14/2008	9:02:30	12/15/2008	8:39:15	1.00	32.6000	1416.75	44274.00	9.56E-09	8.52E-09

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CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	03S5010	TEST DATE:	11/24/2008
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-039-2
SAMPLE DESCRIPTION:	Brn. & gray vf. Sandy silt /so. Clay (tr. Sm. gravel).	DEPTH (FT):	0.5-1.0

FOR ESTIMATING PORE VOLUME ONLY

				WATER CONTENT	
				TRIMMINGS BEFORE TEST	SAMPLE AFTER TEST
SPECIMEN WEIGHT (G)	676.73				
SPECIMEN HEIGHT (IN)	3.103				
DIAMETER (IN)	2.864		TARE + WET SOIL (G)	173.03	729.53
AREA (SQ IN)	6.442		TARE + DRY SOIL (G)	149.27	616.83
VOLUME (CU IN)	19.990		TARE (G)	3.75	50.18
WET DENSITY (PCF)	128.96		WATER (G)	23.76	112.70
DRY DENSITY (PCF)	110.86	*	DRY SOIL (G)	145.52	566.65
WT. DRY SOIL (G)	581.74	*	WATER CONT.(%)	16.33	19.89
VOLUME DRY SOIL (CU IN)	13.148	*			
SP.GR. (ASSUMED)	2.70				
POROSITY (%)	34.23	*	STD. MAX. DEN.(lbs/ft³.)	N/A	
HEIGHT OF HEAD (PSI)	3.30		OPTIMUM MOISTURE (%)	N/A	
HYDRAULIC GRADIANT	29.4		% COMPACTION	N/A	
1/4 PORE VOLUME	28.03	*	PRESSURE HEAD (CM H2O)	232.05	
Initial Degree of Saturation	84.72	*	PANEL NUMBER	6	

TEST METHOD USED: IEPA ASTM D5084

PERMEANT USED: Tap Water

* **Estimates Only**

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HANSON.

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 03S5010
CLIENT: Ameren Duck Creek
JOB DESCRIPTION: Gypsum Stack Clay Liner

TEST DATE:
BORING #: N/A
SAMPLE #: ST-039-2
DEPTH (FT): 0.5-1.0

SPECIMEN HEIGHT (IN) 3.103
DIAMETER (IN) 2.864
AREA (SQ IN) 6.442
1/4 PORE VOLUME 28.03

HEIGHT OF HEAD (PSI) 3.30
PRESSURE HEAD (CM H2O) 232.05
PANEL NUMBER 6

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
11/26/2008	8:05:45	11/26/2008	15:49:45	7.10	7.1000	464.00	464.00	2.08E-07	2.08E-07
11/26/2008	15:54:15	11/28/2008	8:26:45	28.49	35.5900	2432.50	2896.50	1.60E-07	1.84E-07
11/28/2008	8:26:45	12/1/2008	7:54:40	37.00	72.5900	4287.92	7184.42	1.18E-07	1.62E-07
12/1/2008	8:00:00	12/2/2008	8:23:15	11.47	84.0600	1463.25	8647.67	1.07E-07	1.28E-07
12/2/2008	8:23:15	12/3/2008	8:07:50	9.99	94.0500	1424.58	10072.25	9.55E-08	1.07E-07

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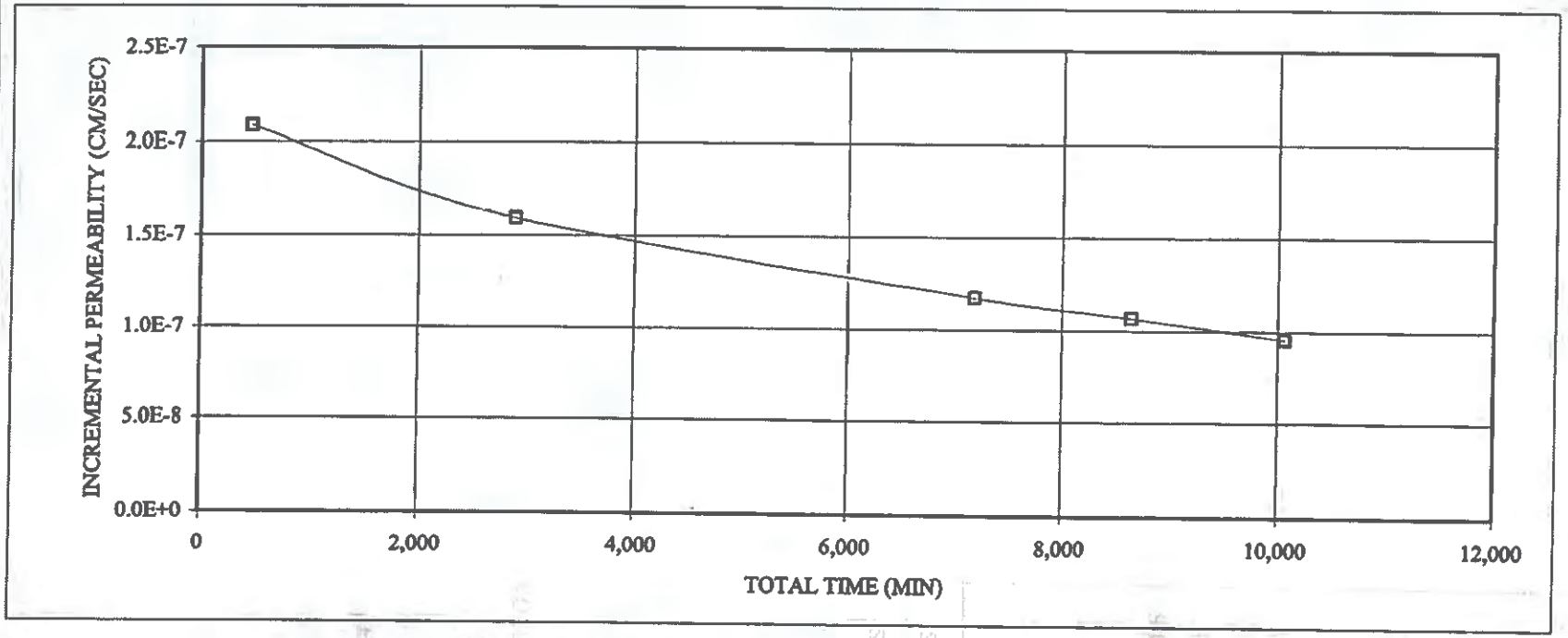
HANSON.

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER:	03S5010	TEST DATE:	
CLIENT:	Ameren Duck Creek	BORING #:	N/A
JOB DESCRIPTION:	Gypsum Stack Clay Liner	SAMPLE #:	ST-039-2
		DEPTH (FT):	0.5-1.0

SPECIMEN HEIGHT (IN)	3.103	HEIGHT OF HEAD (PSI)	3.30
DIAMETER (IN)	2.864	PRESSURE HEAD (CM H2O)	232.05
AREA (SQ IN)	6.442	PANEL NUMBER	6
1/4 PORE VOLUME	28.03		



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Chain of Custody Record

(Form CQAP 6.1, Revision 0)

Gypsum Management and CCB Landfill Facilities

Ameren

Client	Ameren Duck Creek Generating Station
Address	17751 North Cilco Road
City, State Zip Code	Canton, IL 61520
Phone / Facsimile No.	(309) 668-2236 / (217) 347-3106
Client Project	Gypsum Stack
Location	Fulton County, IL
Sampler(s) / Phone	John Mansker / (309) 635-0268
Turnaround Time	Standard [ ] Rush [X] Date Required:
P.O. # or Invoice To	Ameren Energy
Contact Person	Dave Doyce Ameren Construction Mgr. (309) 668-3886

Analysis and/or Method Requested

Sample Description	Sampling Date	Sampling Time	Sample Type[1]	# of Containers	Test per Specifications						Remarks or Observations
ST-038	11/02/08	10:00	O	1	X						
Clay Liner											
G.S. Floor											
ST-039	11/02/08	11:00	O	1	X						
Clay Liner											
G.S. Floor											

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
John M. Mansker	11/04/08	14:30	[signature]	~~15~~ 11/4/08	1530	[signature]
[signature]	11/5/08	1500	[signature]	11-5-08	08:00	

Special Instructions:

Page ____ of ____ Copies: White – CQA Officer Yellow – Testing Firm Pink – Sampler

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GEOSYNTHETIC CLAY LINER MANUFACTURER PRODUCT CERTIFICATIONS

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO
LINING TECHNOLOGIES
800.527.9948 www.cetco.com

Date: 6/6/2008

Purchase Order: 12738-00

ORDER NUMBERS: 023940201, 023940202, 023940203, 023940204, 023940205, 023940206, 023940207, 023940208, 023940209, 023940210, 023940211, 023940212, 023940213, 023940214, 023940215, 023940216, 023940217, 023940218, 023940219, 023940220, 023940221, 023940222, 023940223, 023940224, 023940225, 023940226, 023940227, 023940228, 023940229, 023940230, 023940231, 023940232, 023940233, 023940234, 023940235, 023940236, 023940237, 023940238, 023940239, 023940240, 023940241, 023940243, 023940245

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/5/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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CETCO
LINING TECHNOLOGIES
800.527.9948 www.cetco.com

GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBERS: 023940201, 023940202, 023940203, 023940204, 023940205, 023940206, 023940207, 023940208, 023940209, 023940210, 023940211, 023940212, 023940213, 023940214, 023940215, 023940216, 023940217, 023940218, 023940219, 023940220, 023940221, 023940222, 023940223, 023940224, 023940225, 023940226, 023940227, 023940228, 023940229, 023940230, 023940231, 023940232, 023940233, 023940234, 023940235, 023940236, 023940237, 023940238, 023940239, 023940240, 023940241, 023940243, 023940245
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO
LINING TECHNOLOGIES
800.527.9948 www.cetco.com

PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO
LINING TECHNOLOGIES
800.527.9948 www.cetco.com

Ship Date: 6/5/2008

Order Numbers: 023940201, 023940202, 023940203, 023940204, 023940205, 023940206, 023940207, 02394020 023940209, 023940210, 023940211, 023940212, 023940213, 023940214, 023940215, 023940216, 023940217, 023940218, 023940219, 023940220, 023940221, 023940222, 023940223, 023940224, 023940225, 023940226, 023940227, 023940228, 023940229, 023940230, 023940231, 023940232, 023940233, 023940234, 023940235, 023940236, 023940237, 023940238, 023940239, 023940240, 023940241, 023940243, 023940245

Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

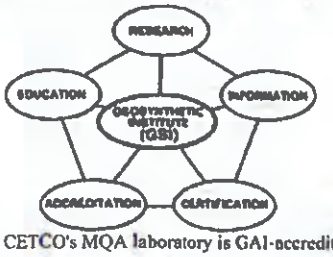
Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO
LINING TECHNOLOGIES
800.527.9948 www.cetco.com

GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940212	LO-BENTOMAT SDN	200820LO	00000001	150	14	2100	2520
023940212	LO-BENTOMAT SDN	200820LO	00000002	150	14	2100	2510
023940212	LO-BENTOMAT SDN	200820LO	00000003	150	14	2100	2500
023940212	LO-BENTOMAT SDN	200820LO	00000004	150	14	2100	2505
023940215	LO-BENTOMAT SDN	200820LO	00000005	150	14	2100	2510
023940207	LO-BENTOMAT SDN	200820LO	00000006	150	14	2100	2500
023940207	LO-BENTOMAT SDN	200820LO	00000007	150	14	2100	2520
023940211	LO-BENTOMAT SDN	200820LO	00000008	150	14	2100	2540
023940203	LO-BENTOMAT SDN	200820LO	00000009	150	14	2100	2535
023940203	LO-BENTOMAT SDN	200820LO	00000010	150	14	2100	2540
023940211	LO-BENTOMAT SDN	200820LO	00000011	150	14	2100	2545
023940211	LO-BENTOMAT SDN	200820LO	00000013	150	14	2100	2575
023940211	LO-BENTOMAT SDN	200820LO	00000014	150	14	2100	2560
023940211	LO-BENTOMAT SDN	200820LO	00000015	150	14	2100	2545
023940205	LO-BENTOMAT SDN	200820LO	00000017	150	13.5	2025	2550
023940207	LO-BENTOMAT SDN	200820LO	00000018	150	13.5	2025	2540
023940203	LO-BENTOMAT SDN	200820LO	00000022	150	13.5	2025	2530
023940205	LO-BENTOMAT SDN	200820LO	00000024	150	13.5	2025	2535
023940203	LO-BENTOMAT SDN	200820LO	00000026	150	13.5	2025	2560
023940203	LO-BENTOMAT SDN	200820LO	00000027	150	13.5	2025	2570
023940205	LO-BENTOMAT SDN	200820LO	00000029	150	13.5	2025	2585
023940223	LO-BENTOMAT SDN	200820LO	00000031	150	13.5	2025	2585
023940223	LO-BENTOMAT SDN	200820LO	00000032	150	13.5	2025	2580
023940223	LO-BENTOMAT SDN	200820LO	00000033	150	13.5	2025	2570
023940203	LO-BENTOMAT SDN	200820LO	00000034	150	13.5	2025	2575
023940217	LO-BENTOMAT SDN	200820LO	00000035	150	13.5	2025	2580
023940211	LO-BENTOMAT SDN	200820LO	00000036	150	13.5	2025	2560

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940223	LO-BENTOMAT SDN	200820LO	00000037	150	13.5	2025	2555
023940223	LO-BENTOMAT SDN	200820LO	00000039	150	13.5	2025	2560
023940223	LO-BENTOMAT SDN	200820LO	00000041	150	13.5	2025	2565
023940219	LO-BENTOMAT SDN	200820LO	00000045	150	13.5	2025	2510
023940201	LO-BENTOMAT SDN	200820LO	00000048	150	13.5	2025	2540
023940216	LO-BENTOMAT SDN	200820LO	00000049	150	13.5	2025	2550
023940206	LO-BENTOMAT SDN	200820LO	00000052	150	13.5	2025	2570
023940217	LO-BENTOMAT SDN	200820LO	00000053	150	13.5	2025	2540
023940219	LO-BENTOMAT SDN	200820LO	00000057	150	13.5	2025	2540
023940219	LO-BENTOMAT SDN	200820LO	00000059	150	13.5	2025	2605
023940221	LO-BENTOMAT SDN	200820LO	00000060	150	13.5	2025	2610
023940221	LO-BENTOMAT SDN	200820LO	00000061	150	13.5	2025	2640
023940206	LO-BENTOMAT SDN	200820LO	00000065	150	13.5	2025	2640
023940206	LO-BENTOMAT SDN	200820LO	00000066	150	13.5	2025	2590
023940203	LO-BENTOMAT SDN	200820LO	00000067	150	13.5	2025	2580
023940203	LO-BENTOMAT SDN	200820LO	00000071	150	13.5	2025	2605
023940205	LO-BENTOMAT SDN	200820LO	00000075	150	13.5	2025	2555
023940241	LO-BENTOMAT SDN	200820LO	00000076	150	13.5	2025	2540
023940241	LO-BENTOMAT SDN	200820LO	00000077	150	13.5	2025	2565
023940223	LO-BENTOMAT SDN	200820LO	00000078	150	13.5	2025	2525
023940221	LO-BENTOMAT SDN	200820LO	00000079	150	13.5	2025	2500
023940221	LO-BENTOMAT SDN	200820LO	00000080	150	13.5	2025	2520
023940204	LO-BENTOMAT SDN	200820LO	00000082	150	13.5	2025	2520
023940223	LO-BENTOMAT SDN	200820LO	00000085	150	13.5	2025	2530
023940203	LO-BENTOMAT SDN	200820LO	00000086	150	13.5	2025	2515
023940241	LO-BENTOMAT SDN	200820LO	00000096	150	13.5	2025	2535
023940241	LO-BENTOMAT SDN	200820LO	00000097	150	13.5	2025	2540
023940221	LO-BENTOMAT SDN	200820LO	00000098	150	13.5	2025	2530
023940221	LO-BENTOMAT SDN	200820LO	00000100	150	13.5	2025	2515
023940217	LO-BENTOMAT SDN	200821LO	00000101	150	13.5	2025	2520
023940204	LO-BENTOMAT SDN	200821LO	00000102	150	13.5	2025	2510
023940204	LO-BENTOMAT SDN	200821LO	00000103	150	13.5	2025	2515

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940206	LO-BENTOMAT SDN	200821LO	00000108	150	13.5	2025	2650
023940241	LO-BENTOMAT SDN	200821LO	00000109	150	13.5	2025	2590
023940206	LO-BENTOMAT SDN	200821LO	00000110	150	13.5	2025	2575
023940204	LO-BENTOMAT SDN	200821LO	00000111	150	13.5	2025	2780
023940222	LO-BENTOMAT SDN	200821LO	00000112	150	13.5	2025	2570
023940206	LO-BENTOMAT SDN	200821LO	00000113	150	13.5	2025	2575
023940241	LO-BENTOMAT SDN	200821LO	00000116	150	13.5	2025	2590
023940219	LO-BENTOMAT SDN	200821LO	00000117	150	13.5	2025	2605
023940221	LO-BENTOMAT SDN	200821LO	00000118	150	13.5	2025	2585
023940203	LO-BENTOMAT SDN	200821LO	00000119	150	13.5	2025	2590
023940221	LO-BENTOMAT SDN	200821LO	00000122	150	13.5	2025	2485
023940223	LO-BENTOMAT SDN	200821LO	00000123	150	13.5	2025	2470
023940221	LO-BENTOMAT SDN	200821LO	00000126	150	13.5	2025	2465
023940223	LO-BENTOMAT SDN	200821LO	00000127	150	13.5	2025	2480
023940241	LO-BENTOMAT SDN	200821LO	00000135	150	13.5	2025	2535
023940222	LO-BENTOMAT SDN	200821LO	00000139	150	13.5	2025	2575
023940221	LO-BENTOMAT SDN	200821LO	00000140	150	13.5	2025	2560
023940241	LO-BENTOMAT SDN	200821LO	00000142	150	13.5	2025	2550
023940223	LO-BENTOMAT SDN	200821LO	00000144	150	13.5	2025	2540
023940202	LO-BENTOMAT SDN	200821LO	00000145	150	13.5	2025	2555
023940201	LO-BENTOMAT SDN	200821LO	00000147	150	13.5	2025	2530
023940210	LO-BENTOMAT SDN	200821LO	00000150	150	13.5	2025	2530
023940214	LO-BENTOMAT SDN	200821LO	00000155	150	13.5	2025	2555
023940214	LO-BENTOMAT SDN	200821LO	00000156	150	13.5	2025	2535
023940214	LO-BENTOMAT SDN	200821LO	00000158	150	13.5	2025	2530
023940241	LO-BENTOMAT SDN	200821LO	00000160	150	13.5	2025	2525
023940214	LO-BENTOMAT SDN	200821LO	00000161	150	13.5	2025	2525
023940241	LO-BENTOMAT SDN	200821LO	00000162	150	13.5	2025	2500
023940214	LO-BENTOMAT SDN	200821LO	00000163	150	13.5	2025	2480
023940241	LO-BENTOMAT SDN	200821LO	00000166	150	13.5	2025	2590
023940211	LO-BENTOMAT SDN	200821LO	00000167	150	13.5	2025	2605
023940241	LO-BENTOMAT SDN	200821LO	00000173	150	13.5	2025	2590

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940222	LO-BENTOMAT SDN	200821LO	00000174	150	13.5	2025	2570
023940222	LO-BENTOMAT SDN	200821LO	00000175	150	13.5	2025	2580
023940211	LO-BENTOMAT SDN	200821LO	00000176	150	13.5	2025	2565
023940207	LO-BENTOMAT SDN	200821LO	00000177	150	13.5	2025	2620
023940209	LO-BENTOMAT SDN	200821LO	00000178	150	13.5	2025	2640
023940214	LO-BENTOMAT SDN	200821LO	00000179	150	13.5	2025	2630
023940213	LO-BENTOMAT SDN	200821LO	00000180	150	13.5	2025	2590
023940214	LO-BENTOMAT SDN	200821LO	00000181	150	13.5	2025	2600
023940219	LO-BENTOMAT SDN	200821LO	00000182	150	13.5	2025	2605
023940241	LO-BENTOMAT SDN	200821LO	00000183	150	13.5	2025	2585
023940211	LO-BENTOMAT SDN	200821LO	00000184	150	13.5	2025	2590
023940241	LO-BENTOMAT SDN	200821LO	00000185	150	13.5	2025	2575
023940207	LO-BENTOMAT SDN	200821LO	00000186	150	13.5	2025	2560
023940211	LO-BENTOMAT SDN	200821LO	00000188	150	13.5	2025	2585
023940207	LO-BENTOMAT SDN	200821LO	00000190	150	13.5	2025	2575
023940222	LO-BENTOMAT SDN	200821LO	00000191	150	13.5	2025	2570
023940207	LO-BENTOMAT SDN	200821LO	00000192	150	13.5	2025	2560
023940220	LO-BENTOMAT SDN	200821LO	00000193	150	13.5	2025	2575
023940222	LO-BENTOMAT SDN	200821LO	00000194	150	13.5	2025	2580
023940207	LO-BENTOMAT SDN	200821LO	00000195	150	13.5	2025	2560
023940220	LO-BENTOMAT SDN	200821LO	00000196	150	13.5	2025	2555
023940222	LO-BENTOMAT SDN	200821LO	00000197	150	13.5	2025	2565
023940221	LO-BENTOMAT SDN	200821LO	00000198	150	13.5	2025	2540
023940221	LO-BENTOMAT SDN	200821LO	00000199	150	13.5	2025	2545
023940221	LO-BENTOMAT SDN	200821LO	00000200	150	13.5	2025	2540
023940221	LO-BENTOMAT SDN	200821LO	00000201	150	13.5	2025	2535
023940222	LO-BENTOMAT SDN	200821LO	00000202	150	13.5	2025	2520
023940222	LO-BENTOMAT SDN	200821LO	00000203	150	13.5	2025	2550
023940207	LO-BENTOMAT SDN	200821LO	00000204	150	13.5	2025	2545
023940211	LO-BENTOMAT SDN	200821LO	00000205	150	13.5	2025	2520
023940221	LO-BENTOMAT SDN	200821LO	00000206	150	13.5	2025	2540
023940217	LO-BENTOMAT SDN	200821LO	00000207	150	13.5	2025	2595

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940221	LO-BENTOMAT SDN	200821LO	00000208	150	13.5	2025	2580
023940211	LO-BENTOMAT SDN	200821LO	00000209	150	13.5	2025	2575
023940207	LO-BENTOMAT SDN	200821LO	00000210	150	13.5	2025	2590
023940221	LO-BENTOMAT SDN	200821LO	00000211	150	13.5	2025	2585
023940223	LO-BENTOMAT SDN	200821LO	00000212	150	13.5	2025	2583
023940222	LO-BENTOMAT SDN	200821LO	00000213	150	13.5	2025	2580
023940223	LO-BENTOMAT SDN	200821LO	00000214	150	13.5	2025	2570
023940220	LO-BENTOMAT SDN	200821LO	00000215	150	13.5	2025	2590
023940219	LO-BENTOMAT SDN	200821LO	00000216	150	13.5	2025	2585
023940219	LO-BENTOMAT SDN	200821LO	00000217	150	13.5	2025	2575
023940202	LO-BENTOMAT SDN	200821LO	00000218	150	13.5	2025	2570
023940220	LO-BENTOMAT SDN	200821LO	00000219	150	13.5	2025	2590
023940220	LO-BENTOMAT SDN	200821LO	00000220	150	13.5	2025	2580
023940204	LO-BENTOMAT SDN	200821LO	00000221	150	13.5	2025	2590
023940204	LO-BENTOMAT SDN	200821LO	00000222	150	13.5	2025	2545
023940207	LO-BENTOMAT SDN	200821LO	00000223	150	13.5	2025	2575
023940217	LO-BENTOMAT SDN	200821LO	00000224	150	13.5	2025	2570
023940211	LO-BENTOMAT SDN	200821LO	00000225	150	13.5	2025	2535
023940202	LO-BENTOMAT SDN	200821LO	00000226	150	13.5	2025	2540
023940241	LO-BENTOMAT SDN	200821LO	00000227	150	13.5	2025	2550
023940202	LO-BENTOMAT SDN	200821LO	00000228	150	13.5	2025	2520
023940201	LO-BENTOMAT SDN	200821LO	00000229	150	13.5	2025	2530
023940201	LO-BENTOMAT SDN	200821LO	00000230	150	13.5	2025	2545
023940212	LO-BENTOMAT SDN	200821LO	00000231	150	13.5	2025	2595
023940223	LO-BENTOMAT SDN	200821LO	00000232	150	13.5	2025	2575
023940201	LO-BENTOMAT SDN	200821LO	00000233	150	13.5	2025	2580
023940204	LO-BENTOMAT SDN	200821LO	00000234	150	13.5	2025	2530
023940211	LO-BENTOMAT SDN	200821LO	00000235	150	13.5	2025	2575
023940201	LO-BENTOMAT SDN	200821LO	00000236	150	13.5	2025	2535
023940211	LO-BENTOMAT SDN	200821LO	00000237	150	13.5	2025	2540
023940201	LO-BENTOMAT SDN	200821LO	00000238	150	13.5	2025	2555
023940219	LO-BENTOMAT SDN	200821LO	00000239	150	13.5	2025	2560

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940207	LO-BENTOMAT SDN	200821LO	00000240	150	13.5	2025	2525
023940217	LO-BENTOMAT SDN	200821LO	00000241	150	13.5	2025	2555
023940219	LO-BENTOMAT SDN	200821LO	00000242	150	13.5	2025	2565
023940220	LO-BENTOMAT SDN	200821LO	00000243	150	13.5	2025	2540
023940204	LO-BENTOMAT SDN	200821LO	00000244	150	13.5	2025	2530
023940207	LO-BENTOMAT SDN	200821LO	00000245	150	13.5	2025	2525
023940211	LO-BENTOMAT SDN	200821LO	00000246	150	13.5	2025	2660
023940207	LO-BENTOMAT SDN	200821LO	00000247	150	13.5	2025	2680
023940202	LO-BENTOMAT SDN	200821LO	00000248	150	13.5	2025	2565
023940201	LO-BENTOMAT SDN	200821LO	00000249	150	13.5	2025	2520
023940223	LO-BENTOMAT SDN	200821LO	00000250	150	13.5	2025	2530
023940220	LO-BENTOMAT SDN	200821LO	00000251	150	13.5	2025	2500
023940201	LO-BENTOMAT SDN	200821LO	00000252	150	13.5	2025	2480
023940204	LO-BENTOMAT SDN	200821LO	00000253	150	13.5	2025	2465
023940206	LO-BENTOMAT SDN	200821LO	00000254	150	13.5	2025	2485
023940202	LO-BENTOMAT SDN	200821LO	00000255	150	13.5	2025	2470
023940219	LO-BENTOMAT SDN	200821LO	00000256	150	13.5	2025	2475
023940216	LO-BENTOMAT SDN	200821LO	00000257	150	13.5	2025	2460
023940219	LO-BENTOMAT SDN	200821LO	00000258	150	13.5	2025	2455
023940204	LO-BENTOMAT SDN	200821LO	00000259	150	13.5	2025	2465
023940204	LO-BENTOMAT SDN	200821LO	00000260	150	13.5	2025	2470
023940202	LO-BENTOMAT SDN	200821LO	00000261	150	13.5	2025	2455
023940204	LO-BENTOMAT SDN	200821LO	00000262	150	13.5	2025	2430
023940204	LO-BENTOMAT SDN	200821LO	00000263	150	13.5	2025	2450
023940220	LO-BENTOMAT SDN	200821LO	00000264	150	13.5	2025	2460
023940202	LO-BENTOMAT SDN	200821LO	00000265	150	13.5	2025	2440
023940220	LO-BENTOMAT SDN	200821LO	00000266	150	13.5	2025	2470
023940201	LO-BENTOMAT SDN	200821LO	00000267	150	13.5	2025	2480
023940207	LO-BENTOMAT SDN	200821LO	00000268	150	13.5	2025	2485
023940206	LO-BENTOMAT SDN	200821LO	00000269	150	13.5	2025	2500
023940206	LO-BENTOMAT SDN	200821LO	00000270	150	13.5	2025	2510
023940215	LO-BENTOMAT SDN	200821LO	00000271	150	13.5	2025	2525

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940206	LO-BENTOMAT SDN	200821LO	00000272	150	13.5	2025	2515
023940215	LO-BENTOMAT SDN	200821LO	00000273	150	13.5	2025	2520
023940216	LO-BENTOMAT SDN	200821LO	00000274	150	14.5	2175	2550
023940206	LO-BENTOMAT SDN	200821LO	00000275	150	14.5	2175	2545
023940204	LO-BENTOMAT SDN	200821LO	00000276	150	14.5	2175	2560
023940207	LO-BENTOMAT SDN	200821LO	00000277	150	14.5	2175	2565
023940204	LO-BENTOMAT SDN	200821LO	00000278	150	14.5	2175	2570
023940204	LO-BENTOMAT SDN	200821LO	00000279	150	14.5	2175	2575
023940214	LO-BENTOMAT SDN	200821LO	00000280	150	14.5	2175	2560
023940201	LO-BENTOMAT SDN	200821LO	00000281	150	14.5	2175	2550
023940206	LO-BENTOMAT SDN	200821LO	00000282	150	14.5	2175	2545
023940206	LO-BENTOMAT SDN	200821LO	00000283	150	14.5	2175	2560
023940206	LO-BENTOMAT SDN	200821LO	00000284	150	14.5	2175	2570
023940206	LO-BENTOMAT SDN	200821LO	00000285	150	14.5	2175	2545
023940219	LO-BENTOMAT SDN	200821LO	00000286	150	14.5	2175	2535
023940202	LO-BENTOMAT SDN	200821LO	00000287	150	14.5	2175	2550
023940206	LO-BENTOMAT SDN	200821LO	00000288	150	14.5	2175	2560
023940206	LO-BENTOMAT SDN	200821LO	00000289	150	14.5	2175	2540
023940201	LO-BENTOMAT SDN	200821LO	00000290	150	14.5	2175	2535
023940202	LO-BENTOMAT SDN	200821LO	00000291	150	14.5	2175	2525
023940202	LO-BENTOMAT SDN	200821LO	00000292	150	14.5	2175	2535
023940202	LO-BENTOMAT SDN	200821LO	00000293	150	14.5	2175	2540
023940207	LO-BENTOMAT SDN	200821LO	00000294	150	14.5	2175	2550
023940204	LO-BENTOMAT SDN	200821LO	00000295	150	14.5	2175	2530
023940202	LO-BENTOMAT SDN	200821LO	00000296	150	14.5	2175	2515
023940220	LO-BENTOMAT SDN	200821LO	00000297	150	14.5	2175	2505
023940217	LO-BENTOMAT SDN	200821LO	00000298	150	14.5	2175	2515
023940223	LO-BENTOMAT SDN	200821LO	00000299	150	14.5	2175	2500
023940219	LO-BENTOMAT SDN	200821LO	00000300	150	14.5	2175	2490
023940217	LO-BENTOMAT SDN	200821LO	00000301	150	14.5	2175	2485
023940212	LO-BENTOMAT SDN	200821LO	00000302	150	14.5	2175	2490
023940212	LO-BENTOMAT SDN	200821LO	00000303	150	14.5	2175	2480

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940212	LO-BENTOMAT SDN	200821LO	00000304	150	14.5	2175	2495
023940212	LO-BENTOMAT SDN	200821LO	00000305	150	14.5	2175	2470
023940212	LO-BENTOMAT SDN	200821LO	00000306	150	14.5	2175	2477
023940220	LO-BENTOMAT SDN	200821LO	00000307	150	14.5	2175	2481
023940219	LO-BENTOMAT SDN	200821LO	00000308	150	14.5	2175	2480
023940217	LO-BENTOMAT SDN	200821LO	00000309	150	14.5	2175	2500
023940217	LO-BENTOMAT SDN	200821LO	00000310	150	14.5	2175	2490
023940217	LO-BENTOMAT SDN	200821LO	00000311	150	14.5	2175	2485
023940215	LO-BENTOMAT SDN	200821LO	00000312	150	14.5	2175	2470
023940215	LO-BENTOMAT SDN	200821LO	00000313	150	14.5	2175	2480
023940215	LO-BENTOMAT SDN	200821LO	00000314	150	14.5	2175	2450
023940205	LO-BENTOMAT SDN	200821LO	00000315	150	14.5	2175	2470
023940205	LO-BENTOMAT SDN	200821LO	00000316	150	14.5	2175	2480
023940215	LO-BENTOMAT SDN	200821LO	00000317	150	14.5	2175	2475
023940202	LO-BENTOMAT SDN	200821LO	00000318	150	14.5	2175	2490
023940202	LO-BENTOMAT SDN	200821LO	00000319	150	14.5	2175	2500
023940220	LO-BENTOMAT SDN	200821LO	00000320	150	14.5	2175	2505
023940205	LO-BENTOMAT SDN	200821LO	00000321	150	14.5	2175	2510
023940205	LO-BENTOMAT SDN	200821LO	00000322	150	14.5	2175	2520
023940212	LO-BENTOMAT SDN	200821LO	00000323	150	14.5	2175	2495
023940212	LO-BENTOMAT SDN	200821LO	00000324	150	14.5	2175	2490
023940202	LO-BENTOMAT SDN	200821LO	00000325	150	14.5	2175	2505
023940202	LO-BENTOMAT SDN	200821LO	00000326	150	14.5	2175	2510
023940212	LO-BENTOMAT SDN	200821LO	00000327	150	14.5	2175	2515
023940215	LO-BENTOMAT SDN	200821LO	00000328	150	14.5	2175	2520
023940219	LO-BENTOMAT SDN	200821LO	00000329	150	14.5	2175	2505
023940220	LO-BENTOMAT SDN	200821LO	00000330	150	14.5	2175	2510
023940215	LO-BENTOMAT SDN	200821LO	00000331	150	14.5	2175	2520
023940215	LO-BENTOMAT SDN	200821LO	00000332	150	14.5	2175	2535
023940219	LO-BENTOMAT SDN	200821LO	00000333	150	14.5	2175	2525
023940216	LO-BENTOMAT SDN	200821LO	00000334	150	14.5	2175	2505
023940217	LO-BENTOMAT SDN	200821LO	00000335	150	14.5	2175	2495

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940212	LO-BENTOMAT SDN	200821LO	00000336	150	14.5	2175	2480
023940217	LO-BENTOMAT SDN	200821LO	00000337	150	14.5	2175	2490
023940203	LO-BENTOMAT SDN	200821LO	00000338	150	14.5	2175	2500
023940203	LO-BENTOMAT SDN	200821LO	00000339	150	14.5	2175	2505
023940203	LO-BENTOMAT SDN	200821LO	00000340	150	14.5	2175	2510
023940205	LO-BENTOMAT SDN	200821LO	00000341	150	14.5	2175	2510
023940217	LO-BENTOMAT SDN	200821LO	00000342	150	14.5	2175	2515
023940205	LO-BENTOMAT SDN	200821LO	00000343	150	14.5	2175	2520
023940215	LO-BENTOMAT SDN	200821LO	00000344	150	14.5	2175	2530
023940214	LO-BENTOMAT SDN	200821LO	00000345	150	14.5	2175	2510
023940214	LO-BENTOMAT SDN	200821LO	00000346	150	14.5	2175	2495
023940214	LO-BENTOMAT SDN	200821LO	00000347	150	14.5	2175	2480
023940220	LO-BENTOMAT SDN	200821LO	00000348	150	14.5	2175	2495
023940216	LO-BENTOMAT SDN	200821LO	00000349	150	14.5	2175	2490
023940223	LO-BENTOMAT SDN	200821LO	00000350	150	14.5	2175	2530
023940216	LO-BENTOMAT SDN	200821LO	00000351	150	14.5	2175	2540
023940217	LO-BENTOMAT SDN	200821LO	00000352	150	14.5	2175	2535
023940203	LO-BENTOMAT SDN	200821LO	00000353	150	14.5	2175	2550
023940203	LO-BENTOMAT SDN	200821LO	00000354	150	14.5	2175	2545
023940205	LO-BENTOMAT SDN	200821LO	00000355	150	14.5	2175	2530
023940203	LO-BENTOMAT SDN	200821LO	00000356	150	14.5	2175	2525
023940203	LO-BENTOMAT SDN	200821LO	00000357	150	14.5	2175	2560
023940205	LO-BENTOMAT SDN	200821LO	00000358	150	14.5	2175	2570
023940220	LO-BENTOMAT SDN	200821LO	00000359	150	14.5	2175	2580
023940220	LO-BENTOMAT SDN	200821LO	00000360	150	14.5	2175	2555
023940222	LO-BENTOMAT SDN	200821LO	00000361	150	14.5	2175	2560
023940222	LO-BENTOMAT SDN	200821LO	00000362	150	14.5	2175	2575
023940211	LO-BENTOMAT SDN	200821LO	00000363	150	14.5	2175	2550
023940222	LO-BENTOMAT SDN	200821LO	00000364	150	14.5	2175	2540
023940222	LO-BENTOMAT SDN	200821LO	00000365	150	14.5	2175	2530
023940222	LO-BENTOMAT SDN	200821LO	00000366	150	14.5	2175	2525
023940222	LO-BENTOMAT SDN	200821LO	00000367	150	14.5	2175	2565

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940222	LO-BENTOMAT SDN	200821LO	00000368	150	14.5	2175	2570
023940220	LO-BENTOMAT SDN	200821LO	00000369	150	14.5	2175	2560
023940216	LO-BENTOMAT SDN	200821LO	00000370	150	14.5	2175	2550
023940216	LO-BENTOMAT SDN	200821LO	00000371	150	14.5	2175	2510
023940216	LO-BENTOMAT SDN	200821LO	00000372	150	14.5	2175	2530
023940216	LO-BENTOMAT SDN	200821LO	00000373	150	14.5	2175	2540
023940217	LO-BENTOMAT SDN	200821LO	00000374	150	14.5	2175	2535
023940216	LO-BENTOMAT SDN	200821LO	00000375	150	14.5	2175	2545
023940216	LO-BENTOMAT SDN	200821LO	00000376	150	14.5	2175	2550
023940216	LO-BENTOMAT SDN	200821LO	00000377	150	14.5	2175	2560
023940216	LO-BENTOMAT SDN	200821LO	00000378	150	14.5	2175	2540
023940216	LO-BENTOMAT SDN	200821LO	00000379	150	14.5	2175	2535
023940216	LO-BENTOMAT SDN	200821LO	00000380	150	14.5	2175	2525
023940216	LO-BENTOMAT SDN	200821LO	00000381	150	14.5	2175	2550
023940217	LO-BENTOMAT SDN	200821LO	00000382	150	14.5	2175	2540
023940210	LO-BENTOMAT SDN	200821LO	00000385	150	14.5	2175	2745
023940210	LO-BENTOMAT SDN	200821LO	00000386	150	14.5	2175	2760
023940212	LO-BENTOMAT SDN	200821LO	00000387	150	14.5	2175	2730
023940212	LO-BENTOMAT SDN	200821LO	00000388	150	14.5	2175	2745
023940215	LO-BENTOMAT SDN	200821LO	00000389	150	14.5	2175	2750
023940208	LO-BENTOMAT SDN	200821LO	00000390	150	14.5	2175	2760
023940208	LO-BENTOMAT SDN	200821LO	00000391	150	14.5	2175	2735
023940209	LO-BENTOMAT SDN	200821LO	00000392	150	14.5	2175	2740
023940209	LO-BENTOMAT SDN	200821LO	00000393	150	14.5	2175	2750
023940208	LO-BENTOMAT SDN	200821LO	00000394	150	14.5	2175	2710
023940208	LO-BENTOMAT SDN	200821LO	00000395	150	14.5	2175	2680
023940214	LO-BENTOMAT SDN	200821LO	00000396	150	14.5	2175	2655
023940210	LO-BENTOMAT SDN	200821LO	00000397	150	14.5	2175	2640
023940214	LO-BENTOMAT SDN	200821LO	00000398	150	14.5	2175	2630
023940210	LO-BENTOMAT SDN	200821LO	00000399	150	14.5	2175	2615
023940210	LO-BENTOMAT SDN	200821LO	00000400	150	14.5	2175	2600
023940213	LO-BENTOMAT SDN	200821LO	00000401	150	14.5	2175	2605

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940209	LO-BENTOMAT SDN	200821LO	00000402	150	14.5	2175	2610
023940213	LO-BENTOMAT SDN	200821LO	00000403	150	14.5	2175	2600
023940213	LO-BENTOMAT SDN	200821LO	00000404	150	14.5	2175	2605
023940213	LO-BENTOMAT SDN	200821LO	00000405	150	14.5	2175	2620
023940210	LO-BENTOMAT SDN	200821LO	00000406	150	14.5	2175	2628
023940210	LO-BENTOMAT SDN	200821LO	00000407	150	14.5	2175	2631
023940208	LO-BENTOMAT SDN	200821LO	00000408	150	14.5	2175	2624
023940215	LO-BENTOMAT SDN	200821LO	00000409	150	14.5	2175	2630
023940213	LO-BENTOMAT SDN	200821LO	00000410	150	14.5	2175	2622
023940215	LO-BENTOMAT SDN	200821LO	00000411	150	14.5	2175	2634
023940208	LO-BENTOMAT SDN	200821LO	00000412	150	14.5	2175	2629
023940209	LO-BENTOMAT SDN	200821LO	00000413	150	14.5	2175	2625
023940208	LO-BENTOMAT SDN	200821LO	00000414	150	14.5	2175	2634
023940219	LO-BENTOMAT SDN	200821LO	00000415	150	14.5	2175	2623
023940208	LO-BENTOMAT SDN	200821LO	00000416	150	14.5	2175	2630
023940209	LO-BENTOMAT SDN	200821LO	00000417	150	14.5	2175	2630
023940209	LO-BENTOMAT SDN	200821LO	00000418	150	14.5	2175	2637
023940209	LO-BENTOMAT SDN	200821LO	00000419	150	14.5	2175	2640
023940208	LO-BENTOMAT SDN	200821LO	00000420	150	14.5	2175	2643
023940208	LO-BENTOMAT SDN	200821LO	00000421	150	14.5	2175	2639
023940209	LO-BENTOMAT SDN	200821LO	00000422	150	14.5	2175	2635
023940208	LO-BENTOMAT SDN	200821LO	00000423	150	14.5	2175	2639
023940209	LO-BENTOMAT SDN	200821LO	00000424	150	14.5	2175	2641
023940208	LO-BENTOMAT SDN	200821LO	00000425	150	14.5	2175	2640
023940209	LO-BENTOMAT SDN	200821LO	00000426	150	14.5	2175	2620
023940209	LO-BENTOMAT SDN	200821LO	00000427	150	14.5	2175	2610
023940213	LO-BENTOMAT SDN	200821LO	00000428	150	14.5	2175	2620
023940209	LO-BENTOMAT SDN	200821LO	00000429	150	14.5	2175	2615
023940209	LO-BENTOMAT SDN	200821LO	00000430	150	14.5	2175	2590
023940209	LO-BENTOMAT SDN	200821LO	00000431	150	14.5	2175	2565
023940209	LO-BENTOMAT SDN	200821LO	00000432	150	14.5	2175	2530
023940209	LO-BENTOMAT SDN	200821LO	00000433	150	14.5	2175	2545

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940213	LO-BENTOMAT SDN	200821LO	00000434	150	14.5	2175	2550
023940213	LO-BENTOMAT SDN	200821LO	00000435	150	14.5	2175	2540
023940213	LO-BENTOMAT SDN	200821LO	00000436	150	14.5	2175	2535
023940213	LO-BENTOMAT SDN	200821LO	00000437	150	14.5	2175	2545
023940210	LO-BENTOMAT SDN	200821LO	00000438	150	14.5	2175	2555
023940213	LO-BENTOMAT SDN	200821LO	00000439	150	14.5	2175	2560
023940210	LO-BENTOMAT SDN	200821LO	00000440	150	14.5	2175	2545
023940210	LO-BENTOMAT SDN	200821LO	00000441	150	14.5	2175	2580
023940210	LO-BENTOMAT SDN	200821LO	00000442	150	14.5	2175	2575
023940210	LO-BENTOMAT SDN	200821LO	00000443	150	14.5	2175	2560
023940214	LO-BENTOMAT SDN	200821LO	00000444	150	14.5	2175	2580
023940208	LO-BENTOMAT SDN	200821LO	00000445	150	14.5	2175	2570
023940210	LO-BENTOMAT SDN	200821LO	00000446	150	14.5	2175	2575
023940213	LO-BENTOMAT SDN	200821LO	00000447	150	14.5	2175	2560
023940215	LO-BENTOMAT SDN	200821LO	00000448	150	14.5	2175	2585
023940214	LO-BENTOMAT SDN	200821LO	00000449	150	14.5	2175	2575
023940214	LO-BENTOMAT SDN	200821LO	00000450	150	14.5	2175	2568
023940215	LO-BENTOMAT SDN	200821LO	00000451	150	14.5	2175	2565
023940214	LO-BENTOMAT SDN	200821LO	00000452	150	14.5	2175	2570
023940213	LO-BENTOMAT SDN	200821LO	00000453	150	14.5	2175	2575
023940213	LO-BENTOMAT SDN	200821LO	00000454	150	14.5	2175	2590
023940210	LO-BENTOMAT SDN	200821LO	00000455	150	14.5	2175	2575
023940210	LO-BENTOMAT SDN	200821LO	00000456	150	14.5	2175	2580
023940213	LO-BENTOMAT SDN	200821LO	00000457	150	14.5	2175	2565
023940208	LO-BENTOMAT SDN	200821LO	00000458	150	14.5	2175	2570
023940213	LO-BENTOMAT SDN	200821LO	00000459	150	14.5	2175	2560
023940208	LO-BENTOMAT SDN	200821LO	00000460	150	14.5	2175	2550
023940208	LO-BENTOMAT SDN	200821LO	00000461	150	14.5	2175	2575
023940208	LO-BENTOMAT SDN	200821LO	00000462	150	14.5	2175	2580
023940212	LO-BENTOMAT SDN	200821LO	00000463	150	14.5	2175	2585
023940215	LO-BENTOMAT SDN	200821LO	00000464	150	14.5	2175	2570
023940210	LO-BENTOMAT SDN	200821LO	00000465	150	14.5	2175	2560

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940218	LO-BENTOMAT SDN	200822LO	00000467	150	14.5	2175	2505
023940232	LO-BENTOMAT SDN	200822LO	00000468	150	14.5	2175	2445
023940239	LO-BENTOMAT SDN	200822LO	00000470	150	14.5	2175	2540
023940235	LO-BENTOMAT SDN	200822LO	00000471	150	14.5	2175	2565
023940235	LO-BENTOMAT SDN	200822LO	00000472	150	14.5	2175	2505
023940241	LO-BENTOMAT SDN	200822LO	00000473	150	14.5	2175	2570
023940241	LO-BENTOMAT SDN	200822LO	00000474	150	14.5	2175	2525
023940233	LO-BENTOMAT SDN	200822LO	00000481	150	14.5	2175	2440
023940233	LO-BENTOMAT SDN	200822LO	00000484	150	14.5	2175	2430
023940233	LO-BENTOMAT SDN	200822LO	00000485	150	14.5	2175	2440
023940231	LO-BENTOMAT SDN	200822LO	00000487	150	14.5	2175	2430
023940243	LO-BENTOMAT SDN	200822LO	00000489	150	14.5	2175	2431
023940243	LO-BENTOMAT SDN	200822LO	00000494	150	14.5	2175	2475
023940226	LO-BENTOMAT SDN	200822LO	00000496	150	14.5	2175	2415
023940239	LO-BENTOMAT SDN	200822LO	00000497	150	14.5	2175	2425
023940233	LO-BENTOMAT SDN	200822LO	00000498	150	14.5	2175	2370
023940235	LO-BENTOMAT SDN	200822LO	00000500	150	14.5	2175	2375
023940226	LO-BENTOMAT SDN	200822LO	00000502	150	14.5	2175	2345
023940235	LO-BENTOMAT SDN	200822LO	00000503	150	14.5	2175	2465
023940226	LO-BENTOMAT SDN	200822LO	00000504	150	14.5	2175	2410
023940243	LO-BENTOMAT SDN	200822LO	00000505	150	14.5	2175	2460
023940243	LO-BENTOMAT SDN	200822LO	00000506	150	14.5	2175	2385
023940243	LO-BENTOMAT SDN	200822LO	00000507	150	14.5	2175	2950
023940218	LO-BENTOMAT SDN	200822LO	00000508	150	14.5	2175	2400
023940226	LO-BENTOMAT SDN	200822LO	00000509	150	14.5	2175	2405
023940226	LO-BENTOMAT SDN	200822LO	00000510	150	14.5	2175	2420
023940232	LO-BENTOMAT SDN	200822LO	00000511	150	14.5	2175	2395
023940229	LO-BENTOMAT SDN	200822LO	00000512	150	14.5	2175	2390
023940226	LO-BENTOMAT SDN	200822LO	00000513	150	14.5	2175	2415
023940226	LO-BENTOMAT SDN	200822LO	00000514	150	14.5	2175	2415
023940239	LO-BENTOMAT SDN	200822LO	00000515	150	14.5	2175	2405
023940226	LO-BENTOMAT SDN	200822LO	00000516	150	14.5	2175	2410

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940243	LO-BENTOMAT SDN	200822LO	00000517	150	14.5	2175	2400
023940243	LO-BENTOMAT SDN	200822LO	00000518	150	14.5	2175	2425
023940231	LO-BENTOMAT SDN	200822LO	00000520	150	14.5	2175	2445
023940224	LO-BENTOMAT SDN	200822LO	00000522	150	14.5	2175	2400
023940229	LO-BENTOMAT SDN	200822LO	00000523	150	14.5	2175	2400
023940224	LO-BENTOMAT SDN	200822LO	00000524	150	14.5	2175	2445
023940224	LO-BENTOMAT SDN	200822LO	00000525	150	14.5	2175	2450
023940232	LO-BENTOMAT SDN	200822LO	00000526	150	14.5	2175	2300
023940232	LO-BENTOMAT SDN	200822LO	00000527	150	14.5	2175	2460
023940218	LO-BENTOMAT SDN	200822LO	00000528	150	14.5	2175	2455
023940226	LO-BENTOMAT SDN	200822LO	00000529	150	14.5	2175	2440
023940226	LO-BENTOMAT SDN	200822LO	00000530	150	14.5	2175	2500
023940226	LO-BENTOMAT SDN	200822LO	00000531	150	14.5	2175	2035
023940226	LO-BENTOMAT SDN	200822LO	00000532	150	14.5	2175	2450
023940226	LO-BENTOMAT SDN	200822LO	00000533	150	14.5	2175	2420
023940235	LO-BENTOMAT SDN	200822LO	00000534	150	14.5	2175	2555
023940231	LO-BENTOMAT SDN	200822LO	00000535	150	14.5	2175	2590
023940231	LO-BENTOMAT SDN	200822LO	00000536	150	14.5	2175	2550
023940232	LO-BENTOMAT SDN	200822LO	00000537	150	14.5	2175	2425
023940243	LO-BENTOMAT SDN	200822LO	00000538	150	14.5	2175	2450
023940240	LO-BENTOMAT SDN	200822LO	00000539	150	14.5	2175	2430
023940224	LO-BENTOMAT SDN	200822LO	00000540	150	14.5	2175	4400
023940224	LO-BENTOMAT SDN	200822LO	00000541	150	14.5	2175	2433
023940239	LO-BENTOMAT SDN	200822LO	00000542	150	14.5	2175	2425
023940225	LO-BENTOMAT SDN	200822LO	00000543	150	14.5	2175	2430
023940225	LO-BENTOMAT SDN	200822LO	00000544	150	14.5	2175	2200
023940224	LO-BENTOMAT SDN	200822LO	00000545	150	14.5	2175	2490
023940224	LO-BENTOMAT SDN	200822LO	00000546	150	14.5	2175	2485
023940224	LO-BENTOMAT SDN	200822LO	00000547	150	14.5	2175	2480
023940231	LO-BENTOMAT SDN	200822LO	00000548	150	14.5	2175	2475
023940239	LO-BENTOMAT SDN	200822LO	00000549	150	14.5	2175	2472
023940231	LO-BENTOMAT SDN	200822LO	00000550	150	14.5	2175	2465

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940239	LO-BENTOMAT SDN	200822LO	00000551	150	14.5	2175	2469
023940218	LO-BENTOMAT SDN	200822LO	00000552	150	14.5	2175	2473
023940218	LO-BENTOMAT SDN	200822LO	00000553	150	14.5	2175	2470
023940239	LO-BENTOMAT SDN	200822LO	00000554	150	14.5	2175	2480
023940224	LO-BENTOMAT SDN	200822LO	00000555	150	14.5	2175	2475
023940239	LO-BENTOMAT SDN	200822LO	00000556	150	14.5	2175	2473
023940226	LO-BENTOMAT SDN	200822LO	00000557	150	14.5	2175	2468
023940226	LO-BENTOMAT SDN	200822LO	00000558	150	14.5	2175	2470
023940232	LO-BENTOMAT SDN	200822LO	00000559	150	14.5	2175	2475
023940226	LO-BENTOMAT SDN	200822LO	00000560	150	14.5	2175	2476
023940226	LO-BENTOMAT SDN	200822LO	00000561	150	14.5	2175	2480
023940218	LO-BENTOMAT SDN	200822LO	00000562	150	14.5	2175	2472
023940218	LO-BENTOMAT SDN	200822LO	00000563	150	14.5	2175	2468
023940218	LO-BENTOMAT SDN	200822LO	00000564	150	14.5	2175	2475
023940218	LO-BENTOMAT SDN	200822LO	00000565	150	14.5	2175	2470
023940232	LO-BENTOMAT SDN	200822LO	00000566	150	14.5	2175	2467
023940218	LO-BENTOMAT SDN	200822LO	00000567	150	14.5	2175	2480
023940224	LO-BENTOMAT SDN	200822LO	00000568	150	14.5	2175	2483
023940224	LO-BENTOMAT SDN	200822LO	00000569	150	14.5	2175	2480
023940224	LO-BENTOMAT SDN	200822LO	00000570	150	14.5	2175	2477
023940235	LO-BENTOMAT SDN	200822LO	00000571	150	14.5	2175	2430
023940231	LO-BENTOMAT SDN	200822LO	00000572	150	14.5	2175	2465
023940231	LO-BENTOMAT SDN	200822LO	00000573	150	14.5	2175	2480
023940232	LO-BENTOMAT SDN	200822LO	00000575	150	14.5	2175	2465
023940243	LO-BENTOMAT SDN	200822LO	00000576	150	14.5	2175	2480
023940224	LO-BENTOMAT SDN	200822LO	00000577	150	14.5	2175	2450
023940235	LO-BENTOMAT SDN	200822LO	00000578	150	14.5	2175	2475
023940224	LO-BENTOMAT SDN	200822LO	00000579	150	14.5	2175	2435
023940231	LO-BENTOMAT SDN	200822LO	00000580	150	14.5	2175	2470
023940218	LO-BENTOMAT SDN	200822LO	00000581	150	14.5	2175	2455
023940231	LO-BENTOMAT SDN	200822LO	00000582	150	14.5	2175	2485
023940243	LO-BENTOMAT SDN	200822LO	00000583	150	14.5	2175	2490

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940232	LO-BENTOMAT SDN	200822LO	00000584	150	14.5	2175	2500
023940218	LO-BENTOMAT SDN	200822LO	00000585	150	14.5	2175	2445
023940232	LO-BENTOMAT SDN	200822LO	00000586	150	14.5	2175	2510
023940232	LO-BENTOMAT SDN	200822LO	00000587	150	14.5	2175	2515
023940232	LO-BENTOMAT SDN	200822LO	00000588	150	14.5	2175	2505
023940235	LO-BENTOMAT SDN	200822LO	00000589	150	14.5	2175	2520
023940240	LO-BENTOMAT SDN	200822LO	00000591	150	14.5	2175	2524
023940232	LO-BENTOMAT SDN	200822LO	00000592	150	14.5	2175	2520
023940218	LO-BENTOMAT SDN	200822LO	00000593	150	14.5	2175	2515
023940231	LO-BENTOMAT SDN	200822LO	00000594	150	14.5	2175	2620
023940225	LO-BENTOMAT SDN	200822LO	00000595	150	14.5	2175	2560
023940224	LO-BENTOMAT SDN	200822LO	00000596	150	14.5	2175	2600
023940232	LO-BENTOMAT SDN	200822LO	00000597	150	14.5	2175	2610
023940231	LO-BENTOMAT SDN	200822LO	00000598	150	14.5	2175	2605
023940224	LO-BENTOMAT SDN	200822LO	00000599	150	14.5	2175	2615
023940245	LO-BENTOMAT SDN	200822LO	00000600	150	14.5	2175	2620
023940232	LO-BENTOMAT SDN	200822LO	00000601	150	14.5	2175	2625
023940231	LO-BENTOMAT SDN	200822LO	00000602	150	14.5	2175	2615
023940231	LO-BENTOMAT SDN	200822LO	00000603	150	14.5	2175	2620
023940224	LO-BENTOMAT SDN	200822LO	00000604	150	14.5	2175	2610
023940227	LO-BENTOMAT SDN	200822LO	00000605	150	14.5	2175	2615
023940233	LO-BENTOMAT SDN	200822LO	00000606	150	14.5	2175	2610
023940225	LO-BENTOMAT SDN	200822LO	00000607	150	14.5	2175	2625
023940218	LO-BENTOMAT SDN	200822LO	00000608	150	14.5	2175	2605
023940218	LO-BENTOMAT SDN	200822LO	00000609	150	14.5	2175	2620
023940232	LO-BENTOMAT SDN	200822LO	00000610	150	14.5	2175	2615
023940232	LO-BENTOMAT SDN	200822LO	00000611	150	14.5	2175	2610
023940228	LO-BENTOMAT SDN	200822LO	00000612	150	14.5	2175	2620
023940245	LO-BENTOMAT SDN	200822LO	00000613	150	14.5	2175	2615
023940218	LO-BENTOMAT SDN	200822LO	00000614	150	14.5	2175	2625
023940239	LO-BENTOMAT SDN	200822LO	00000615	150	14.5	2175	2620
023940218	LO-BENTOMAT SDN	200822LO	00000616	150	14.5	2175	2630

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940227	LO-BENTOMAT SDN	200822LO	00000617	150	14.5	2175	2615
023940227	LO-BENTOMAT SDN	200822LO	00000618	150	14.5	2175	2600
023940228	LO-BENTOMAT SDN	200822LO	00000619	150	14.5	2175	2605
023940227	LO-BENTOMAT SDN	200822LO	00000620	150	14.5	2175	2615
023940237	LO-BENTOMAT SDN	200822LO	00000621	150	14.5	2175	2600
023940225	LO-BENTOMAT SDN	200822LO	00000622	150	14.5	2175	2620
023940228	LO-BENTOMAT SDN	200822LO	00000623	150	14.5	2175	2615
023940228	LO-BENTOMAT SDN	200822LO	00000624	150	14.5	2175	2620
023940228	LO-BENTOMAT SDN	200822LO	00000625	150	14.5	2175	2625
023940225	LO-BENTOMAT SDN	200822LO	00000626	150	14.5	2175	2630
023940228	LO-BENTOMAT SDN	200822LO	00000627	150	14.5	2175	2620
023940230	LO-BENTOMAT SDN	200822LO	00000628	150	14.5	2175	2615
023940227	LO-BENTOMAT SDN	200822LO	00000629	150	14.5	2175	2620
023940225	LO-BENTOMAT SDN	200822LO	00000630	150	14.5	2175	2625
023940228	LO-BENTOMAT SDN	200822LO	00000631	150	14.5	2175	2630
023940228	LO-BENTOMAT SDN	200822LO	00000632	150	14.5	2175	2610
023940227	LO-BENTOMAT SDN	200822LO	00000633	150	14.5	2175	2610
023940225	LO-BENTOMAT SDN	200822LO	00000634	150	14.5	2175	2615
023940225	LO-BENTOMAT SDN	200822LO	00000635	150	14.5	2175	2610
023940225	LO-BENTOMAT SDN	200822LO	00000636	150	14.5	2175	2620
023940228	LO-BENTOMAT SDN	200822LO	00000637	150	14.5	2175	2630
023940225	LO-BENTOMAT SDN	200822LO	00000638	150	14.5	2175	2635
023940228	LO-BENTOMAT SDN	200822LO	00000639	150	14.5	2175	2620
023940225	LO-BENTOMAT SDN	200822LO	00000640	150	14.5	2175	2590
023940225	LO-BENTOMAT SDN	200822LO	00000641	150	14.5	2175	2600
023940228	LO-BENTOMAT SDN	200822LO	00000642	150	14.5	2175	2610
023940228	LO-BENTOMAT SDN	200822LO	00000643	150	14.5	2175	2615
023940225	LO-BENTOMAT SDN	200822LO	00000644	150	14.5	2175	2610
023940228	LO-BENTOMAT SDN	200822LO	00000645	150	14.5	2175	2620
023940228	LO-BENTOMAT SDN	200822LO	00000646	150	14.5	2175	2600
023940228	LO-BENTOMAT SDN	200822LO	00000647	150	14.5	2175	2615
023940228	LO-BENTOMAT SDN	200822LO	00000648	150	14.5	2175	2620

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940228	LO-BENTOMAT SDN	200822LO	00000649	150	14.5	2175	2630
023940227	LO-BENTOMAT SDN	200822LO	00000650	150	14.5	2175	2610
023940227	LO-BENTOMAT SDN	200822LO	00000651	150	14.5	2175	2615
023940227	LO-BENTOMAT SDN	200822LO	00000652	150	14.5	2175	2610
023940227	LO-BENTOMAT SDN	200822LO	00000653	150	14.5	2175	2620
023940240	LO-BENTOMAT SDN	200822LO	00000654	150	14.5	2175	2630
023940239	LO-BENTOMAT SDN	200822LO	00000655	150	14.5	2175	2625
023940233	LO-BENTOMAT SDN	200822LO	00000656	150	14.5	2175	2600
023940227	LO-BENTOMAT SDN	200822LO	00000657	150	14.5	2175	2620
023940227	LO-BENTOMAT SDN	200822LO	00000658	150	14.5	2175	2630
023940227	LO-BENTOMAT SDN	200822LO	00000659	150	14.5	2175	2625
023940227	LO-BENTOMAT SDN	200822LO	00000660	150	14.5	2175	2620
023940227	LO-BENTOMAT SDN	200822LO	00000661	150	14.5	2175	2630
023940227	LO-BENTOMAT SDN	200822LO	00000662	150	14.5	2175	2430
023940227	LO-BENTOMAT SDN	200822LO	00000663	150	14.5	2175	2445
023940225	LO-BENTOMAT SDN	200822LO	00000664	150	14.5	2175	2500
023940225	LO-BENTOMAT SDN	200822LO	00000665	150	14.5	2175	2450
023940229	LO-BENTOMAT SDN	200822LO	00000666	150	14.5	2175	2200
023940229	LO-BENTOMAT SDN	200822LO	00000667	150	14.5	2175	2350
023940234	LO-BENTOMAT SDN	200822LO	00000669	150	14.5	2175	2315
023940225	LO-BENTOMAT SDN	200822LO	00000670	150	14.5	2175	2465
023940230	LO-BENTOMAT SDN	200822LO	00000671	150	14.5	2175	2530
023940240	LO-BENTOMAT SDN	200822LO	00000672	150	14.5	2175	2510
023940231	LO-BENTOMAT SDN	200822LO	00000673	150	14.5	2175	2470
023940243	LO-BENTOMAT SDN	200822LO	00000674	150	14.5	2175	2455
023940237	LO-BENTOMAT SDN	200822LO	00000675	150	14.5	2175	2580
023940239	LO-BENTOMAT SDN	200822LO	00000676	150	14.5	2175	2730
023940243	LO-BENTOMAT SDN	200822LO	00000677	150	14.5	2175	2520
023940237	LO-BENTOMAT SDN	200822LO	00000678	150	14.5	2175	2520
023940237	LO-BENTOMAT SDN	200822LO	00000679	150	14.5	2175	2440
023940245	LO-BENTOMAT SDN	200822LO	00000680	150	14.5	2175	2490
023940237	LO-BENTOMAT SDN	200822LO	00000681	150	14.5	2175	2500

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940239	LO-BENTOMAT SDN	200822LO	00000682	150	14.5	2175	2590
023940245	LO-BENTOMAT SDN	200822LO	00000683	150	14.5	2175	2590
023940236	LO-BENTOMAT SDN	200822LO	00000684	150	14.5	2175	2600
023940237	LO-BENTOMAT SDN	200822LO	00000685	150	14.5	2175	2620
023940237	LO-BENTOMAT SDN	200822LO	00000686	150	14.5	2175	2630
023940237	LO-BENTOMAT SDN	200822LO	00000687	150	14.5	2175	2615
023940237	LO-BENTOMAT SDN	200822LO	00000688	150	14.5	2175	2625
023940237	LO-BENTOMAT SDN	200822LO	00000689	150	14.5	2175	2550
023940231	LO-BENTOMAT SDN	200822LO	00000690	150	14.5	2175	2630
023940234	LO-BENTOMAT SDN	200822LO	00000691	150	14.5	2175	2620
023940230	LO-BENTOMAT SDN	200822LO	00000692	150	14.5	2175	2650
023940240	LO-BENTOMAT SDN	200822LO	00000693	150	14.5	2175	2650
023940240	LO-BENTOMAT SDN	200822LO	00000694	150	14.5	2175	2610
023940245	LO-BENTOMAT SDN	200822LO	00000695	150	14.5	2175	2650
023940245	LO-BENTOMAT SDN	200822LO	00000696	150	14.5	2175	2670
023940237	LO-BENTOMAT SDN	200822LO	00000697	150	14.5	2175	2645
023940245	LO-BENTOMAT SDN	200822LO	00000698	150	14.5	2175	2660
023940237	LO-BENTOMAT SDN	200822LO	00000699	150	14.5	2175	2635
023940240	LO-BENTOMAT SDN	200822LO	00000700	150	14.5	2175	2350
023940240	LO-BENTOMAT SDN	200822LO	00000701	150	14.5	2175	2675
023940237	LO-BENTOMAT SDN	200822LO	00000702	150	14.5	2175	2680
023940240	LO-BENTOMAT SDN	200822LO	00000703	150	14.5	2175	2680
023940237	LO-BENTOMAT SDN	200822LO	00000704	150	14.5	2175	2640
023940231	LO-BENTOMAT SDN	200822LO	00000705	150	14.5	2175	2655
023940237	LO-BENTOMAT SDN	200822LO	00000706	150	14.5	2175	2670
023940243	LO-BENTOMAT SDN	200822LO	00000707	150	14.5	2175	2655
023940236	LO-BENTOMAT SDN	200822LO	00000708	150	14.5	2175	2680
023940240	LO-BENTOMAT SDN	200822LO	00000709	150	14.5	2175	2640
023940240	LO-BENTOMAT SDN	200822LO	00000710	150	14.5	2175	2655
023940237	LO-BENTOMAT SDN	200822LO	00000711	150	14.5	2175	2670
023940240	LO-BENTOMAT SDN	200822LO	00000712	150	14.5	2175	2625
023940236	LO-BENTOMAT SDN	200822LO	00000713	150	14.5	2175	2635

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940237	LO-BENTOMAT SDN	200822LO	00000714	150	14.5	2175	2675
023940240	LO-BENTOMAT SDN	200822LO	00000715	150	14.5	2175	2640
023940229	LO-BENTOMAT SDN	200822LO	00000716	150	14.5	2175	2670
023940236	LO-BENTOMAT SDN	200822LO	00000717	150	14.5	2175	2690
023940229	LO-BENTOMAT SDN	200822LO	00000718	150	14.5	2175	2670
023940240	LO-BENTOMAT SDN	200822LO	00000719	150	14.5	2175	2670
023940229	LO-BENTOMAT SDN	200822LO	00000720	150	14.5	2175	2655
023940229	LO-BENTOMAT SDN	200822LO	00000721	150	14.5	2175	2640
023940233	LO-BENTOMAT SDN	200822LO	00000722	150	14.5	2175	2635
023940229	LO-BENTOMAT SDN	200822LO	00000723	150	14.5	2175	2675
023940229	LO-BENTOMAT SDN	200822LO	00000724	150	14.5	2175	2695
023940229	LO-BENTOMAT SDN	200822LO	00000725	150	14.5	2175	2630
023940229	LO-BENTOMAT SDN	200822LO	00000726	150	14.5	2175	2645
023940229	LO-BENTOMAT SDN	200822LO	00000727	150	14.5	2175	2655
023940245	LO-BENTOMAT SDN	200822LO	00000729	150	14.5	2175	2620
023940233	LO-BENTOMAT SDN	200822LO	00000730	150	14.5	2175	2655
023940243	LO-BENTOMAT SDN	200822LO	00000731	150	14.5	2175	2670
023940245	LO-BENTOMAT SDN	200822LO	00000733	150	14.5	2175	2620
023940240	LO-BENTOMAT SDN	200822LO	00000734	150	14.5	2175	2670
023940233	LO-BENTOMAT SDN	200822LO	00000735	150	14.5	2175	2645
023940239	LO-BENTOMAT SDN	200822LO	00000736	150	14.5	2175	2650
023940239	LO-BENTOMAT SDN	200822LO	00000737	150	14.5	2175	2660
023940245	LO-BENTOMAT SDN	200822LO	00000738	150	14.5	2175	2645
023940245	LO-BENTOMAT SDN	200822LO	00000739	150	14.5	2175	2630
023940229	LO-BENTOMAT SDN	200822LO	00000740	150	14.5	2175	2665
023940235	LO-BENTOMAT SDN	200822LO	00000743	150	14.5	2175	2615
023940235	LO-BENTOMAT SDN	200822LO	00000744	150	14.5	2175	2620
023940235	LO-BENTOMAT SDN	200822LO	00000745	150	14.5	2175	2625
023940235	LO-BENTOMAT SDN	200822LO	00000746	150	14.5	2175	2615
023940235	LO-BENTOMAT SDN	200822LO	00000747	150	14.5	2175	2610
023940229	LO-BENTOMAT SDN	200822LO	00000748	150	14.5	2175	2615
023940238	LO-BENTOMAT SDN	200822LO	00000749	150	14.5	2175	2620

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940229	LO-BENTOMAT SDN	200822LO	00000750	150	14.5	2175	2610
023940229	LO-BENTOMAT SDN	200822LO	00000751	150	14.5	2175	2615
023940235	LO-BENTOMAT SDN	200822LO	00000752	150	14.5	2175	2620
023940230	LO-BENTOMAT SDN	200822LO	00000753	150	14.5	2175	2630
023940234	LO-BENTOMAT SDN	200822LO	00000754	150	14.5	2175	2610
023940234	LO-BENTOMAT SDN	200822LO	00000755	150	14.5	2175	2625
023940238	LO-BENTOMAT SDN	200822LO	00000756	150	14.5	2175	2615
023940236	LO-BENTOMAT SDN	200822LO	00000757	150	14.5	2175	2610
023940230	LO-BENTOMAT SDN	200822LO	00000758	150	14.5	2175	2615
023940238	LO-BENTOMAT SDN	200822LO	00000759	150	14.5	2175	2620
023940236	LO-BENTOMAT SDN	200822LO	00000760	150	14.5	2175	2620
023940233	LO-BENTOMAT SDN	200822LO	00000761	150	14.5	2175	2625
023940243	LO-BENTOMAT SDN	200822LO	00000762	150	14.5	2175	2615
023940243	LO-BENTOMAT SDN	200822LO	00000763	150	14.5	2175	2620
023940235	LO-BENTOMAT SDN	200822LO	00000764	150	14.5	2175	2625
023940233	LO-BENTOMAT SDN	200822LO	00000765	150	14.5	2175	2630
023940233	LO-BENTOMAT SDN	200822LO	00000766	150	14.5	2175	2615
023940243	LO-BENTOMAT SDN	200822LO	00000767	150	14.5	2175	2610
023940233	LO-BENTOMAT SDN	200822LO	00000768	150	14.5	2175	2615
023940235	LO-BENTOMAT SDN	200822LO	00000769	150	14.5	2175	2600
023940230	LO-BENTOMAT SDN	200822LO	00000770	150	14.5	2175	2605
023940233	LO-BENTOMAT SDN	200822LO	00000771	150	14.5	2175	2615
023940230	LO-BENTOMAT SDN	200822LO	00000772	150	14.5	2175	2610
023940233	LO-BENTOMAT SDN	200822LO	00000773	150	14.5	2175	2605
023940245	LO-BENTOMAT SDN	200822LO	00000774	150	14.5	2175	2610
023940233	LO-BENTOMAT SDN	200822LO	00000775	150	14.5	2175	2615
023940245	LO-BENTOMAT SDN	200822LO	00000776	150	14.5	2175	2600
023940235	LO-BENTOMAT SDN	200822LO	00000777	150	14.5	2175	2620
023940239	LO-BENTOMAT SDN	200822LO	00000778	150	14.5	2175	2615
023940233	LO-BENTOMAT SDN	200822LO	00000780	150	14.5	2175	2610
023940236	LO-BENTOMAT SDN	200822LO	00000781	150	14.5	2175	2615
023940238	LO-BENTOMAT SDN	200822LO	00000782	150	14.5	2175	2600

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940234	LO-BENTOMAT SDN	200822LO	00000783	150	14.5	2175	2590
023940230	LO-BENTOMAT SDN	200822LO	00000784	150	14.5	2175	2620
023940230	LO-BENTOMAT SDN	200822LO	00000785	150	14.5	2175	2610
023940238	LO-BENTOMAT SDN	200822LO	00000786	150	14.5	2175	2615
023940238	LO-BENTOMAT SDN	200822LO	00000787	150	14.5	2175	2620
023940236	LO-BENTOMAT SDN	200822LO	00000788	150	14.5	2175	2610
023940238	LO-BENTOMAT SDN	200822LO	00000789	150	14.5	2175	2615
023940239	LO-BENTOMAT SDN	200822LO	00000790	150	14.5	2175	2600
023940236	LO-BENTOMAT SDN	200822LO	00000791	150	14.5	2175	2620
023940236	LO-BENTOMAT SDN	200822LO	00000792	150	14.5	2175	2625
023940245	LO-BENTOMAT SDN	200822LO	00000793	150	14.5	2175	2630
023940234	LO-BENTOMAT SDN	200822LO	00000794	150	14.5	2175	2635
023940234	LO-BENTOMAT SDN	200822LO	00000795	150	14.5	2175	2630
023940230	LO-BENTOMAT SDN	200822LO	00000796	150	14.5	2175	2620
023940240	LO-BENTOMAT SDN	200822LO	00000797	150	14.5	2175	2625
023940238	LO-BENTOMAT SDN	200822LO	00000799	150	14.5	2175	2620
023940236	LO-BENTOMAT SDN	200822LO	00000800	150	14.5	2175	2610
023940236	LO-BENTOMAT SDN	200822LO	00000802	150	14.5	2175	2630
023940230	LO-BENTOMAT SDN	200822LO	00000803	150	14.5	2175	2675
023940238	LO-BENTOMAT SDN	200822LO	00000804	150	14.5	2175	2640
023940238	LO-BENTOMAT SDN	200822LO	00000805	150	14.5	2175	2655
023940238	LO-BENTOMAT SDN	200822LO	00000806	150	14.5	2175	2640
023940234	LO-BENTOMAT SDN	200822LO	00000807	150	14.5	2175	2675
023940234	LO-BENTOMAT SDN	200822LO	00000808	150	14.5	2175	2640
023940245	LO-BENTOMAT SDN	200822LO	00000809	150	14.5	2175	2655
023940236	LO-BENTOMAT SDN	200822LO	00000810	150	14.5	2175	2690
023940230	LO-BENTOMAT SDN	200822LO	00000811	150	14.5	2175	2630
023940236	LO-BENTOMAT SDN	200822LO	00000812	150	14.5	2175	2660
023940238	LO-BENTOMAT SDN	200822LO	00000813	150	14.5	2175	2670
023940236	LO-BENTOMAT SDN	200822LO	00000814	150	14.5	2175	2670
023940234	LO-BENTOMAT SDN	200822LO	00000815	150	14.5	2175	2645
023940238	LO-BENTOMAT SDN	200822LO	00000816	150	14.5	2175	2635

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940234	LO-BENTOMAT SDN	200822LO	00000817	150	14.5	2175	2640
023940234	LO-BENTOMAT SDN	200822LO	00000818	150	14.5	2175	2670
023940239	LO-BENTOMAT SDN	200822LO	00000819	150	14.5	2175	2655
023940234	LO-BENTOMAT SDN	200822LO	00000820	150	14.5	2175	2680
023940234	LO-BENTOMAT SDN	200822LO	00000821	150	14.5	2175	2645
023940234	LO-BENTOMAT SDN	200822LO	00000822	150	14.5	2175	2680
023940234	LO-BENTOMAT SDN	200822LO	00000823	150	14.5	2175	2645
023940234	LO-BENTOMAT SDN	200822LO	00000824	150	14.5	2175	2670
023940238	LO-BENTOMAT SDN	200822LO	00000825	150	14.5	2175	2645
023940238	LO-BENTOMAT SDN	200822LO	00000826	150	14.5	2175	2670
023940236	LO-BENTOMAT SDN	200822LO	00000827	150	14.5	2175	2645
023940240	LO-BENTOMAT SDN	200822LO	00000828	150	14.5	2175	2695
023940236	LO-BENTOMAT SDN	200822LO	00000829	150	14.5	2175	2680
023940238	LO-BENTOMAT SDN	200822LO	00000830	150	14.5	2175	2620
023940245	LO-BENTOMAT SDN	200822LO	00000831	150	14.5	2175	2650
023940238	LO-BENTOMAT SDN	200822LO	00000832	150	14.5	2175	2670
			Totals:	**107250**	**10185.5**	**1527825**	**1832519**
						Total Number of Rolls Certified: **715**	

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200820LO	00000001	00000001	2009462583			2009032535	042608C
200820LO	00000002	00000001	2009462583			2009032535	042608C
200820LO	00000003	00000001	2009462583			2009032535	042608C
200820LO	00000004	00000001	2009462583			2009032535	042608C
200820LO	00000005	00000001	2009462583			2009032535	042608C
200820LO	00000006	00000001	2009462583			2009032535	042608C
200820LO	00000007	00000001	2009462583			2009032535	042608C
200820LO	00000008	00000001	2009462583			2009032535	042608C
200820LO	00000009	00000001	2010015538			2009032535	042608C
200820LO	00000010	00000001	2010015538			2009032535	042608C
200820LO	00000011	00000001	2010015538			2009032535	042608C
200820LO	00000013	00000001	2010015538			2009032535	042608C
200820LO	00000014	00000001	2010015538			2009032535	042608C
200820LO	00000015	00000001	2010015538			2009032535	042608C
200820LO	00000017	00000001	2010015538			2009032537	042608C
200820LO	00000018	00000001	2010015538			2009032537	042608C
200820LO	00000022	00000019	2010015429			2009032537	042608C
200820LO	00000024	00000019	2010015429			2009032537	042608C
200820LO	00000026	00000019	2010015429			2009032537	042608C
200820LO	00000027	00000019	2010082556			2009032537	042608C
200820LO	00000029	00000019	2010082556			2009032537	042608C
200820LO	00000031	00000019	2010082556			2009032537	042608D
200820LO	00000032	00000019	2010082556			2009032537	042608D
200820LO	00000033	00000019	2010082556			2009032537	042608D
200820LO	00000034	00000019	2010082556			2009032537	042608D
200820LO	00000035	00000019	2010082556			2009032530	042608D
200820LO	00000036	00000019	2010082556			2009032530	042608D
200820LO	00000037	00000037	2008676316			2009032530	042608D
200820LO	00000039	00000037	2008676316			2009032530	042608D

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200820LO	00000041	00000037	2008676316			2009032530	042608D
200820LO	00000045	00000037	2008676316			2009032530	042608D
200820LO	00000048	00000037	2010015534			2009032530	042608D
200820LO	00000049	00000037	2010015534			2009032530	042608D
200820LO	00000052	00000037	2010015534			2009032528	042608D
200820LO	00000053	00000037	2010015534			2009032528	042608D
200820LO	00000057	00000055	2010015534			2009032528	042608D
200820LO	00000059	00000055	2009476399			2009032528	042608D
200820LO	00000060	00000055	2009476399			2009032528	042608D
200820LO	00000061	00000055	2009476399			2009032528	042608D
200820LO	00000065	00000055	2009476399			2009032528	042608D
200820LO	00000066	00000055	2010082554			2009032528	042608D
200820LO	00000067	00000055	2010082554			2009032528	042608D
200820LO	00000071	00000055	2010082554			2009032529	042608D
200820LO	00000075	00000073	2010082554			2009032529	042608E
200820LO	00000076	00000073	2010082554			2009032529	042608E
200820LO	00000077	00000073	2008673884			2009032529	042608E
200820LO	00000078	00000073	2008673884			2009032529	042608E
200820LO	00000079	00000073	2008673884			2009032529	042608E
200820LO	00000080	00000073	2008673884			2009032529	042608E
200820LO	00000082	00000073	2008673884			2009032529	042608E
200820LO	00000085	00000073	2008673884			2009032529	042608E
200820LO	00000086	00000073	2008673884			2009032527	042608E
200820LO	00000096	00000091	2010257164			2009032527	042608E
200820LO	00000097	00000091	2010257164			2009032527	042608E
200820LO	00000098	00000091	2009476416			2009032527	042608E
200820LO	00000100	00000091	2009476416			2009032527	042608E
200821LO	00000101	00000101	2009476416			2009032527	042608E
200821LO	00000102	00000101	2009476416			2009032527	042608E
200821LO	00000103	00000101	2009476416			2009032533	042608E
200821LO	00000108	00000101	2007381516			2009032533	042608E
200821LO	00000109	00000101	2007381516			2009032533	042608E
200821LO	00000110	00000101	2007381516			2009032533	042608E
200821LO	00000111	00000101	2007381516			2009032533	042608E
200821LO	00000112	00000101	2007381516			2009032533	042608E

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000113	00000101	2007381516			2009032533	042608E
200821LO	00000116	00000101	2007381516			2009032533	042708A
200821LO	00000117	00000101	2009462584			2009032533	042708A
200821LO	00000118	00000101	2009462584			2009032533	042708A
200821LO	00000119	00000119	2009462584			2009032532	042708A
200821LO	00000122	00000119	2009462584			2009032532	042708A
200821LO	00000123	00000119	2009462584			2009032532	042708A
200821LO	00000126	00000119	2009462584			2009032532	042708A
200821LO	00000127	00000119	2009476392			2009032532	042708A
200821LO	00000135	00000119	2009476392			2009032532	042708A
200821LO	00000139	00000137	2008673922			2009032520	042708A
200821LO	00000140	00000137	2008673922			2009032520	042708A
200821LO	00000142	00000137	2008673922			2009032520	042708A
200821LO	00000144	00000137	2008673922			2009032520	042708A
200821LO	00000145	00000137	2008673922			2009032520	042708A
200821LO	00000147	00000137	2008673888			2009032520	042708A
200821LO	00000150	00000137	2008673888			2009032520	042708A
200821LO	00000155	00000155	2008673888			2009032525	042708A
200821LO	00000156	00000155	2008673888			2009032525	042708A
200821LO	00000158	00000155	2010082557			2009032525	042708A
200821LO	00000160	00000155	2010082557			2009032525	042708A
200821LO	00000161	00000155	2010082557			2009032525	042908A
200821LO	00000162	00000155	2010082557			2009032525	042908A
200821LO	00000163	00000155	2010082557			2009032525	042908A
200821LO	00000166	00000155	2010082557			2009032525	042908A
200821LO	00000167	00000155	2010082557			2009032525	042908A
200821LO	00000173	00000173	2009476414			2009032536	042908A
200821LO	00000174	00000173	2009476414			2009032536	042908A
200821LO	00000175	00000173	2009476414			2009032536	042908A
200821LO	00000176	00000173	2009476414			2009032536	042908A
200821LO	00000177	00000173	2009462601			2009032536	042908A
200821LO	00000178	00000173	2009462601			2009032536	042908A
200821LO	00000179	00000173	2009462601			2009032536	042908A
200821LO	00000180	00000173	2009462601			2009032536	042908A
200821LO	00000181	00000173	2009462601			2009032536	042908A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000182	00000173	2009462601			2009032536	042908A
200821LO	00000183	00000173	2009462601			2009032536	042908A
200821LO	00000184	00000173	2009462601			2009032536	042908A
200821LO	00000185	00000173	2009462601			2009032536	042908A
200821LO	00000186	00000173	2009476388			2009032536	042908A
200821LO	00000188	00000173	2009476388			2009032536	042908A
200821LO	00000190	00000173	2009476388			2009032521	042908A
200821LO	00000191	00000191	2009476388			2009032521	042908A
200821LO	00000192	00000191	2009476388			2009032521	042908A
200821LO	00000193	00000191	2009476388			2009032521	042908A
200821LO	00000194	00000191	2009476388			2009032521	042908A
200821LO	00000195	00000191	2009476388			2009032521	042908A
200821LO	00000196	00000191	2009476388			2009032521	042908A
200821LO	00000197	00000191	2008673734			2009032521	042908A
200821LO	00000198	00000191	2008673734			2009032521	042908A
200821LO	00000199	00000191	2008673734			2009032521	042908A
200821LO	00000200	00000191	2008673734			2009032521	042908A
200821LO	00000201	00000191	2008673734			2009032521	042908A
200821LO	00000202	00000191	2008673734			2009032521	042908A
200821LO	00000203	00000191	2008673734			2009032521	042908A
200821LO	00000204	00000191	2008673734			2009032521	042908A
200821LO	00000205	00000191	2008673734			2009032521	042908A
200821LO	00000206	00000191	2008673332			2009028215	043008A
200821LO	00000207	00000191	2008673332			2009028215	043008A
200821LO	00000208	00000191	2008673332			2009028215	043008A
200821LO	00000209	00000209	2008673332			2009028215	043008A
200821LO	00000210	00000209	2008673332			2009028215	043008A
200821LO	00000211	00000209	2008673332			2009028215	043008A
200821LO	00000212	00000209	2008673332			2009028215	043008A
200821LO	00000213	00000209	2008673332			2009028215	043008A
200821LO	00000214	00000209	2008673332			2009028215	043008A
200821LO	00000215	00000209	2007381469			2009028215	043008A
200821LO	00000216	00000209	2007381469			2009028215	043008A
200821LO	00000217	00000209	2007381469			2009028215	043008A
200821LO	00000218	00000209	2007381469			2009028215	043008A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000219	00000209	2007381469			2009028215	043008A
200821LO	00000220	00000209	2007381469			2009028215	043008A
200821LO	00000221	00000209	2007381469			2009028215	043008A
200821LO	00000222	00000209	2007381469			2009028215	043008A
200821LO	00000223	00000209	2007381469			2009032524	043008A
200821LO	00000224	00000209	2007381469			2009032524	043008A
200821LO	00000225	00000209	2007381469			2009032524	043008A
200821LO	00000226	00000209	2009476391			2009032524	043008A
200821LO	00000227	00000227	2009476391			2009032524	043008A
200821LO	00000228	00000227	2009476391			2009032524	043008A
200821LO	00000229	00000227	2009476391			2009032524	043008A
200821LO	00000230	00000227	2009476391			2009032524	043008A
200821LO	00000231	00000227	2009476391			2009032524	043008A
200821LO	00000232	00000227	2009476391			2009032524	043008A
200821LO	00000233	00000227	2009476391			2009032524	043008A
200821LO	00000234	00000227	2009476391			2009032524	043008A
200821LO	00000235	00000227	2009476165			2009032524	043008A
200821LO	00000236	00000227	2009476165			2009032524	043008A
200821LO	00000237	00000227	2009476165			2009032524	043008A
200821LO	00000238	00000227	2009476165			2009032524	043008A
200821LO	00000239	00000227	2009476165			2009032524	043008A
200821LO	00000240	00000227	2009476165			2009032531	043008A
200821LO	00000241	00000227	2009476165			2009032531	043008A
200821LO	00000242	00000227	2009476165			2009032531	043008A
200821LO	00000243	00000227	2009476165			2009032531	043008A
200821LO	00000244	00000227	2009476165			2009032531	043008A
200821LO	00000245	00000245	2009476165			2009032531	043008A
200821LO	00000246	00000245	2008411170			2009032531	043008A
200821LO	00000247	00000245	2008411170			2009032531	043008A
200821LO	00000248	00000245	2008411170			2009032531	043008A
200821LO	00000249	00000245	2008411170			2009032531	043008A
200821LO	00000250	00000245	2008411170			2009032531	043008A
200821LO	00000251	00000251	2008411170			2009032531	043008B
200821LO	00000252	00000251	2008411170			2009032531	043008B
200821LO	00000253	00000251	2008411170			2009032531	043008B

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000254	00000251	2008673731			2009032531	043008B
200821LO	00000255	00000251	2008673731			2009032523	043008B
200821LO	00000256	00000251	2008673731			2009032523	043008B
200821LO	00000257	00000251	2008673731			2009032523	043008B
200821LO	00000258	00000251	2008673731			2009032523	043008B
200821LO	00000259	00000251	2008673731			2009032523	043008B
200821LO	00000260	00000251	2008673731			2009032523	043008B
200821LO	00000261	00000251	2008673731			2009032523	043008B
200821LO	00000262	00000251	2008673731			2009032523	043008B
200821LO	00000263	00000251	2008673331			2009032523	043008B
200821LO	00000264	00000251	2008673331			2009032523	043008B
200821LO	00000265	00000251	2008673331			2009032523	043008B
200821LO	00000266	00000251	2008673331			2009032523	043008B
200821LO	00000267	00000251	2008673331			2009032523	043008B
200821LO	00000268	00000251	2008673331			2009032523	043008B
200821LO	00000269	00000269	2008673331			2009032523	043008B
200821LO	00000270	00000269	2008673331			2009032523	043008B
200821LO	00000271	00000269	2008673331			2009032523	043008B
200821LO	00000272	00000269	2008673331			2009032523	043008B
200821LO	00000273	00000269	2008673331			2010342838	043008B
200821LO	00000274	00000269	2009476401			2010342838	043008B
200821LO	00000275	00000269	2009476401			2010342838	043008B
200821LO	00000276	00000269	2009476401			2010342838	043008B
200821LO	00000277	00000269	2009476401			2010342838	043008B
200821LO	00000278	00000269	2009476401			2010342838	043008B
200821LO	00000279	00000269	2009476401			2010342838	043008B
200821LO	00000280	00000269	2009476401			2010342838	043008B
200821LO	00000281	00000269	2009476401			2010342838	043008B
200821LO	00000282	00000269	2009476401			2010342838	043008B
200821LO	00000283	00000269	2008673925			2010342838	043008B
200821LO	00000284	00000269	2008673925			2010342838	043008B
200821LO	00000285	00000269	2008673925			2010342838	043008B
200821LO	00000286	00000269	2008673925			2010342838	043008B
200821LO	00000287	00000287	2008673925			2010342884	043008B
200821LO	00000288	00000287	2008673925			2010342884	043008B

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000289	00000287	2008673925			2010342884	043008B
200821LO	00000290	00000287	2008673925			2010342884	043008B
200821LO	00000291	00000287	2008673925			2010342884	043008B
200821LO	00000292	00000287	2008673925			2010342884	043008B
200821LO	00000293	00000287	2008673925			2010342884	043008B
200821LO	00000294	00000287	2009476406			2010342884	043008B
200821LO	00000295	00000287	2009476406			2010342884	043008B
200821LO	00000296	00000287	2009476406			2010342884	043008B
200821LO	00000297	00000287	2009476406			2010342884	043008C
200821LO	00000298	00000287	2009476406			2010342884	043008C
200821LO	00000299	00000287	2009476406			2010342884	043008C
200821LO	00000300	00000287	2009476406			2010342884	043008C
200821LO	00000301	00000287	2009476406			2010342884	043008C
200821LO	00000302	00000287	2009476406			2010342884	043008C
200821LO	00000303	00000287	2007381475			2010342880	043008C
200821LO	00000304	00000287	2007381475			2010342880	043008C
200821LO	00000305	00000305	2007381475			2010342880	043008C
200821LO	00000306	00000305	2007381475			2010342880	043008C
200821LO	00000307	00000305	2007381475			2010342880	043008C
200821LO	00000308	00000305	2007381475			2010342880	043008C
200821LO	00000309	00000305	2007381475			2010342880	043008C
200821LO	00000310	00000305	2007381475			2010342880	043008C
200821LO	00000311	00000305	2008673913			2010342880	043008C
200821LO	00000312	00000305	2008673913			2010342880	043008C
200821LO	00000313	00000305	2008673913			2010342880	043008C
200821LO	00000314	00000305	2008673913			2010342880	043008C
200821LO	00000315	00000305	2008673913			2010342880	043008C
200821LO	00000316	00000305	2008673913			2010342880	043008C
200821LO	00000317	00000305	2008673913			2010342880	043008C
200821LO	00000318	00000305	2008673913			2010342880	043008C
200821LO	00000319	00000305	2008673913			2010342832	043008C
200821LO	00000320	00000305	2008673913			2010342832	043008C
200821LO	00000321	00000305	2008544951			2010342832	043008C
200821LO	00000322	00000305	2008544951			2010342832	043008C
200821LO	00000323	00000323	2008544951			2010342832	043008C

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000324	00000323	2008544951			2010342832	043008C
200821LO	00000325	00000323	2008544951			2010342832	043008C
200821LO	00000326	00000323	2008544951			2010342832	043008C
200821LO	00000327	00000323	2008544951			2010342832	043008C
200821LO	00000328	00000323	2008544951			2010342832	043008C
200821LO	00000329	00000323	2008544951			2010342832	043008C
200821LO	00000330	00000323	2008544951			2010342832	043008C
200821LO	00000331	00000323	2008544951			2010342832	043008C
200821LO	00000332	00000323	2008673915			2010342830	043008C
200821LO	00000333	00000323	2008673915			2010342830	043008C
200821LO	00000334	00000323	2008673915			2010342830	043008C
200821LO	00000335	00000323	2008673915			2010342830	043008C
200821LO	00000336	00000323	2008673915			2010342830	043008C
200821LO	00000337	00000323	2008673915			2010342830	043008C
200821LO	00000338	00000323	2008673915			2010342830	043008C
200821LO	00000339	00000323	2008673915			2010342830	043008C
200821LO	00000340	00000323	2008673915			2010342830	043008C
200821LO	00000341	00000341	2008673915			2010342830	043008D
200821LO	00000342	00000341	2008544921			2010342830	043008D
200821LO	00000343	00000341	2008544921			2010342830	043008D
200821LO	00000344	00000341	2008544921			2010342830	043008D
200821LO	00000345	00000341	2008544921			2010342830	043008D
200821LO	00000346	00000341	2008544921			2010342830	043008D
200821LO	00000347	00000341	2008544921			2010342830	043008D
200821LO	00000348	00000341	2008544921			2010342830	043008D
200821LO	00000349	00000341	2008544921			2010342830	043008D
200821LO	00000350	00000341	2008544921			2010342833	043008D
200821LO	00000351	00000341	2008408214			2010342833	043008D
200821LO	00000352	00000341	2008408214			2010342833	043008D
200821LO	00000353	00000341	2008408214			2010342833	043008D
200821LO	00000354	00000341	2008408214			2010342833	043008D
200821LO	00000355	00000341	2008408214			2010342833	043008D
200821LO	00000356	00000341	2008408214			2010342833	043008D
200821LO	00000357	00000341	2008408214			2010342833	043008D
200821LO	00000358	00000341	2008408214			2010342833	043008D

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000359	00000359	2009462582			2010342833	043008D
200821LO	00000360	00000359	2009462582			2010342833	043008D
200821LO	00000361	00000359	2009462582			2010342833	043008D
200821LO	00000362	00000359	2009462582			2010342833	043008D
200821LO	00000363	00000359	2009462582			2010342833	043008D
200821LO	00000364	00000359	2009462582			2010342833	043008D
200821LO	00000365	00000359	2009462582			2010342833	043008D
200821LO	00000366	00000359	2009462582			2010342833	043008D
200821LO	00000367	00000359	2009462582			2010342827	043008D
200821LO	00000368	00000359	2008408202			2010342827	043008D
200821LO	00000369	00000359	2008408202			2010342827	043008D
200821LO	00000370	00000359	2008408202			2010342827	043008D
200821LO	00000371	00000359	2008408202			2010342827	043008D
200821LO	00000372	00000359	2008408202			2010342827	043008D
200821LO	00000373	00000359	2008408202			2010342827	043008D
200821LO	00000374	00000359	2008408202			2010342827	043008D
200821LO	00000375	00000359	2008408202			2010342827	043008D
200821LO	00000376	00000359	2008443528			2010342827	043008D
200821LO	00000377	00000377	2008443528			2010342827	043008D
200821LO	00000378	00000377	2008443528			2010342827	043008D
200821LO	00000379	00000377	2008443528			2010342827	043008D
200821LO	00000380	00000377	2008443528			2010342827	043008D
200821LO	00000381	00000377	2008443528			2010342827	043008D
200821LO	00000382	00000377	2008443528			2010342827	043008D
200821LO	00000385	00000385	2008443528			2010342849	050108C
200821LO	00000386	00000385	2008443528			2010342849	050108C
200821LO	00000387	00000385	2010231215			2010342849	050108C
200821LO	00000388	00000385	2010231215			2010342849	050108C
200821LO	00000389	00000385	2010231215			2010342849	050108C
200821LO	00000390	00000385	2010231215			2010342849	050108C
200821LO	00000391	00000385	2010231215			2010342849	050108C
200821LO	00000392	00000385	2010231215			2010342849	050108C
200821LO	00000393	00000385	2010231215			2010342849	050108C
200821LO	00000394	00000385	2010231215			2010342849	050108C
200821LO	00000395	00000385	2010231215			2010342849	050108C

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000396	00000385	2010231214			2010342849	050108C
200821LO	00000397	00000385	2010231214			2010342849	050108C
200821LO	00000398	00000385	2010231214			2010342849	050108C
200821LO	00000399	00000385	2010231214			2010342849	050108C
200821LO	00000400	00000385	2010231214			2010342847	050108C
200821LO	00000401	00000385	2010231214			2010342847	050108C
200821LO	00000402	00000385	2010231214			2010342847	050108C
200821LO	00000403	00000403	2010231214			2010342847	050108C
200821LO	00000404	00000403	2010231214			2010342847	050108C
200821LO	00000405	00000403	2010231222			2010342847	050108C
200821LO	00000406	00000403	2010231222			2010342847	050108C
200821LO	00000407	00000403	2010231222			2010342847	050108C
200821LO	00000408	00000403	2010231222			2010342847	050108C
200821LO	00000409	00000403	2010231222			2010342847	050108C
200821LO	00000410	00000403	2010231222			2010342847	050108C
200821LO	00000411	00000403	2010231222			2010342847	050108C
200821LO	00000412	00000403	2010231222			2010342847	050108C
200821LO	00000413	00000403	2010231222			2010342847	050108C
200821LO	00000414	00000403	2010231222			2010342847	050108C
200821LO	00000415	00000403	2010231210			2010342847	050108C
200821LO	00000416	00000403	2010231210			2010342845	050108C
200821LO	00000417	00000403	2010231210			2010342845	050108C
200821LO	00000418	00000403	2010231210			2010342845	050108C
200821LO	00000419	00000403	2010231210			2010342845	050108C
200821LO	00000420	00000403	2010231210			2010342845	050108C
200821LO	00000421	00000421	2010231210			2010342845	050108C
200821LO	00000422	00000421	2010231210			2010342845	050108C
200821LO	00000423	00000421	2010231210			2010342845	050108C
200821LO	00000424	00000421	2010231210			2010342845	050108C
200821LO	00000425	00000421	2010231210			2010342845	050108C
200821LO	00000426	00000421	2010231235			2010342845	050108D
200821LO	00000427	00000421	2010231235			2010342845	050108D
200821LO	00000428	00000421	2010231235			2010342845	050108D
200821LO	00000429	00000421	2010231235			2010342845	050108D
200821LO	00000430	00000421	2010231235			2010342845	050108D

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000431	00000421	2010231235			2010342845	050108D
200821LO	00000432	00000421	2010231235			2010342848	050108D
200821LO	00000433	00000421	2010231208			2010342848	050108D
200821LO	00000434	00000421	2010231208			2010342848	050108D
200821LO	00000435	00000421	2010231208			2010342848	050108D
200821LO	00000436	00000421	2010231208			2010342848	050108D
200821LO	00000437	00000421	2010231208			2010342848	050108D
200821LO	00000438	00000421	2010231208			2010342848	050108D
200821LO	00000439	00000439	2010231208			2010342848	050108D
200821LO	00000440	00000439	2010231208			2010342848	050108D
200821LO	00000441	00000439	2010231208			2010342848	050108D
200821LO	00000442	00000439	2010231208			2010342848	050108D
200821LO	00000443	00000439	2010231208			2010342848	050108D
200821LO	00000444	00000439	2010257138			2010342848	050108D
200821LO	00000445	00000439	2010257138			2010342848	050108D
200821LO	00000446	00000439	2010257138			2010342848	050108D
200821LO	00000447	00000439	2010257138			2010342848	050108D
200821LO	00000448	00000439	2010257138			2010342848	050108D
200821LO	00000449	00000439	2010257138			2010342843	050108D
200821LO	00000450	00000439	2010257138			2010342843	050108D
200821LO	00000451	00000439	2010257138			2010342843	050108D
200821LO	00000452	00000439	2010257138			2010342843	050108D
200821LO	00000453	00000439	2010231180			2010342843	050108D
200821LO	00000454	00000439	2010231180			2010342843	050108D
200821LO	00000455	00000439	2010231180			2010342843	050108D
200821LO	00000456	00000439	2010231180			2010342843	050108D
200821LO	00000457	00000457	2010231180			2010342843	050108D
200821LO	00000458	00000457	2010231180			2010342843	050108D
200821LO	00000459	00000457	2010231180			2010342843	050108D
200821LO	00000460	00000457	2010231180			2010342843	050108D
200821LO	00000461	00000457	2010231180			2010342843	050108D
200821LO	00000462	00000457	2010231200			2010342843	050108D
200821LO	00000463	00000457	2010231200			2010342843	050108D
200821LO	00000464	00000457	2010231200			2010342843	050108D
200821LO	00000465	00000457	2010231200			2010342843	050208A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000467	00000467	200819CV	00001813	00001810	2010431246	051008A
200822LO	00000468	00000467	200819CV	00001813	00001810	2010431246	051008A
200822LO	00000470	00000467	200819CV	00001813	00001810	2010431246	051008A
200822LO	00000471	00000467	200819CV	00001813	00001810	2010431246	051008A
200822LO	00000472	00000467	2010231181			2010431246	051008A
200822LO	00000473	00000467	2010231181			2010431246	051008A
200822LO	00000474	00000467	2010231181			2010431246	051008A
200822LO	00000481	00000467	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000484	00000467	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000485	00000485	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000487	00000485	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000489	00000485	2010231159			2010431247	051008A
200822LO	00000494	00000485	2010231159			2010162646	051008A
200822LO	00000496	00000485	2010231159			2010162646	051008A
200822LO	00000497	00000485	2010015423			2010162646	051008A
200822LO	00000498	00000485	2010015423			2010162646	051008A
200822LO	00000500	00000485	2010015423			2010162646	051008A
200822LO	00000502	00000485	2010015423			2010162646	051008A
200822LO	00000503	00000503	2010015423			2010162646	051008A
200822LO	00000504	00000503	2010015423			2010162646	051008A
200822LO	00000505	00000503	2010231137			2010162646	051008A
200822LO	00000506	00000503	2010231137			2010162646	051008A
200822LO	00000507	00000503	2010231137			2010162646	051008A
200822LO	00000508	00000503	2010231137			2010431237	051008A
200822LO	00000509	00000503	2010231137			2010431237	051008A
200822LO	00000510	00000503	2010231137			2010431237	051008B
200822LO	00000511	00000503	2010231137			2010431237	051008B
200822LO	00000512	00000503	2010231137			2010431237	051008B
200822LO	00000513	00000503	2010231139			2010431237	051008B
200822LO	00000514	00000503	2010231139			2010431237	051008B
200822LO	00000515	00000503	2010231139			2010431237	051008B
200822LO	00000516	00000503	2010231139			2010431237	051008B
200822LO	00000517	00000503	2010231139			2010431237	051008B
200822LO	00000518	00000503	2010231139			2010431237	051008B
200822LO	00000520	00000503	2010231139			2010431237	051008B

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000522	00000521	2010015461			2010431139	051008B
200822LO	00000523	00000521	2010015461			2010431139	051008B
200822LO	00000524	00000521	2010015461			2010431139	051008B
200822LO	00000525	00000521	2010015461			2010431139	051008B
200822LO	00000526	00000521	2010015461			2010431139	051008B
200822LO	00000527	00000521	2010015461			2010431139	051008B
200822LO	00000528	00000521	2010015461			2010431139	051008B
200822LO	00000529	00000521	2010015461			2010431139	051008B
200822LO	00000530	00000521	2010015461			2010431241	051008B
200822LO	00000531	00000521	2010231163			2010431241	051008B
200822LO	00000532	00000521	2010231163			2010431241	051008B
200822LO	00000533	00000521	2010231163			2010431241	051008B
200822LO	00000534	00000521	2010231163			2010431241	051008B
200822LO	00000535	00000521	2010231163			2010431241	051008B
200822LO	00000536	00000521	2010231163			2010431241	051008B
200822LO	00000537	00000521	2010231163			2010431241	051008B
200822LO	00000538	00000521	2010231163			2010431241	051008B
200822LO	00000539	00000539	2010231162			2010431241	051008B
200822LO	00000540	00000539	2010231162			2010431241	051008B
200822LO	00000541	00000539	2010231162			2010431241	051008B
200822LO	00000542	00000539	2010231162			2010431241	051008B
200822LO	00000543	00000539	2010231162			2010431241	051008B
200822LO	00000544	00000539	2010231162			2010431241	051008B
200822LO	00000545	00000539	2010231162			2010438009	051008B
200822LO	00000546	00000539	2010231162			2020438009	051008B
200822LO	00000547	00000539	2010231162			2020438009	051008B
200822LO	00000548	00000539	2010231162			2020438009	051008B
200822LO	00000549	00000539	2010231162			2020438009	051008B
200822LO	00000550	00000539	2010231162			2020438009	051008B
200822LO	00000551	00000539	2010080866			2020438009	051008B
200822LO	00000552	00000539	2010080866			2020438009	051008B
200822LO	00000553	00000539	2010080866			2020438009	051008B
200822LO	00000554	00000539	2010080866			2020438009	051008B
200822LO	00000555	00000539	2010080866			2020438009	051008B
200822LO	00000556	00000539	2010080866			2020438009	051208A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000557	00000557	2010080866			2020438009	051208A
200822LO	00000558	00000557	2010080866			2020438009	051208A
200822LO	00000559	00000557	2010231183			2020438009	051208A
200822LO	00000560	00000557	2010231183			2020438009	051208A
200822LO	00000561	00000557	2010231183			2020438009	051208A
200822LO	00000562	00000557	2010231183			2020438009	051208A
200822LO	00000563	00000557	2010231183			2010437128	051208A
200822LO	00000564	00000557	2010231183			2010437128	051208A
200822LO	00000565	00000557	2010231183			2010437128	051208A
200822LO	00000566	00000557	2010231183			2010437128	051208A
200822LO	00000567	00000557	2010231183			2010437128	051208A
200822LO	00000568	00000557	2010015465			2010437128	051208A
200822LO	00000569	00000557	2010015465			2010437128	051208A
200822LO	00000570	00000557	2010015465			2010437128	051208A
200822LO	00000571	00000557	2010015465			2010437128	051208A
200822LO	00000572	00000557	2010015465			2010437128	051208A
200822LO	00000573	00000557	2010015465			2010437128	051208A
200822LO	00000575	00000575	2010015465			2010437128	051208A
200822LO	00000576	00000575	2010231145			2010162650	051208A
200822LO	00000577	00000575	2010231145			2010162650	051208A
200822LO	00000578	00000575	2010231145			2010162650	051208A
200822LO	00000579	00000575	2010231145			2010162650	051208A
200822LO	00000580	00000575	2010231145			2010162650	051208A
200822LO	00000581	00000575	2010231145			2010162650	051208A
200822LO	00000582	00000575	2010231145			2010162650	051208A
200822LO	00000583	00000575	2010231145			2010162650	051208A
200822LO	00000584	00000575	2010231145			2010162650	051208A
200822LO	00000585	00000575	2010231145			2010162650	051208A
200822LO	00000586	00000575	2010231145			2010162650	051208A
200822LO	00000587	00000575	2010231238			2010162650	051208A
200822LO	00000588	00000575	2010231238			2010162650	051208A
200822LO	00000589	00000575	2010231238			2010162650	051208A
200822LO	00000591	00000575	2010231238			2010162650	051208B
200822LO	00000592	00000575	2010231238			2010162650	051208B
200822LO	00000593	00000593	2010231238			2010162650	051208B

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000594	00000593	2010231238			2010431240	051208B
200822LO	00000595	00000593	2010231238			2010431240	051208B
200822LO	00000596	00000593	2010231238			2010431240	051208B
200822LO	00000597	00000593	2010231142			2010431240	051208B
200822LO	00000598	00000593	2010231142			2010431240	051208B
200822LO	00000599	00000593	2010231142			2010431240	051208B
200822LO	00000600	00000593	2010231142			2010431240	051208B
200822LO	00000601	00000593	2010231142			2010431240	051208B
200822LO	00000602	00000593	2010231142			2010431240	051208B
200822LO	00000603	00000593	2010231142			2010431240	051208B
200822LO	00000604	00000593	2010231142			2010431240	051208B
200822LO	00000605	00000593	2010231142			2010431240	051208B
200822LO	00000606	00000593	2010231140			2010431240	051208B
200822LO	00000607	00000593	2010231140			2010431240	051208B
200822LO	00000608	00000593	2010231140			2010431240	051208B
200822LO	00000609	00000593	2010231140			2010431240	051208B
200822LO	00000610	00000593	2010231140			2010431240	051208B
200822LO	00000611	00000611	2010231140			2010431240	051208B
200822LO	00000612	00000611	2010231140			2010438013	051208B
200822LO	00000613	00000611	2010231140			2010438013	051208B
200822LO	00000614	00000611	2010231144			2010438013	051208B
200822LO	00000615	00000611	2010231144			2010438013	051208B
200822LO	00000616	00000611	2010231144			2010438013	051208B
200822LO	00000617	00000611	2010231144			2010438013	051208B
200822LO	00000618	00000611	2010231144			2010438013	051208B
200822LO	00000619	00000611	2010231144			2010438013	051208B
200822LO	00000620	00000611	2010231144			2010438013	051208B
200822LO	00000621	00000611	2010231144			2010438013	051208B
200822LO	00000622	00000611	2010231144			2010438013	051208B
200822LO	00000623	00000611	2010231144			2010438013	051208B
200822LO	00000624	00000611	2010231138			2010438013	051208B
200822LO	00000625	00000611	2010231138			2010438013	051208B
200822LO	00000626	00000611	2010231138			2010438013	051208B
200822LO	00000627	00000611	2010231138			2010438013	051208B
200822LO	00000628	00000611	2010231138			2010437150	051208B

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000629	00000629	2010231138			2010437150	051208B
200822LO	00000630	00000629	2010231182			2010437150	051208B
200822LO	00000631	00000629	2010231182			2010437150	051208B
200822LO	00000632	00000629	2010231182			2010437150	051208B
200822LO	00000633	00000629	2010231182			2010437150	051208B
200822LO	00000634	00000629	2010231182			2010437150	051208B
200822LO	00000635	00000629	2010231182			2010437150	051208C
200822LO	00000636	00000629	2010231182			2010437150	051208C
200822LO	00000637	00000629	2010231182			2010437150	051208C
200822LO	00000638	00000629	2010231182			2010437150	051208C
200822LO	00000639	00000629	2010231182			2010437150	051208C
200822LO	00000640	00000629	2010231171			2010437150	051208C
200822LO	00000641	00000629	2010231171			2010437150	051208C
200822LO	00000642	00000629	2010231171			2010437150	051208C
200822LO	00000643	00000629	2010231171			2010437150	051208C
200822LO	00000644	00000629	2010231171			2010437150	051208C
200822LO	00000645	00000629	2010231171			2010437150	051208C
200822LO	00000646	00000629	2010231171			2010437145	051208C
200822LO	00000647	00000647	2010231171			2010437145	051208C
200822LO	00000648	00000647	2010231171			2010437145	051208C
200822LO	00000649	00000647	2010231171			2010437145	051208C
200822LO	00000650	00000647	2010231141			2010437145	051208C
200822LO	00000651	00000647	2010231141			2010437145	051208C
200822LO	00000652	00000647	2010231141			2010437145	051208C
200822LO	00000653	00000647	2010231141			2010437145	051208C
200822LO	00000654	00000647	2010231141			2010437145	051208C
200822LO	00000655	00000647	2010231141			2010437145	051208C
200822LO	00000656	00000647	2010231141			2010437145	051208C
200822LO	00000657	00000647	2010231141			2010437145	051208C
200822LO	00000658	00000647	2010231141			2010437145	051208C
200822LO	00000659	00000647	2010231147			2010437145	051208C
200822LO	00000660	00000647	2010231147			2010437145	051208C
200822LO	00000661	00000647	2010231147			2010437145	051208C
200822LO	00000662	00000647	2010231147			2010437145	051208C
200822LO	00000663	00000647	2010231147			2010437145	051208C

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000664	00000647	2010231147			2010437145	051208C
200822LO	00000665	00000665	2010231147			2010437145	051208C
200822LO	00000666	00000665	2010231161			2010438010	051208C
200822LO	00000667	00000665	2010231161			2010438010	051208C
200822LO	00000669	00000665	2010231161			2010438010	051208C
200822LO	00000670	00000665	2010231161			2010438010	051208C
200822LO	00000671	00000665	2010231161			2010438010	051208C
200822LO	00000672	00000665	2010231161			2010438010	051208C
200822LO	00000673	00000665	2010231161			2010438010	051208C
200822LO	00000674	00000665	2010231161			2010438010	051208C
200822LO	00000675	00000665	2008443524			2010438010	051208C
200822LO	00000676	00000665	2008443524			2010438010	051208C
200822LO	00000677	00000665	2008443524			2010438010	051208C
200822LO	00000678	00000665	2008443524			2010431239	051308A
200822LO	00000679	00000665	2008443524			2010431239	051308A
200822LO	00000680	00000665	2008443524			2010431239	051308A
200822LO	00000681	00000665	2008443524			2010431239	051308A
200822LO	00000682	00000665	2008443524			2010461239	051308A
200822LO	00000683	00000683	2008443524			2010431239	051308A
200822LO	00000684	00000683	2010231172			2010431239	051308A
200822LO	00000685	00000683	2010231172			2010431239	051308A
200822LO	00000686	00000683	2010231172			2010431239	051308A
200822LO	00000687	00000683	2010231172			2010431239	051308A
200822LO	00000688	00000683	2010231172			2010342898	051308A
200822LO	00000689	00000683	2010231172			2010342898	051308A
200822LO	00000690	00000683	2010231172			2010342898	051308A
200822LO	00000691	00000683	2010231172			2010342898	051308A
200822LO	00000692	00000683	2010231172			2010342898	051308A
200822LO	00000693	00000683	2010231172			2010342898	051308A
200822LO	00000694	00000683	2010231172			2010342898	051308A
200822LO	00000695	00000683	2010231172			2010342898	051308A
200822LO	00000696	00000683	2010231172			2010342898	051308A
200822LO	00000697	00000683	2010231172			2010342898	051308A
200822LO	00000698	00000683	2010231172			2010342898	051308A
200822LO	00000699	00000683	2010231172			2010342898	051308A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000700	00000683	2010231172			2010342898	051308A
200822LO	00000701	00000701	2010231172			2010342898	051308A
200822LO	00000702	00000701	2008673351			2010342898	051308A
200822LO	00000703	00000701	2008673351			2010342898	051308A
200822LO	00000704	00000701	2008673351			2010342898	051308A
200822LO	00000705	00000701	2008673351			2010342898	051308A
200822LO	00000706	00000701	2008673351			2010342898	051308A
200822LO	00000707	00000701	2008673351			2010342898	051308A
200822LO	00000708	00000701	2008673351			2010342898	051308A
200822LO	00000709	00000701	2008673351			2010342828	051308A
200822LO	00000710	00000701	2008673899			2010342828	051308A
200822LO	00000711	00000701	2008673899			2010342828	051308A
200822LO	00000712	00000701	2008673899			2010342828	051308A
200822LO	00000713	00000701	2008673899			2010342828	051308A
200822LO	00000714	00000701	2008673899			2010342828	051308A
200822LO	00000715	00000701	2008673899			2010342828	051308A
200822LO	00000716	00000701	2008673899			2010342828	051308A
200822LO	00000717	00000701	2008673899			2010342828	051308A
200822LO	00000718	00000701	2008673899			2010342828	051308A
200822LO	00000719	00000719	2008673899			2010342828	051308A
200822LO	00000720	00000719	2008408217			2010342828	051308A
200822LO	00000721	00000719	2008408217			2010342828	051308A
200822LO	00000722	00000719	2008408217			2010342828	051308A
200822LO	00000723	00000719	2008408217			2010342828	051308A
200822LO	00000724	00000719	2008408217			2010431242	051308A
200822LO	00000725	00000719	2008408217			2010431242	051308A
200822LO	00000726	00000719	2008408217			2010431242	051308B
200822LO	00000727	00000719	2008408217			2010431242	051308B
200822LO	00000729	00000719	2008408217			2010431242	051308B
200822LO	00000730	00000719	2010231164			2010431242	051308B
200822LO	00000731	00000719	2010231164			2010431242	051308B
200822LO	00000733	00000719	2010231164			2010431242	051308B
200822LO	00000734	00000719	2010231164			2010431242	051308B
200822LO	00000735	00000719	2010231164			2010342844	051308B
200822LO	00000736	00000719	2010231164			2010342844	051308B

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000737	00000737	2010231164			2010342844	051308B
200822LO	00000738	00000737	2010231164			2010342844	051308B
200822LO	00000739	00000737	2010015462			2010342844	051308B
200822LO	00000740	00000737	2010015462			2010342844	051308B
200822LO	00000743	00000737	2010015462			2010342844	051308C
200822LO	00000744	00000737	2010015462			2010342844	051308C
200822LO	00000745	00000737	2010015462			2010342844	051308C
200822LO	00000746	00000737	2010015462			2010342844	051308C
200822LO	00000747	00000737	2010015462			2010342844	051308C
200822LO	00000748	00000737	2010015462			2010342844	051308C
200822LO	00000749	00000737	2010015459			2010342844	051308C
200822LO	00000750	00000737	2010015459			2010342844	051308C
200822LO	00000751	00000737	2010015459			2010342844	051308C
200822LO	00000752	00000737	2010015459			2010342844	051308C
200822LO	00000753	00000737	2010015459			2010342844	051308C
200822LO	00000754	00000737	2010015459			2010342844	051308C
200822LO	00000755	00000755	2010015459			2010342844	051308C
200822LO	00000756	00000755	2010015459			2010342844	051308C
200822LO	00000757	00000755	2010015459			2010342844	051308C
200822LO	00000758	00000755	2010015459			2010342844	051308C
200822LO	00000759	00000755	200811CV	00000905	00000902	2010342844	051308C
200822LO	00000760	00000755	200811CV	00000905	00000902	2010342887	051308C
200822LO	00000761	00000755	200811CV	00000905	00000902	2010342887	051308C
200822LO	00000762	00000755	200811CV	00000905	00000902	2010342887	051308C
200822LO	00000763	00000755	200811CV	00000905	00000902	2010342887	051308C
200822LO	00000764	00000755	200811CV	00000905	00000902	2010342887	051308C
200822LO	00000765	00000755	200818CV	00001818	00001708	2010342887	051308C
200822LO	00000766	00000755	200818CV	00001818	00001708	2010342887	051308C
200822LO	00000767	00000755	200818CV	00001818	00001708	2010342887	051308C
200822LO	00000768	00000755	200818CV	00001818	00001708	2010342887	051308C
200822LO	00000769	00000755	200818CV	00001818	00001708	2010342887	051308C
200822LO	00000770	00000755	200818CV	00001818	00001708	2010342887	051308C
200822LO	00000771	00000755	200818CV	00001818	00001708	2010342887	051308C
200822LO	00000772	00000755	200819CV	00001812	00001810	2010342887	051308C
200822LO	00000773	00000773	200819CV	00001812	00001810	2010342887	051308C

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000774	00000773	200819CV	00001812	00001810	2010342887	051308C
200822LO	00000775	00000773	200819CV	00001812	00001810	2010342841	051308C
200822LO	00000776	00000773	200819CV	00001812	00001810	2010342841	051308C
200822LO	00000777	00000773	200819CV	00001812	00001810	2010342841	051308C
200822LO	00000778	00000773	200819CV	00001812	00001810	2010342841	051308C
200822LO	00000780	00000773	200805CV	00000316	00000313	2010342841	051308C
200822LO	00000781	00000773	200805CV	00000316	00000313	2010342841	051308C
200822LO	00000782	00000773	200805CV	00000316	00000313	2010342841	051308C
200822LO	00000783	00000773	200805CV	00000316	00000313	2010342841	051308C
200822LO	00000784	00000773	200805CV	00000316	00000313	2010342841	051308C
200822LO	00000785	00000773	200805CV	00000316	00000313	2010342841	051308C
200822LO	00000786	00000773	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000787	00000773	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000788	00000773	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000789	00000773	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000790	00000773	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000791	00000791	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000792	00000791	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000793	00000791	200805CV	00000319	00000313	2010342841	051408A
200822LO	00000794	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000795	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000796	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000797	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000799	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000800	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000802	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000803	00000791	200819CV	00001816	00001810	2010353163	051408A
200822LO	00000804	00000791	200819CV	00001810	00001810	2010353163	051408A
200822LO	00000805	00000791	200819CV	00001810	00001810	2010353163	051408A
200822LO	00000806	00000791	200819CV	00001810	00001810	2010353163	051408A
200822LO	00000807	00000791	200819CV	00001810	00001810	2010353163	051408A
200822LO	00000808	00000791	200819CV	00001810	00001810	2010353163	051408A
200822LO	00000809	00000809	200819CV	00001810	00001810	2010342850	051408A
200822LO	00000810	00000809	200819CV	00001815	00001810	2010342850	051408A
200822LO	00000811	00000809	200819CV	00001815	00001810	2010342850	051408A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000812	00000809	200819CV	00001815	00001810	2010342850	051408A
200822LO	00000813	00000809	200819CV	00001815	00001810	2010342850	051408A
200822LO	00000814	00000809	200819CV	00001815	00001810	2010342850	051408A
200822LO	00000815	00000809	200819CV	00001815	00001810	2010342850	051408A
200822LO	00000816	00000809	200819CV	00001815	00001810	2010342850	051408A
200822LO	00000817	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000818	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000819	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000820	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000821	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000822	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000823	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000824	00000809	200819CV	00001809	00001800	2010342850	051408A
200822LO	00000825	00000809	200813CV	00001128	00001124	2010342881	051408A
200822LO	00000826	00000809	200813CV	00001128	00001124	2010342881	051408A
200822LO	00000827	00000827	200813CV	00001128	00001124	2010342881	051408A
200822LO	00000828	00000827	200813CV	00001128	00001124	2010342881	051408A
200822LO	00000829	00000827	200813CV	00001128	00001124	2010342881	051408A
200822LO	00000830	00000827	200813CV	00001128	00001124	2010342881	051408A
200822LO	00000831	00000827	200813CV	00001128	00001124	2010342881	051408A
200822LO	00000832	00000827	200814CV	00001162	00001157	2010342881	051408B

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200820LO	00000001	0.88	65.5	4.2
LO-BENTOMAT SDN	200820LO	00000019	0.90	65.5	8.6
LO-BENTOMAT SDN	200820LO	00000037	0.91	65.5	13.6
LO-BENTOMAT SDN	200820LO	00000055	1.04	65.5	9.7
LO-BENTOMAT SDN	200820LO	00000073	1.02	61.5	12.8
LO-BENTOMAT SDN	200820LO	00000091	0.96	61.5	8.8
LO-BENTOMAT SDN	200821LO	00000101	0.94	54.0	11.2
LO-BENTOMAT SDN	200821LO	00000119	0.95	54.0	6.5
LO-BENTOMAT SDN	200821LO	00000137	0.94	54.0	11
LO-BENTOMAT SDN	200821LO	00000155	0.93	54.0	11.3
LO-BENTOMAT SDN	200821LO	00000173	0.95	54.0	6.5
LO-BENTOMAT SDN	200821LO	00000191	0.93	57.9	12.1
LO-BENTOMAT SDN	200821LO	00000209	0.93	57.9	11.9
LO-BENTOMAT SDN	200821LO	00000227	0.91	57.9	8.5
LO-BENTOMAT SDN	200821LO	00000245	0.92	57.9	6.7
LO-BENTOMAT SDN	200821LO	00000251	0.97	53.5	6
LO-BENTOMAT SDN	200821LO	00000269	0.96	53.5	7.1
LO-BENTOMAT SDN	200821LO	00000287	1.00	53.5	9.7
LO-BENTOMAT SDN	200821LO	00000305	0.83	53.5	12.8
LO-BENTOMAT SDN	200821LO	00000323	0.85	53.5	10.8
LO-BENTOMAT SDN	200821LO	00000341	0.91	37.1	8.1
LO-BENTOMAT SDN	200821LO	00000359	0.88	37.1	8.6
LO-BENTOMAT SDN	200821LO	00000377	0.89	37.1	10
LO-BENTOMAT SDN	200821LO	00000385	0.90	34.1	9.5
LO-BENTOMAT SDN	200821LO	00000403	0.87	34.1	5.6
LO-BENTOMAT SDN	200821LO	00000421	0.87	34.1	7.9
LO-BENTOMAT SDN	200821LO	00000439	0.85	31.4	4.7
LO-BENTOMAT SDN	200821LO	00000457	0.87	31.4	6
LO-BENTOMAT SDN	200822LO	00000467	0.91	34.7	5.3
LO-BENTOMAT SDN	200822LO	00000485	0.85	34.7	5.9
LO-BENTOMAT SDN	200822LO	00000503	0.92	34.7	5.7

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LO-BENTOMAT SDN	200822LO	00000521	0.85	34.7	6.9
LO-BENTOMAT SDN	200822LO	00000539	0.88	42.1	5.8
LO-BENTOMAT SDN	200822LO	00000557	0.88	42.1	8.8
LO-BENTOMAT SDN	200822LO	00000575	0.94	42.1	8.1
LO-BENTOMAT SDN	200822LO	00000593	0.89	42.1	8.3
LO-BENTOMAT SDN	200822LO	00000611	0.94	42.1	9
LO-BENTOMAT SDN	200822LO	00000629	0.89	51.8	8.4
LO-BENTOMAT SDN	200822LO	00000647	0.90	51.8	9.2
LO-BENTOMAT SDN	200822LO	00000665	0.85	51.8	9.2
LO-BENTOMAT SDN	200822LO	00000683	0.86	51.8	11.2
LO-BENTOMAT SDN	200822LO	00000701	0.90	51.8	7.4
LO-BENTOMAT SDN	200822LO	00000719	0.90	37.6	7.7
LO-BENTOMAT SDN	200822LO	00000737	0.88	37.6	5.6
LO-BENTOMAT SDN	200822LO	00000755	0.91	33.4	5.4
LO-BENTOMAT SDN	200822LO	00000773	0.88	33.4	6
LO-BENTOMAT SDN	200822LO	00000791	0.85	33.4	6.8
LO-BENTOMAT SDN	200822LO	00000809	0.86	33.4	7.5
LO-BENTOMAT SDN	200822LO	00000827	0.85	33.4	6.4

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200820LO	00000001	27.5	262.2
LO-BENTOMAT SDN	200820LO	00000019	45.6	262.2
LO-BENTOMAT SDN	200820LO	00000037	64.7	262.2
LO-BENTOMAT SDN	200820LO	00000055	49.5	262.2
LO-BENTOMAT SDN	200820LO	00000073	64.3	246.0
LO-BENTOMAT SDN	200820LO	00000091	47.5	246.0
LO-BENTOMAT SDN	200821LO	00000101	55.9	216.1
LO-BENTOMAT SDN	200821LO	00000119	35.8	216.1
LO-BENTOMAT SDN	200821LO	00000137	56.5	216.1
LO-BENTOMAT SDN	200821LO	00000155	56.8	216.1
LO-BENTOMAT SDN	200821LO	00000173	37.0	216.1
LO-BENTOMAT SDN	200821LO	00000191	61.5	231.7
LO-BENTOMAT SDN	200821LO	00000209	59.2	231.7
LO-BENTOMAT SDN	200821LO	00000227	44.2	231.7
LO-BENTOMAT SDN	200821LO	00000245	34.2	231.7
LO-BENTOMAT SDN	200821LO	00000251	37.5	214.6
LO-BENTOMAT SDN	200821LO	00000269	38.0	214.2
LO-BENTOMAT SDN	200821LO	00000287	55.5	214.2
LO-BENTOMAT SDN	200821LO	00000305	65.3	214.2
LO-BENTOMAT SDN	200821LO	00000323	64.0	214.2
LO-BENTOMAT SDN	200821LO	00000341	55.8	148.4
LO-BENTOMAT SDN	200821LO	00000359	45.7	148.4
LO-BENTOMAT SDN	200821LO	00000377	57.2	148.4
LO-BENTOMAT SDN	200821LO	00000385	54.2	136.5
LO-BENTOMAT SDN	200821LO	00000403	29.6	136.5
LO-BENTOMAT SDN	200821LO	00000421	41.2	136.5
LO-BENTOMAT SDN	200821LO	00000439	30.1	125.7
LO-BENTOMAT SDN	200821LO	00000457	34.9	125.7
LO-BENTOMAT SDN	200822LO	00000467	27.0	138.8
LO-BENTOMAT SDN	200822LO	00000485	29.9	138.8
LO-BENTOMAT SDN	200822LO	00000503	30.2	138.8

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LO-BENTOMAT SDN	200822LO	00000521	37.8	138.8
LO-BENTOMAT SDN	200822LO	00000539	30.8	168.6
LO-BENTOMAT SDN	200822LO	00000557	46.3	168.6
LO-BENTOMAT SDN	200822LO	00000575	42.6	168.6
LO-BENTOMAT SDN	200822LO	00000593	42.9	168.6
LO-BENTOMAT SDN	200822LO	00000611	49.1	168.6
LO-BENTOMAT SDN	200822LO	00000629	48.6	207.2
LO-BENTOMAT SDN	200822LO	00000647	50.5	207.2
LO-BENTOMAT SDN	200822LO	00000665	48.4	207.2
LO-BENTOMAT SDN	200822LO	00000683	54.0	207.2
LO-BENTOMAT SDN	200822LO	00000701	39.3	207.2
LO-BENTOMAT SDN	200822LO	00000719	39.5	150.7
LO-BENTOMAT SDN	200822LO	00000737	29.3	150.7
LO-BENTOMAT SDN	200822LO	00000755	30.4	133.9
LO-BENTOMAT SDN	200822LO	00000773	33.7	133.9
LO-BENTOMAT SDN	200822LO	00000791	43.8	133.9
LO-BENTOMAT SDN	200822LO	00000809	41.8	133.9
LO-BENTOMAT SDN	200822LO	00000827	33.4	133.9

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
042608C	27.0	15.6
042608D	27.0	14.4
042608E	30.0	14.4
042708A	27.0	13.8
042908A	25.0	16.4
043008A	28.0	16.4
043008B	25.0	15.6
043008C	28.0	15.6
043008D	26.0	16.8
050108C	28.0	16.2
050108D	28.0	16.8
050208A	24.0	16.2
051008A	26.0	17.2
051008B	25.0	17.2
051208A	27.0	15.4
051208B	26.0	15.8
051208C	27.0	15.6
051308A	28.0	15.8
051308B	29.0	15.4
051308C	28.0	15.6
051408A	28.0	15.0
051408B	27.0	15.4

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GEOTEXTILE TEST RESULTS FOR RAW MATERIAL SUPPLIED BY A CETCO FACILITY

The GCL in certification package number 000239402 was manufactured using these geotextiles:

Material	Lot #	Roll #	Mass Area	Grab Strenth
CV-NON-WOVEN	200805CV	00000313	6.6	35.0
CV-NON-WOVEN	200811CV	00000902	6.6	31.4
CV-NON-WOVEN	200813CV	00001124	7.2	43.8
CV-NON-WOVEN	200814CV	00001157	6.7	50.1
CV-NON-WOVEN	200818CV	00001708	6.7	39.9
CV-NON-WOVEN	200819CV	00001800	6.6	42.5
CV-NON-WOVEN	200819CV	00001810	6.7	42.5
CV-NON-WOVEN	200819CV	00001820	6.7	35.3

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 311	2009028215	3.3	85.4
PPX 311	2009032520	3.3	86.9
PPX 311	2009032521	3.3	86.9
PPX 311	2009032523	3.5	86.2
PPX 311	2009032524	3.5	86.2
PPX 311	2009032525	3.8	105.0
PPX 311	2009032527	3.8	105.0
PPX 311	2009032528	3.3	92.3
PPX 311	2009032529	3.3	92.3
PPX 311	2009032530	3.3	92.3
PPX 311	2009032531	3.4	96.7
PPX 311	2009032532	3.4	96.7
PPX 311	2009032533	3.4	96.7
PPX 311	2009032535	3.8	100.7
PPX 311	2009032536	3.8	100.7
PPX 311	2009032537	3.8	100.7
PPX 311	2010162646	3.4	83.7
PPX 311	2010162650	4.0	92.7
PPX 311	2010342827	3.0	66.0
PPX 311	2010342828	3.0	66.0
PPX 311	2010342830	3.0	66.0
PPX 311	2010342832	3.0	66.0
PPX 311	2010342832	3.0	66.0
PPX 311	2010342833	3.0	66.0
PPX 311	2010342838	3.0	66.0
PPX 311	2010342841	3.7	76.6
PPX 311	2010342843	3.7	76.6
PPX 311	2010342844	3.7	76.6
PPX 311	2010342845	3.7	76.6
PPX 311	2010342847	3.7	76.6
PPX 311	2010342848	3.7	76.6
PPX 311	2010342849	3.7	76.6
PPX 311	2010342850	3.7	76.6

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PPX 311	2010342880	3.4	85.2
PPX 311	2010342881	3.4	85.2
PPX 311	2010342884	3.4	85.2
PPX 311	2010342887	3.4	85.2
PPX 311	2010342898	3.4	85.2
PPX 311	2010353163	3.6	77.7
PPX 311	2010422547	3.6	79.2
PPX 311	2010431237	3.9	96.5
PPX 311	2010431239	3.9	96.5
PPX 311	2010431240	3.9	96.5
PPX 311	2010431241	3.9	96.5
PPX 311	2010431242	3.9	96.5
PPX 311	2010431246	3.8	85.8
PPX 311	2010431247	3.8	85.8
PPX 311	2010437128	3.6	79.7
PPX 311	2010437145	3.6	70.2
PPX 311	2010437150	3.6	70.2
PPX 311	2010438009	3.7	75.8
PPX 311	2010438010	3.7	75.8
PPX 311	2010438013	3.7	75.8
PPX 311	2010438729	3.5	78.3
PPX HH65L	2010494123	7.3	152.1

CAP

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 650	2007381469	7.2	79.4
PPX 650	2007381475	7.0	89.9
PPX 650	2007381516	7.3	95.9
PPX 650	2008408202	8.0	127.0
PPX 650	2008408214	6.5	113.7
PPX 650	2008408217	6.5	113.7
PPX 650	2008411170	6.4	93.8
PPX 650	2008443524	6.7	87.3
PPX 650	2008443528	6.7	87.3
PPX 650	2008544921	6.9	66.3
PPX 650	2008544951	6.8	60.2
PPX 650	2008673331	6.7	124.6
PPX 650	2008673332	6.7	124.6
PPX 650	2008673351	7.2	101.6
PPX 650	2008673731	7.3	80.1
PPX 650	2008673734	6.6	82.4
PPX 650	2008673884	7.2	87.1
PPX 650	2008673888	7.1	113.9
PPX 650	2008673899	7.2	87.1
PPX 650	2008673913	6.9	71.3
PPX 650	2008673915	6.5	93.0
PPX 650	2008673922	6.5	79.6
PPX 650	2008673925	6.2	69.0
PPX 650	2008673936	6.9	95.7
PPX 650	2009462582	6.7	160.8

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PPX 650	2009462583	6.2	197.2
PPX 650	2009462584	6.2	197.2
PPX 650	2009462601	6.3	144.4
PPX 650	2009476165	6.4	82.4
PPX 650	2009476388	6.9	80.5
PPX 650	2009476391	7.2	111.0
PPX 650	2009476392	7.2	111.0
PPX 650	2009476399	6.5	95.8
PPX 650	2009476401	6.5	95.8
PPX 650	2009476406	6.7	125.4
PPX 650	2009476414	6.9	80.8
PPX 650	2009476416	6.9	80.8
PPX 650	2010015423	7.3	115.1
PPX 650	2010015429	7.2	113.7
PPX 650	2010015459	7.0	83.9
PPX 650	2010015461	7.0	83.9
PPX 650	2010015462	7.0	83.9
PPX 650	2010015465	6.6	87.4
PPX 650	2010015534	7.1	82.2
PPX 650	2010015538	7.5	86.1
PPX 650	2010080866	7.1	115.8
PPX 650	2010082554	8.3	178.6
PPX 650	2010082556	8.3	182.1
PPX 650	2010082557	8.3	182.1
PPX 650	2010231137	6.9	84.2
PPX 650	2010231138	6.9	84.2
PPX 650	2010231139	6.9	84.2
PPX 650	2010231140	6.9	84.2
PPX 650	2010231141	6.9	84.2
PPX 650	2010231142	7.4	83.8
PPX 650	2010231144	7.4	83.8
PPX 650	2010231145	7.4	83.8
PPX 650	2010231147	7.6	91.5
PPX 650	2010231159	7.1	93.5
PPX 650	2010231161	7.1	93.5
PPX 650	2010231162	6.9	84.8
PPX 650	2010231163	6.9	84.8
PPX 650	2010231164	6.9	84.8
PPX 650	2010231171	6.9	98.6
PPX 650	2010231172	6.9	98.6
PPX 650	2010231179	7.2	87.2
PPX 650	2010231181	7.2	87.2
PPX 650	2010231182	7.2	87.2
PPX 650	2010231183	7.0	81.3
PPX 650	2010231185	7.0	93.5
PPX 650	2010231208	6.8	85.6
PPX 650	2010231210	6.8	85.6
PPX 650	2010231214	7.0	87.1
PPX 650	2010231215	6.7	77.2
PPX 650	2010231222	6.8	91.0

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PPX 650	2010231235	6.7	80.6
PPX 650	2010231238	7.2	80.5
PPX 650	2010257138	7.7	106.2
PPX 650	2010257164	7.7	100.4

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 6/7/2008
Purchase Order: 12738-00
ORDER NUMBERS: 023940242, 023940244, 023940246, 023940248

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/6/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBERS: 023940242, 023940244, 023940246, 023940248
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

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Ship Date: 6/6/2008
Order Numbers: 023940242, 023940244, 023940246, 023940248
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940246	LO-BENTOMAT SDN	200820LO	00000030	150	13.5	2025	2590
023940246	LO-BENTOMAT SDN	200820LO	00000038	150	13.5	2025	2540
023940242	LO-BENTOMAT SDN	200820LO	00000047	150	13.5	2025	2535
023940246	LO-BENTOMAT SDN	200820LO	00000051	150	13.5	2025	2560
023940246	LO-BENTOMAT SDN	200820LO	00000056	150	13.5	2025	2570
023940242	LO-BENTOMAT SDN	200820LO	00000058	150	13.5	2025	2600
023940248	LO-BENTOMAT SDN	200820LO	00000062	150	13.5	2025	2635
023940242	LO-BENTOMAT SDN	200820LO	00000063	150	13.5	2025	2620
023940242	LO-BENTOMAT SDN	200820LO	00000064	150	13.5	2025	2625
023940246	LO-BENTOMAT SDN	200820LO	00000068	150	13.5	2025	2615
023940246	LO-BENTOMAT SDN	200820LO	00000069	150	13.5	2025	2620
023940248	LO-BENTOMAT SDN	200820LO	00000081	150	13.5	2025	2535
023940242	LO-BENTOMAT SDN	200820LO	00000083	150	13.5	2025	2510
023940242	LO-BENTOMAT SDN	200820LO	00000084	150	13.5	2025	2525
023940246	LO-BENTOMAT SDN	200820LO	00000087	150	13.5	2025	2540
023940246	LO-BENTOMAT SDN	200820LO	00000088	150	13.5	2025	2520
023940248	LO-BENTOMAT SDN	200820LO	00000099	150	13.5	2025	2535
023940242	LO-BENTOMAT SDN	200821LO	00000104	150	13.5	2025	2540
023940242	LO-BENTOMAT SDN	200821LO	00000114	150	13.5	2025	2580
023940246	LO-BENTOMAT SDN	200821LO	00000120	150	13.5	2025	2580
023940246	LO-BENTOMAT SDN	200821LO	00000121	150	13.5	2025	2460
023940248	LO-BENTOMAT SDN	200821LO	00000128	150	13.5	2025	2485
023940248	LO-BENTOMAT SDN	200821LO	00000129	150	13.5	2025	2550
023940242	LO-BENTOMAT SDN	200821LO	00000130	150	13.5	2025	2530
023940246	LO-BENTOMAT SDN	200821LO	00000131	150	13.5	2025	2525
023940246	LO-BENTOMAT SDN	200821LO	00000132	150	13.5	2025	2530
023940246	LO-BENTOMAT SDN	200821LO	00000136	150	13.5	2025	2540

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940242	LO-BENTOMAT SDN	200821LO	00000138	150	13.5	2025	2525
023940248	LO-BENTOMAT SDN	200821LO	00000141	150	13.5	2025	2540
023940248	LO-BENTOMAT SDN	200821LO	00000143	150	13.5	2025	2535
023940242	LO-BENTOMAT SDN	200821LO	00000146	150	13.5	2025	2550
023940242	LO-BENTOMAT SDN	200821LO	00000148	150	13.5	2025	2525
023940246	LO-BENTOMAT SDN	200821LO	00000151	150	13.5	2025	2540
023940246	LO-BENTOMAT SDN	200821LO	00000152	150	13.5	2025	2525
023940242	LO-BENTOMAT SDN	200821LO	00000153	150	13.5	2025	2535
023940248	LO-BENTOMAT SDN	200821LO	00000154	150	13.5	2025	2540
023940246	LO-BENTOMAT SDN	200821LO	00000157	150	13.5	2025	2520
023940246	LO-BENTOMAT SDN	200821LO	00000159	150	13.5	2025	2540
023940242	LO-BENTOMAT SDN	200821LO	00000164	150	13.5	2025	2475
023940242	LO-BENTOMAT SDN	200821LO	00000165	150	13.5	2025	2460
023940248	LO-BENTOMAT SDN	200821LO	00000168	150	13.5	2025	2610
023940248	LO-BENTOMAT SDN	200821LO	00000169	150	13.5	2025	2620
023940248	LO-BENTOMAT SDN	200821LO	00000170	150	13.5	2025	2610
023940242	LO-BENTOMAT SDN	200821LO	00000171	150	13.5	2025	2600
023940242	LO-BENTOMAT SDN	200821LO	00000172	150	13.5	2025	2620
023940248	LO-BENTOMAT SDN	200821LO	00000187	150	13.5	2025	2570
023940248	LO-BENTOMAT SDN	200821LO	00000189	150	13.5	2025	2580
023940248	LO-BENTOMAT SDN	200822LO	00000475	150	14.5	2175	2485
023940248	LO-BENTOMAT SDN	200822LO	00000476	150	14.5	2175	2475
023940244	LO-BENTOMAT SDN	200822LO	00000477	150	14.5	2175	2460
023940248	LO-BENTOMAT SDN	200822LO	00000478	150	14.5	2175	2545
023940248	LO-BENTOMAT SDN	200822LO	00000479	150	14.5	2175	2435
023940244	LO-BENTOMAT SDN	200822LO	00000480	150	14.5	2175	2430
023940244	LO-BENTOMAT SDN	200822LO	00000482	150	14.5	2175	2410
023940244	LO-BENTOMAT SDN	200822LO	00000483	150	14.5	2175	2420
023940244	LO-BENTOMAT SDN	200822LO	00000486	150	14.5	2175	2420
023940244	LO-BENTOMAT SDN	200822LO	00000488	150	14.5	2175	2420
023940244	LO-BENTOMAT SDN	200822LO	00000490	150	14.5	2175	2415
023940244	LO-BENTOMAT SDN	200822LO	00000492	150	14.5	2175	2351

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940244	LO-BENTOMAT SDN	200822LO	00000493	150	14.5	2175	2415
023940244	LO-BENTOMAT SDN	200822LO	00000495	150	14.5	2175	2460
023940244	LO-BENTOMAT SDN	200822LO	00000499	150	14.5	2175	2390
023940244	LO-BENTOMAT SDN	200822LO	00000501	150	14.5	2175	2335
023940244	LO-BENTOMAT SDN	200822LO	00000519	150	14.5	2175	2450
023940244	LO-BENTOMAT SDN	200822LO	00000521	150	14.5	2175	2300
023940244	LO-BENTOMAT SDN	200822LO	00000574	150	14.5	2175	2470
023940244	LO-BENTOMAT SDN	200822LO	00000728	150	14.5	2175	2680
023940244	LO-BENTOMAT SDN	200822LO	00000732	150	14.5	2175	2640
			Totals:	10200	939	140850	171421
				Total Number of Rolls Certified: 68			

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200820LO	00000030	00000019	2010082556			2009032537	042608C
200820LO	00000038	00000037	2008676316			2009032530	042608D
200820LO	00000047	00000037	2008676316			2009032530	042608D
200820LO	00000051	00000037	2010015534			2009032530	042608D
200820LO	00000056	00000055	2010015534			2009032528	042608D
200820LO	00000058	00000055	2009476399			2009032528	042608D
200820LO	00000062	00000055	2009476399			2009032528	042608D
200820LO	00000063	00000055	2009476399			2009032528	042608D
200820LO	00000064	00000055	2009476399			2009032528	042608D
200820LO	00000068	00000055	2010082554			2009032528	042608D
200820LO	00000069	00000055	2010082554			2009032529	042608D
200820LO	00000081	00000073	2008673884			2009032529	042608E
200820LO	00000083	00000073	2008673884			2009032529	042608E
200820LO	00000084	00000073	2008673884			2009032529	042608E
200820LO	00000087	00000073	2010257164			2009032527	042608E
200820LO	00000088	00000073	2010257164			2009032527	042608E
200820LO	00000099	00000091	2009476416			2009032527	042608E
200821LO	00000104	00000101	2009476416			2009032533	042608E
200821LO	00000114	00000101	2007381516			2009032533	042608E
200821LO	00000120	00000119	2009462584			2009032532	042708A
200821LO	00000121	00000119	2009462584			2009032532	042708A
200821LO	00000128	00000119	2009476392			2009032532	042708A
200821LO	00000129	00000119	2009476392			2009032532	042708A
200821LO	00000130	00000119	2009476392			2009032532	042708A
200821LO	00000131	00000119	2009476392			2009032532	042708A
200821LO	00000132	00000119	2009476392			2009032532	042708A
200821LO	00000136	00000119	2009476392			2009032532	042708A
200821LO	00000138	00000137	2008673922			2009032520	042708A
200821LO	00000141	00000137	2008673922			2009032520	042708A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200821LO	00000143	00000137	2008673922			2009032520	042708A
200821LO	00000146	00000137	2008673922			2009032520	042708A
200821LO	00000148	00000137	2008673888			2009032520	042708A
200821LO	00000151	00000137	2008673888			2009032520	042708A
200821LO	00000152	00000137	2008673888			2009032520	042708A
200821LO	00000153	00000137	2008673888			2009032520	042708A
200821LO	00000154	00000137	2008673888			2009032525	042708A
200821LO	00000157	00000155	2008673888			2009032525	042708A
200821LO	00000159	00000155	2010082557			2009032525	042708A
200821LO	00000164	00000155	2010082557			2009032525	042908A
200821LO	00000165	00000155	2010082557			2009032525	042908A
200821LO	00000168	00000155	2009476414			2009032525	042908A
200821LO	00000169	00000155	2009476414			2009032525	042908A
200821LO	00000170	00000155	2009476414			2009032525	042908A
200821LO	00000171	00000155	2009476414			2009032536	042908A
200821LO	00000172	00000155	2009476414			2009032536	042908A
200821LO	00000187	00000173	2009476388			2009032536	042908A
200821LO	00000189	00000173	2009476388			2009032521	042908A
200822LO	00000475	00000467	2010231181			2010431246	051008A
200822LO	00000476	00000467	2010231181			2010431246	051008A
200822LO	00000477	00000467	2010231181			2010431246	051008A
200822LO	00000478	00000467	2010231181			2010431246	051008A
200822LO	00000479	00000467	2010231181			2010431246	051008A
200822LO	00000480	00000467	2010231181			2010431246	051008A
200822LO	00000482	00000467	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000483	00000467	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000486	00000485	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000488	00000485	2010231159			2010431247	051008A
200822LO	00000490	00000485	2010231159			2010431247	051008A
200822LO	00000492	00000485	2010231159			2010431247	051008A
200822LO	00000493	00000485	2010231159			2010162646	051008A
200822LO	00000495	00000485	2010231159			2010162646	051008A
200822LO	00000499	00000485	2010015423			2010162646	051008A
200822LO	00000501	00000485	2010015423			2010162646	051008A
200822LO	00000519	00000503	2010231139			2010431237	051008B

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000521	00000521	2010015461			2010431237	051008B
200822LO	00000574	00000557	2010015465			2010437128	051208A
200822LO	00000728	00000719	2008408217			2010431242	051308B
200822LO	00000732	00000719	2010231164			2010431242	051308B

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200820LO	00000019	0.90	65.5	8.6
LO-BENTOMAT SDN	200820LO	00000037	0.91	65.5	13.6
LO-BENTOMAT SDN	200820LO	00000055	1.04	65.5	9.7
LO-BENTOMAT SDN	200820LO	00000073	1.02	61.5	12.8
LO-BENTOMAT SDN	200820LO	00000091	0.96	61.5	8.8
LO-BENTOMAT SDN	200821LO	00000101	0.94	54.0	11.2
LO-BENTOMAT SDN	200821LO	00000119	0.95	54.0	6.5
LO-BENTOMAT SDN	200821LO	00000137	0.94	54.0	11
LO-BENTOMAT SDN	200821LO	00000155	0.93	54.0	11.3
LO-BENTOMAT SDN	200821LO	00000173	0.95	54.0	6.5
LO-BENTOMAT SDN	200822LO	00000467	0.91	34.7	5.3
LO-BENTOMAT SDN	200822LO	00000485	0.85	34.7	5.9
LO-BENTOMAT SDN	200822LO	00000503	0.92	34.7	5.7
LO-BENTOMAT SDN	200822LO	00000521	0.85	34.7	6.9
LO-BENTOMAT SDN	200822LO	00000557	0.88	42.1	8.8
LO-BENTOMAT SDN	200822LO	00000719	0.90	37.6	7.7

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200820LO	00000019	45.6	262.2
LO-BENTOMAT SDN	200820LO	00000037	64.7	262.2
LO-BENTOMAT SDN	200820LO	00000055	49.5	262.2
LO-BENTOMAT SDN	200820LO	00000073	64.3	246.0
LO-BENTOMAT SDN	200820LO	00000091	47.5	246.0
LO-BENTOMAT SDN	200821LO	00000101	55.9	216.1
LO-BENTOMAT SDN	200821LO	00000119	35.8	216.1
LO-BENTOMAT SDN	200821LO	00000137	56.5	216.1
LO-BENTOMAT SDN	200821LO	00000155	56.8	216.1
LO-BENTOMAT SDN	200821LO	00000173	37.0	216.1
LO-BENTOMAT SDN	200822LO	00000467	27.0	138.8
LO-BENTOMAT SDN	200822LO	00000485	29.9	138.8
LO-BENTOMAT SDN	200822LO	00000503	30.2	138.8
LO-BENTOMAT SDN	200822LO	00000521	37.8	138.8

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LO-BENTOMAT SDN	200822LO	00000557	46.3	168.6
LO-BENTOMAT SDN	200822LO	00000719	39.5	150.7

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
042608C	27.0	15.6
042608D	27.0	14.4
042608E	30.0	14.4
042708A	27.0	13.8
042908A	25.0	16.4
051008A	26.0	17.2
051008B	25.0	17.2
051208A	27.0	15.4
051308B	29.0	15.4

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GEOTEXTILE TEST RESULTS FOR RAW MATERIAL SUPPLIED BY A CETCO FACILITY

The GCL in certification package number 000239402 was manufactured using these geotextiles:

Material	Lot #	Roll #	Mass Area	Grab Strenth
CV-NON-WOVEN	200819CV	00001820	6.7	35.3

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 311	2009032520	3.3	86.9
PPX 311	2009032521	3.3	86.9
PPX 311	2009032525	3.8	105.0
PPX 311	2009032527	3.8	105.0
PPX 311	2009032528	3.3	92.3
PPX 311	2009032529	3.3	92.3
PPX 311	2009032530	3.3	92.3
PPX 311	2009032532	3.4	96.7
PPX 311	2009032533	3.4	96.7
PPX 311	2009032536	3.8	100.7
PPX 311	2009032537	3.8	100.7
PPX 311	2010162646	3.4	83.7
PPX 311	2010431237	3.9	96.5
PPX 311	2010431242	3.9	96.5
PPX 311	2010431246	3.8	85.8
PPX 311	2010431247	3.8	85.8
PPX 311	2010437128	3.6	79.7

CAP

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 650	2007381516	7.3	95.9
PPX 650	2008408217	6.5	113.7
PPX 650	2008673884	7.2	87.1
PPX 650	2008673888	7.1	113.9
PPX 650	2008673922	6.5	79.6
PPX 650	2008673936	6.9	95.7
PPX 650	2009462584	6.2	197.2
PPX 650	2009476388	6.9	80.5
PPX 650	2009476392	7.2	111.0
PPX 650	2009476399	6.5	95.8
PPX 650	2009476414	6.9	80.8
PPX 650	2009476416	6.9	80.8
PPX 650	2010015423	7.3	115.1

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PPX 650	2010015461	7.0	83.9
PPX 650	2010015465	6.6	87.4
PPX 650	2010015534	7.1	82.2
PPX 650	2010082554	8.3	178.6
PPX 650	2010082556	8.3	182.1
PPX 650	2010082557	8.3	182.1
PPX 650	2010231139	6.9	84.2
PPX 650	2010231159	7.1	93.5
PPX 650	2010231164	6.9	84.8
PPX 650	2010231181	7.2	87.2
PPX 650	2010257164	7.7	100.4

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 6/10/2008
Purchase Order: 12738-00
ORDER NUMBERS: 023940244, 023940252, 023940255

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/9/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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CETCO
LINING TECHNOLOGIES
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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBERS: 023940244, 023940252, 023940255
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

Electronic Filing: Received, Clerk's Office 06/20/2024

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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO LINING TECHNOLOGIES
800.527.9948 www.cetco.com

Ship Date: 6/9/2008
Order Numbers: 023940244, 023940252, 023940255
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

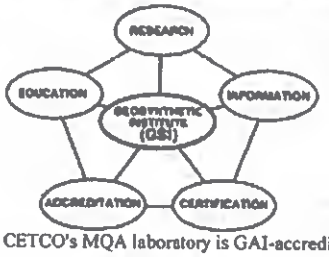
Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940252	LO-BENTOMAT SDN	200820LO	00000012	150	14	2100	2570
023940252	LO-BENTOMAT SDN	200820LO	00000016	150	14	2100	2570
023940252	LO-BENTOMAT SDN	200820LO	00000019	150	13.5	2025	2560
023940252	LO-BENTOMAT SDN	200820LO	00000020	150	13.5	2025	2535
023940255	LO-BENTOMAT SDN	200820LO	00000021	150	13.5	2025	2550
023940255	LO-BENTOMAT SDN	200820LO	00000023	150	13.5	2025	2525
023940255	LO-BENTOMAT SDN	200820LO	00000025	150	13.5	2025	2555
023940255	LO-BENTOMAT SDN	200820LO	00000028	150	13.5	2025	2540
023940252	LO-BENTOMAT SDN	200820LO	00000040	150	13.5	2025	2545
023940252	LO-BENTOMAT SDN	200820LO	00000050	150	13.5	2025	2575
023940252	LO-BENTOMAT SDN	200820LO	00000054	150	13.5	2025	2560
023940252	LO-BENTOMAT SDN	200820LO	00000055	150	13.5	2025	2555
023940255	LO-BENTOMAT SDN	200821LO	00000149	150	13.5	2025	2515
023940244	LO-BENTOMAT SDN	200822LO	00000477	150	14.5	2175	2460
023940244	LO-BENTOMAT SDN	200822LO	00000480	150	14.5	2175	2430
023940244	LO-BENTOMAT SDN	200822LO	00000482	150	14.5	2175	2410
023940252	LO-BENTOMAT SDN	200822LO	00000483	150	14.5	2175	2420
023940244	LO-BENTOMAT SDN	200822LO	00000486	150	14.5	2175	2420
023940244	LO-BENTOMAT SDN	200822LO	00000488	150	14.5	2175	2420
023940244	LO-BENTOMAT SDN	200822LO	00000490	150	14.5	2175	2415
023940244	LO-BENTOMAT SDN	200822LO	00000491	150	14.5	2175	2355
023940244	LO-BENTOMAT SDN	200822LO	00000492	150	14.5	2175	2351
023940244	LO-BENTOMAT SDN	200822LO	00000493	150	14.5	2175	2415
023940244	LO-BENTOMAT SDN	200822LO	00000495	150	14.5	2175	2460
023940244	LO-BENTOMAT SDN	200822LO	00000499	150	14.5	2175	2390
023940244	LO-BENTOMAT SDN	200822LO	00000501	150	14.5	2175	2335
023940244	LO-BENTOMAT SDN	200822LO	00000519	150	14.5	2175	2450

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940244	LO-BENTOMAT SDN	200822LO	00000521	150	14.5	2175	2300
023940244	LO-BENTOMAT SDN	200822LO	00000574	150	14.5	2175	2470
023940255	LO-BENTOMAT SDN	200822LO	00000668	150	14.5	2175	2495
023940244	LO-BENTOMAT SDN	200822LO	00000728	150	14.5	2175	2680
023940244	LO-BENTOMAT SDN	200822LO	00000732	150	14.5	2175	2640
023940255	LO-BENTOMAT SDN	200823LO	00000848	150	13.5	2025	2465
023940255	LO-BENTOMAT SDN	200823LO	00000850	150	13.5	2025	2415
023940255	LO-BENTOMAT SDN	200823LO	00000851	150	13.5	2025	2475
023940255	LO-BENTOMAT SDN	200823LO	00000852	150	14	2100	2435
023940255	LO-BENTOMAT SDN	200823LO	00000853	150	14	2100	2450
023940255	LO-BENTOMAT SDN	200823LO	00000854	150	14	2100	2470
023940255	LO-BENTOMAT SDN	200823LO	00000855	150	14	2100	2445
023940255	LO-BENTOMAT SDN	200823LO	00000876	150	14	2100	2470
023940255	LO-BENTOMAT SDN	200823LO	00000888	150	15	2250	2560
023940255	LO-BENTOMAT SDN	200823LO	00000903	150	15	2250	2500
023940255	LO-BENTOMAT SDN	200823LO	00000924	150	14.5	2175	2520
			Totals:	6450	607	91050	106676
						Total Number of Rolls Certified: 43	

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200820LO	00000012	00000001	2010015538			2009032535	042608C
200820LO	00000016	00000001	2010015538			2009032535	042608C
200820LO	00000019	00000019	2010015429			2009032537	042608C
200820LO	00000020	00000019	2010015429			2009032537	042608C
200820LO	00000021	00000019	2010015429			2009032537	042608C
200820LO	00000023	00000019	2010015429			2009032537	042608C
200820LO	00000025	00000019	2010015429			2009032537	042608C
200820LO	00000028	00000019	2010082556			2009032537	042608C
200820LO	00000040	00000037	2008676316			2009032530	042608D
200820LO	00000050	00000037	2010015534			2009032530	042608D
200820LO	00000054	00000037	2010015534			2009032528	042608D
200820LO	00000055	00000055	2010015534			2009032528	042608D
200821LO	00000149	00000137	2008673888			2009032520	042708A
200822LO	00000477	00000467	2010231181			2010431246	051008A
200822LO	00000480	00000467	2010231181			2010431246	051008A
200822LO	00000482	00000467	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000483	00000467	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000486	00000485	200819CV	00001820	00001820	2010431247	051008A
200822LO	00000488	00000485	2010231159			2010431247	051008A
200822LO	00000490	00000485	2010231159			2010431247	051008A
200822LO	00000491	00000485	2010231159			2010431247	051008A
200822LO	00000492	00000485	2010231159			2010431247	051008A
200822LO	00000493	00000485	2010231159			2010162646	051008A
200822LO	00000495	00000485	2010231159			2010162646	051008A
200822LO	00000499	00000485	2010015423			2010162646	051008A
200822LO	00000501	00000485	2010015423			2010162646	051008A
200822LO	00000519	00000503	2010231139			2010431237	051008B
200822LO	00000521	00000521	2010015461			2010431237	051008B
200822LO	00000574	00000557	2010015465			2010437128	051208A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200822LO	00000668	00000665	2010231161			2010438010	051208C
200822LO	00000728	00000719	2008408217			2010431242	051308B
200822LO	00000732	00000719	2010231164			2010431242	051308B
200823LO	00000848	00000836	2010231177			2009032519	052308D
200823LO	00000850	00000836	2010231177			2010437146	052308D
200823LO	00000851	00000836	2010242448			2010437146	052308D
200823LO	00000852	00000836	2010242448			2010437146	052308D
200823LO	00000853	00000836	2010242448			2010437146	052308D
200823LO	00000854	00000854	2010242448			2010437146	052308D
200823LO	00000855	00000854	2010242448			2010437146	052308D
200823LO	00000876	00000872	2010231216			2009032526	052308D
200823LO	00000888	00000872	2010231188			2010431244	052408A
200823LO	00000903	00000890	2010231191			2010342881	052408A
200823LO	00000924	00000908	2010257123			2010342842	052408A

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200820LO	00000001	0.88	65.5	4.2
LO-BENTOMAT SDN	200820LO	00000019	0.90	65.5	8.6
LO-BENTOMAT SDN	200820LO	00000037	0.91	65.5	13.6
LO-BENTOMAT SDN	200820LO	00000055	1.04	65.5	9.7
LO-BENTOMAT SDN	200821LO	00000137	0.94	54.0	11
LO-BENTOMAT SDN	200822LO	00000467	0.91	34.7	5.3
LO-BENTOMAT SDN	200822LO	00000485	0.85	34.7	5.9
LO-BENTOMAT SDN	200822LO	00000503	0.92	34.7	5.7
LO-BENTOMAT SDN	200822LO	00000521	0.85	34.7	6.9
LO-BENTOMAT SDN	200822LO	00000557	0.88	42.1	8.8
LO-BENTOMAT SDN	200822LO	00000665	0.85	51.8	9.2
LO-BENTOMAT SDN	200822LO	00000719	0.90	37.6	7.7
LO-BENTOMAT SDN	200823LO	00000836	0.93	62.5	6.2
LO-BENTOMAT SDN	200823LO	00000854	0.86	62.5	7.3
LO-BENTOMAT SDN	200823LO	00000872	0.94	62.5	7.9
LO-BENTOMAT SDN	200823LO	00000890	0.85	62.5	9.1
LO-BENTOMAT SDN	200823LO	00000908	0.87	62.5	10.8

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200820LO	00000001	27.5	262.2
LO-BENTOMAT SDN	200820LO	00000019	45.6	262.2
LO-BENTOMAT SDN	200820LO	00000037	64.7	262.2
LO-BENTOMAT SDN	200820LO	00000055	49.5	262.2
LO-BENTOMAT SDN	200821LO	00000137	56.5	216.1
LO-BENTOMAT SDN	200822LO	00000467	27.0	138.8
LO-BENTOMAT SDN	200822LO	00000485	29.9	138.8
LO-BENTOMAT SDN	200822LO	00000503	30.2	138.8
LO-BENTOMAT SDN	200822LO	00000521	37.8	138.8
LO-BENTOMAT SDN	200822LO	00000557	46.3	168.6
LO-BENTOMAT SDN	200822LO	00000665	48.4	207.2
LO-BENTOMAT SDN	200822LO	00000719	39.5	150.7
LO-BENTOMAT SDN	200823LO	00000836	33.3	250.1

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LO-BENTOMAT SDN	200823LO	00000854	40.3	250.1
LO-BENTOMAT SDN	200823LO	00000872	43.0	250.1
LO-BENTOMAT SDN	200823LO	00000890	49.6	250.1
LO-BENTOMAT SDN	200823LO	00000908	51.7	250.1

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
042608C	27.0	15.6
042608D	27.0	14.4
042708A	27.0	13.8
051008A	26.0	17.2
051008B	25.0	17.2
051208A	27.0	15.4
051208C	27.0	15.6
051308B	29.0	15.4
052308D	25.0	15.2
052408A	26.0	15.8

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GEOTEXTILE TEST RESULTS FOR RAW MATERIAL SUPPLIED BY A CETCO FACILITY

The GCL in certification package number 000239402 was manufactured using these geotextiles:

Material	Lot #	Roll #	Mass Area	Grab Strenth
CV-NON-WOVEN	200819CV	00001820	6.7	35.3

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 311	2009032519	3.3	86.9
PPX 311	2009032520	3.3	86.9
PPX 311	2009032526	3.8	105.0
PPX 311	2009032528	3.3	92.3
PPX 311	2009032530	3.3	92.3
PPX 311	2009032535	3.8	100.7
PPX 311	2009032537	3.8	100.7
PPX 311	2010162646	3.4	83.7
PPX 311	2010342842	3.7	76.6
PPX 311	2010342881	3.4	85.2
PPX 311	2010431237	3.9	96.5
PPX 311	2010431242	3.9	96.5
PPX 311	2010431244	3.9	96.5
PPX 311	2010431246	3.8	85.8
PPX 311	2010431247	3.8	85.8
PPX 311	2010437128	3.6	79.7
PPX 311	2010437146	3.6	70.2
PPX 311	2010438010	3.7	75.8

CAP

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 650	2008408217	6.5	113.7
PPX 650	2008673888	7.1	113.9
PPX 650	2008673936	6.9	95.7
PPX 650	2010015423	7.3	115.1
PPX 650	2010015429	7.2	113.7
PPX 650	2010015461	7.0	83.9
PPX 650	2010015465	6.6	87.4
PPX 650	2010015534	7.1	82.2
PPX 650	2010015538	7.5	86.1
PPX 650	2010082556	8.3	182.1
PPX 650	2010231139	6.9	84.2
PPX 650	2010231159	7.1	93.5

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PPX 650	2010231161	7.1	93.5
PPX 650	2010231164	6.9	84.8
PPX 650	2010231177	6.7	73.3
PPX 650	2010231181	7.2	87.2
PPX 650	2010231188	7.0	81.3
PPX 650	2010231191	7.3	85.1
PPX 650	2010231216	6.7	77.2
PPX 650	2010242448	7.6	94.2
PPX 650	2010257123	7.5	88.7

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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CETCO
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Date: 8/29/2008
Purchase Order: 12738-00
ORDER NUMBER: 023940247

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 06/06/2008.

If you have any questions regarding this information, please contact Chris Athanassopoulos, Technical Support Engineer, at (847) 818-7945.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

Electronic Filing: Received, Clerk's Office 06/20/2024

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBER: 023940247
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
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- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
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E-Mail: rwilke@cetco.com

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO
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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO
LINING TECHNOLOGIES
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Ship Date: 06/06/2008
Order Number: 023940247
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 6243	GCL Hydrated Internal Shear Strength	Periodic	500 psf (48 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 023940247

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940247	LO-BENTOMAT SDN	200820LO	00000042	150	13.5	2025	2560
023940247	LO-BENTOMAT SDN	200820LO	00000043	150	13.5	2025	2550
023940247	LO-BENTOMAT SDN	200820LO	00000044	150	13.5	2025	2520
023940247	LO-BENTOMAT SDN	200820LO	00000046	150	13.5	2025	2520
023940247	LO-BENTOMAT SDN	200820LO	00000089	150	13.5	2025	2535
023940247	LO-BENTOMAT SDN	200820LO	00000090	150	13.5	2025	2525
023940247	LO-BENTOMAT SDN	200820LO	00000091	150	13.5	2025	2530
023940247	LO-BENTOMAT SDN	200820LO	00000092	150	13.5	2025	2520
023940247	LO-BENTOMAT SDN	200820LO	00000093	150	13.5	2025	2525
023940247	LO-BENTOMAT SDN	200821LO	00000106	150	13.5	2025	2555
023940247	LO-BENTOMAT SDN	200821LO	00000107	150	13.5	2025	2630
023940247	LO-BENTOMAT SDN	200821LO	00000115	150	13.5	2025	2570
023940247	LO-BENTOMAT SDN	200821LO	00000124	150	13.5	2025	2505
023940247	LO-BENTOMAT SDN	200821LO	00000125	150	13.5	2025	2490
023940247	LO-BENTOMAT SDN	200821LO	00000133	150	13.5	2025	2515
023940247	LO-BENTOMAT SDN	200821LO	00000134	150	13.5	2025	2520
023940247	LO-BENTOMAT SDN	200821LO	00000137	150	13.5	2025	2530
			Totals:	**2550**	**229.5**	**34425**	**43100**
						Total Number of Rolls Certified: **17**	

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 023940247

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200820LO	00000042	00000037	2008676316			2009032530	042608D
200820LO	00000043	00000037	2008676316			2009032530	042608D
200820LO	00000044	00000037	2008676316			2009032530	042608D
200820LO	00000046	00000037	2008676316			2009032530	042608D
200820LO	00000089	00000073	2010257164			2009032527	042608E
200820LO	00000090	00000073	2010257164			2009032527	042608E
200820LO	00000091	00000091	2010257164			2009032527	042608E
200820LO	00000092	00000091	2010257164			2009032527	042608E
200820LO	00000093	00000091	2010257164			2009032527	042608E
200821LO	00000106	00000101	2009476416			2009032533	042608E
200821LO	00000107	00000101	2009476416			2009032533	042608E
200821LO	00000115	00000101	2007381516			2009032533	042708A
200821LO	00000124	00000119	2009462584			2009032532	042708A
200821LO	00000125	00000119	2009462584			2009032532	042708A
200821LO	00000133	00000119	2009476392			2009032532	042708A
200821LO	00000134	00000119	2009476392			2009032532	042708A
200821LO	00000137	00000137	2008673922			2009032520	042708A

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 023940247 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in Min
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200820LO	00000037	0.91	65.5	13.6
LO-BENTOMAT SDN	200820LO	00000073	1.02	61.5	12.8
LO-BENTOMAT SDN	200820LO	00000091	0.96	61.5	8.8
LO-BENTOMAT SDN	200821LO	00000101	0.94	54.0	11.2
LO-BENTOMAT SDN	200821LO	00000119	0.95	54.0	6.5
LO-BENTOMAT SDN	200821LO	00000137	0.94	54.0	11

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200820LO	00000037	64.7	262.2
LO-BENTOMAT SDN	200820LO	00000073	64.3	246.0
LO-BENTOMAT SDN	200820LO	00000091	47.5	246.0
LO-BENTOMAT SDN	200821LO	00000101	55.9	216.1
LO-BENTOMAT SDN	200821LO	00000119	35.8	216.1
LO-BENTOMAT SDN	200821LO	00000137	56.5	216.1

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 023940247 has been tested by American Colloid Company and yeilded the following test results.

Reference	Moist	Swell	Fluid Loss
Test Method:	ASTM D 2216	ASTM D 5890	ASTM D 5891
Specification:	12% Max	24 ml/2g Min	18 ml Max
042608D	10.4	27.0	14.4
042608E	10.4	30.0	14.4
042708A	10.4	27.0	13.8

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 023940247 was manufactured with geotextiles which were tested with the following results.

BASE

Material	Roll Number	Mass Area oz/yd2	Grab Strength lbs
PPX 311	2009032520	3.3	86.9
PPX 311	2009032527	3.8	105.0
PPX 311	2009032530	3.3	92.3
PPX 311	2009032532	3.4	96.7
PPX 311	2009032533	3.4	96.7

CAP

Material	Roll Number	Mass Area oz/yd2	Grab Strength lbs
PPX 650	2007381516	7.3	95.9
PPX 650	2008673922	6.5	79.6
PPX 650	2008673936	6.9	95.7
PPX 650	2009462584	6.2	197.2
PPX 650	2009476392	7.2	111.0
PPX 650	2009476416	6.9	80.8
PPX 650	2010257164	7.7	100.4

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 6/9/2008
Purchase Order: 12738-00
ORDER NUMBERS: 023940249, 023940250, 023940251, 023940253, 023940254

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/8/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBERS: 023940249, 023940250, 023940251, 023940253, 023940254
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

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LINING TECHNOLOGIES
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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

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CETCO LINING TECHNOLOGIES
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Ship Date: 6/8/2008
Order Numbers: 023940249, 023940250, 023940251, 023940253, 023940254
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940249	LO-BENTOMAT SDN	200820LO	00000070	150	13.5	2025	2610
023940250	LO-BENTOMAT SDN	200820LO	00000072	150	13.5	2025	2620
023940250	LO-BENTOMAT SDN	200820LO	00000073	150	13.5	2025	2575
023940250	LO-BENTOMAT SDN	200820LO	00000074	150	13.5	2025	2590
023940250	LO-BENTOMAT SDN	200820LO	00000094	150	13.5	2025	2515
023940250	LO-BENTOMAT SDN	200820LO	00000095	150	13.5	2025	2545
023940251	LO-BENTOMAT SDN	200821LO	00000105	150	13.5	2025	2545
023940250	LO-BENTOMAT SDN	200823LO	00000836	150	13.5	2025	2650
023940251	LO-BENTOMAT SDN	200823LO	00000837	150	13.5	2025	2620
023940251	LO-BENTOMAT SDN	200823LO	00000838	150	13.5	2025	2645
023940249	LO-BENTOMAT SDN	200823LO	00000839	150	13.5	2025	2605
023940251	LO-BENTOMAT SDN	200823LO	00000840	150	13.5	2025	2490
023940251	LO-BENTOMAT SDN	200823LO	00000841	150	13.5	2025	2450
023940251	LO-BENTOMAT SDN	200823LO	00000842	150	13.5	2025	2435
023940249	LO-BENTOMAT SDN	200823LO	00000843	150	13.5	2025	2410
023940249	LO-BENTOMAT SDN	200823LO	00000844	150	13.5	2025	2430
023940249	LO-BENTOMAT SDN	200823LO	00000845	150	13.5	2025	2420
023940249	LO-BENTOMAT SDN	200823LO	00000846	150	13.5	2025	2435
023940249	LO-BENTOMAT SDN	200823LO	00000847	150	13.5	2025	2410
023940249	LO-BENTOMAT SDN	200823LO	00000849	150	13.5	2025	2430
023940249	LO-BENTOMAT SDN	200823LO	00000856	150	14	2100	2435
023940254	LO-BENTOMAT SDN	200823LO	00000857	150	14	2100	2460
023940250	LO-BENTOMAT SDN	200823LO	00000858	150	14	2100	2485
023940254	LO-BENTOMAT SDN	200823LO	00000859	150	14	2100	2490
023940253	LO-BENTOMAT SDN	200823LO	00000860	150	14	2100	2440
023940249	LO-BENTOMAT SDN	200823LO	00000861	150	14	2100	2450
023940249	LO-BENTOMAT SDN	200823LO	00000862	150	14	2100	2485

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940251	LO-BENTOMAT SDN	200823LO	00000863	150	14	2100	2470
023940250	LO-BENTOMAT SDN	200823LO	00000864	150	14	2100	2465
023940249	LO-BENTOMAT SDN	200823LO	00000865	150	14	2100	2420
023940254	LO-BENTOMAT SDN	200823LO	00000866	150	14	2100	2455
023940254	LO-BENTOMAT SDN	200823LO	00000867	150	14	2100	2460
023940254	LO-BENTOMAT SDN	200823LO	00000868	150	14	2100	2475
023940251	LO-BENTOMAT SDN	200823LO	00000869	150	13.5	2025	2480
023940250	LO-BENTOMAT SDN	200823LO	00000870	150	14	2100	2495
023940253	LO-BENTOMAT SDN	200823LO	00000871	150	14	2100	2440
023940253	LO-BENTOMAT SDN	200823LO	00000872	150	14	2100	2500
023940249	LO-BENTOMAT SDN	200823LO	00000873	150	14	2100	2495
023940249	LO-BENTOMAT SDN	200823LO	00000874	150	14	2100	2510
023940249	LO-BENTOMAT SDN	200823LO	00000875	150	14	2100	2505
023940254	LO-BENTOMAT SDN	200823LO	00000877	150	14	2100	2480
023940254	LO-BENTOMAT SDN	200823LO	00000878	150	14	2100	2510
023940254	LO-BENTOMAT SDN	200823LO	00000879	150	14	2100	2490
023940253	LO-BENTOMAT SDN	200823LO	00000880	150	14	2100	2520
023940249	LO-BENTOMAT SDN	200823LO	00000881	150	14	2100	2535
023940251	LO-BENTOMAT SDN	200823LO	00000882	150	14	2100	2505
023940250	LO-BENTOMAT SDN	200823LO	00000883	150	14	2100	2510
023940254	LO-BENTOMAT SDN	200823LO	00000884	150	14	2100	2530
023940253	LO-BENTOMAT SDN	200823LO	00000885	150	14	2100	2500
023940249	LO-BENTOMAT SDN	200823LO	00000886	150	15	2250	2585
023940254	LO-BENTOMAT SDN	200823LO	00000887	150	15	2250	2570
023940254	LO-BENTOMAT SDN	200823LO	00000889	150	15	2250	2545
023940254	LO-BENTOMAT SDN	200823LO	00000890	150	15	2250	2530
023940253	LO-BENTOMAT SDN	200823LO	00000891	150	15	2250	2575
023940253	LO-BENTOMAT SDN	200823LO	00000892	150	15	2250	2590
023940251	LO-BENTOMAT SDN	200823LO	00000893	150	15	2250	2580
023940251	LO-BENTOMAT SDN	200823LO	00000894	150	15	2250	2555
023940251	LO-BENTOMAT SDN	200823LO	00000895	150	15	2250	2545
023940250	LO-BENTOMAT SDN	200823LO	00000896	150	15	2250	2555

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940250	LO-BENTOMAT SDN	200823LO	00000897	150	15	2250	2505
023940254	LO-BENTOMAT SDN	200823LO	00000898	150	15	2250	2525
023940253	LO-BENTOMAT SDN	200823LO	00000899	150	15	2250	2530
023940254	LO-BENTOMAT SDN	200823LO	00000900	150	15	2250	2595
023940254	LO-BENTOMAT SDN	200823LO	00000901	150	15	2250	2570
023940251	LO-BENTOMAT SDN	200823LO	00000902	150	15	2250	2540
023940250	LO-BENTOMAT SDN	200823LO	00000904	150	15	2250	2540
023940250	LO-BENTOMAT SDN	200823LO	00000905	150	15	2250	2520
023940254	LO-BENTOMAT SDN	200823LO	00000906	150	15	2250	2535
023940250	LO-BENTOMAT SDN	200823LO	00000907	150	15	2250	2530
023940253	LO-BENTOMAT SDN	200823LO	00000908	150	15	2250	2545
023940251	LO-BENTOMAT SDN	200823LO	00000909	150	15	2250	2530
023940253	LO-BENTOMAT SDN	200823LO	00000910	150	14.5	2175	2545
023940253	LO-BENTOMAT SDN	200823LO	00000911	150	14.5	2175	2530
023940251	LO-BENTOMAT SDN	200823LO	00000912	150	14.5	2175	2525
023940253	LO-BENTOMAT SDN	200823LO	00000913	150	14.5	2175	2500
023940253	LO-BENTOMAT SDN	200823LO	00000914	150	14.5	2175	2510
023940253	LO-BENTOMAT SDN	200823LO	00000915	150	14.5	2175	2525
023940253	LO-BENTOMAT SDN	200823LO	00000916	150	14.5	2175	2540
023940251	LO-BENTOMAT SDN	200823LO	00000917	150	14.5	2175	2515
023940250	LO-BENTOMAT SDN	200823LO	00000918	150	14.5	2175	2530
023940251	LO-BENTOMAT SDN	200823LO	00000919	150	14.5	2175	2500
023940250	LO-BENTOMAT SDN	200823LO	00000920	150	14.5	2175	2490
023940253	LO-BENTOMAT SDN	200823LO	00000921	150	14.5	2175	2485
023940253	LO-BENTOMAT SDN	200823LO	00000922	150	14.5	2175	2490
023940254	LO-BENTOMAT SDN	200823LO	00000923	150	14.5	2175	2505
			Totals:	12750	1208.5	181275	213710
						Total Number of Rolls Certified: 85	

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200820LO	00000070	00000055	2010082554			2009032529	042608D
200820LO	00000072	00000055	2010082554			2009032529	042608D
200820LO	00000073	00000073	2010082554			2009032529	042608D
200820LO	00000074	00000073	2010082554			2009032529	042608D
200820LO	00000094	00000091	2010257164			2009032527	042608E
200820LO	00000095	00000091	2010257164			2009032527	042608E
200821LO	00000105	00000101	2009476416			2009032533	042608E
200823LO	00000836	00000836	2010231467			2009032519	052308D
200823LO	00000837	00000836	2010231467			2009032519	052308D
200823LO	00000838	00000836	2010231467			2009032519	052308D
200823LO	00000839	00000836	2010231467			2009032519	052308D
200823LO	00000840	00000836	2010231467			2009032519	052308D
200823LO	00000841	00000836	2010231467			2009032519	052308D
200823LO	00000842	00000836	2010231177			2009032519	052308D
200823LO	00000843	00000836	2010231177			2009032519	052308D
200823LO	00000844	00000836	2010231177			2009032519	052308D
200823LO	00000845	00000836	2010231177			2009032519	052308D
200823LO	00000846	00000836	2010231177			2009032519	052308D
200823LO	00000847	00000836	2010231177			2009032519	052308D
200823LO	00000849	00000836	2010231177			2009032519	052308D
200823LO	00000856	00000854	2010242448			2010437146	052308D
200823LO	00000857	00000854	2010242448			2010437146	052308D
200823LO	00000858	00000854	2010242448			2010437146	052308D
200823LO	00000859	00000854	2010242448			2010437146	052308D
200823LO	00000860	00000854	2010231211			2010437146	052308D
200823LO	00000861	00000854	2010231211			2010437146	052308D
200823LO	00000862	00000854	2010231211			2010437146	052308D
200823LO	00000863	00000854	2010231211			2010437146	052308D
200823LO	00000864	00000854	2010231211			2010437146	052308D

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200823LO	00000865	00000854	2010231211			2010437146	052308D
200823LO	00000866	00000854	2010231211			2010437146	052308D
200823LO	00000867	00000854	2010231211			2010437146	052308D
200823LO	00000868	00000854	2010231211			2010437146	052308D
200823LO	00000869	00000854	2010231211			2009032526	052308D
200823LO	00000870	00000854	2010231216			2009032526	052308D
200823LO	00000871	00000854	2010231216			2009032526	052308D
200823LO	00000872	00000872	2010231216			2009032526	052308D
200823LO	00000873	00000872	2010231216			2009032526	052308D
200823LO	00000874	00000872	2010231216			2009032526	052308D
200823LO	00000875	00000872	2010231216			2009032526	052308D
200823LO	00000877	00000872	2010231216			2009032526	052308D
200823LO	00000878	00000872	2010231216			2009032526	052308D
200823LO	00000879	00000872	2010231206			2009032526	052308D
200823LO	00000880	00000872	2010231206			2009032526	052408A
200823LO	00000881	00000872	2010231206			2009032526	052408A
200823LO	00000882	00000872	2010231206			2009032526	052408A
200823LO	00000883	00000872	2010231206			2009032526	052408A
200823LO	00000884	00000872	2010231206			2009032526	052408A
200823LO	00000885	00000872	2010231206			2010431244	052408A
200823LO	00000886	00000872	2010231206			2010431244	052408A
200823LO	00000887	00000872	2010231206			2010431244	052408A
200823LO	00000889	00000872	2010231188			2010431244	052408A
200823LO	00000890	00000890	2010231188			2010431244	052408A
200823LO	00000891	00000890	2010231188			2010431244	052408A
200823LO	00000892	00000890	2010231188			2010431244	052408A
200823LO	00000893	00000890	2010231188			2010431244	052408A
200823LO	00000894	00000890	2010231188			2010431244	052408A
200823LO	00000895	00000890	2010231188			2010431244	052408A
200823LO	00000896	00000890	2010231188			2010431244	052408A
200823LO	00000897	00000890	2010231188			2010431244	052408A
200823LO	00000898	00000890	2010231191			2010431244	052408A
200823LO	00000899	00000890	2010231191			2010431244	052408A
200823LO	00000900	00000890	2010231191			2010342881	052408A
200823LO	00000901	00000890	2010231191			2010342881	052408A

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200823LO	00000902	00000890	2010231191			2010342881	052408A
200823LO	00000904	00000890	2010231191			2010342881	052408A
200823LO	00000905	00000890	2010231191			2010437149	052408A
200823LO	00000906	00000890	2010231191			2010437149	052408A
200823LO	00000907	00000890	2010257133			2010437149	052408A
200823LO	00000908	00000908	2010257133			2010437149	052408A
200823LO	00000909	00000908	2010257133			2010437149	052408A
200823LO	00000910	00000908	2010257133			2010437149	052408A
200823LO	00000911	00000908	2010257133			2010437149	052408A
200823LO	00000912	00000908	2010257133			2010437149	052408A
200823LO	00000913	00000908	2010257133			2010437149	052408A
200823LO	00000914	00000908	2010257133			2010437149	052408A
200823LO	00000915	00000908	2010257133			2010437149	052408A
200823LO	00000916	00000908	2010257123			2010437149	052408A
200823LO	00000917	00000908	2010257123			2010437149	052408A
200823LO	00000918	00000908	2010257123			2010437149	052408A
200823LO	00000919	00000908	2010257123			2010437149	052408A
200823LO	00000920	00000908	2010257123			2010437149	052408A
200823LO	00000921	00000908	2010257123			2010437149	052408A
200823LO	00000922	00000908	2010257123			2010437149	052408A
200823LO	00000923	00000908	2010257123			2010342842	052408A

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200820LO	00000055	1.04	65.5	9.7
LO-BENTOMAT SDN	200820LO	00000073	1.02	61.5	12.8
LO-BENTOMAT SDN	200820LO	00000091	0.96	61.5	8.8
LO-BENTOMAT SDN	200821LO	00000101	0.94	54.0	11.2
LO-BENTOMAT SDN	200823LO	00000836	0.93	62.5	6.2
LO-BENTOMAT SDN	200823LO	00000854	0.86	62.5	7.3
LO-BENTOMAT SDN	200823LO	00000872	0.94	62.5	7.9
LO-BENTOMAT SDN	200823LO	00000890	0.85	62.5	9.1
LO-BENTOMAT SDN	200823LO	00000908	0.87	62.5	10.8

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200820LO	00000055	49.5	262.2
LO-BENTOMAT SDN	200820LO	00000073	64.3	246.0
LO-BENTOMAT SDN	200820LO	00000091	47.5	246.0
LO-BENTOMAT SDN	200821LO	00000101	55.9	216.1
LO-BENTOMAT SDN	200823LO	00000836	33.3	250.1
LO-BENTOMAT SDN	200823LO	00000854	40.3	250.1
LO-BENTOMAT SDN	200823LO	00000872	43.0	250.1
LO-BENTOMAT SDN	200823LO	00000890	49.6	250.1
LO-BENTOMAT SDN	200823LO	00000908	51.7	250.1

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
042608D	27.0	14.4
042608E	30.0	14.4
052308D	25.0	15.2
052408A	26.0	15.8

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 311	2009032519	3.3	86.9
PPX 311	2009032526	3.8	105.0
PPX 311	2009032527	3.8	105.0
PPX 311	2009032529	3.3	92.3
PPX 311	2009032533	3.4	96.7
PPX 311	2010342842	3.7	76.6
PPX 311	2010342881	3.4	85.2
PPX 311	2010431244	3.9	96.5
PPX 311	2010437146	3.6	70.2
PPX 311	2010437149	3.6	70.2

CAP

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 650	2009476416	6.9	80.8
PPX 650	2010082554	8.3	178.6
PPX 650	2010231177	6.7	73.3
PPX 650	2010231188	7.0	81.3
PPX 650	2010231191	7.3	85.1
PPX 650	2010231206	6.9	85.7
PPX 650	2010231211	7.0	87.1
PPX 650	2010231216	6.7	77.2
PPX 650	2010231259	7.2	80.6
PPX 650	2010242448	7.6	94.2
PPX 650	2010257123	7.5	88.7
PPX 650	2010257133	7.6	81.7
PPX 650	2010257164	7.7	100.4

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 6/20/2008
Purchase Order: 12738-00
ORDER NUMBERS: 023940256, 023940258, 023940260

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/19/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBERS: 023940256, 023940258, 023940260
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

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Ship Date: 6/19/2008
Order Numbers: 023940256, 023940258, 023940260
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

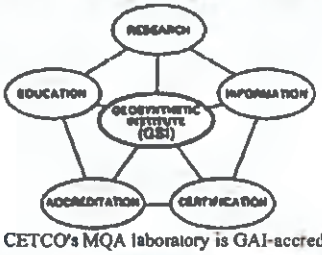
Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940256	LO-BENTOMAT SDN	200825LO	00001411	150	15	2250	2530
023940258	LO-BENTOMAT SDN	200825LO	00001414	150	15	2250	2520
023940258	LO-BENTOMAT SDN	200825LO	00001427	150	15	2250	2480
023940258	LO-BENTOMAT SDN	200825LO	00001430	150	14.5	2175	2470
023940256	LO-BENTOMAT SDN	200825LO	00001458	150	14.5	2175	2480
023940260	LO-BENTOMAT SDN	200825LO	00001476	150	15	2250	2520
023940260	LO-BENTOMAT SDN	200825LO	00001479	150	15	2250	2560
023940260	LO-BENTOMAT SDN	200825LO	00001486	150	15	2250	2610
023940256	LO-BENTOMAT SDN	200825LO	00001494	150	15	2250	2560
023940260	LO-BENTOMAT SDN	200825LO	00001497	150	15	2250	2550
023940258	LO-BENTOMAT SDN	200825LO	00001499	150	15	2250	2540
023940260	LO-BENTOMAT SDN	200825LO	00001501	150	15	2250	2565
023940256	LO-BENTOMAT SDN	200825LO	00001503	150	15	2250	2575
023940256	LO-BENTOMAT SDN	200825LO	00001504	150	15	2250	2545
023940260	LO-BENTOMAT SDN	200825LO	00001509	150	14.5	2175	2550
023940260	LO-BENTOMAT SDN	200825LO	00001510	150	14.5	2175	2555
023940256	LO-BENTOMAT SDN	200825LO	00001511	150	14.5	2175	2540
023940258	LO-BENTOMAT SDN	200825LO	00001512	150	14.5	2175	2555
023940260	LO-BENTOMAT SDN	200825LO	00001513	150	14.5	2175	2540
023940258	LO-BENTOMAT SDN	200825LO	00001514	150	14.5	2175	2535
023940260	LO-BENTOMAT SDN	200825LO	00001517	150	14.5	2175	2540
023940260	LO-BENTOMAT SDN	200825LO	00001518	150	14.5	2175	2530
023940260	LO-BENTOMAT SDN	200825LO	00001519	150	14.5	2175	2535
023940256	LO-BENTOMAT SDN	200825LO	00001520	150	14.5	2175	2540
023940260	LO-BENTOMAT SDN	200825LO	00001521	150	14.5	2175	2550
023940256	LO-BENTOMAT SDN	200825LO	00001522	150	14.5	2175	2545
023940256	LO-BENTOMAT SDN	200825LO	00001526	150	14.5	2175	2585

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940260	LO-BENTOMAT SDN	200825LO	00001527	150	14.5	2175	2565
023940256	LO-BENTOMAT SDN	200825LO	00001528	150	14.5	2175	2565
023940260	LO-BENTOMAT SDN	200825LO	00001530	150	14.5	2175	2560
023940260	LO-BENTOMAT SDN	200825LO	00001533	150	14.5	2175	2550
023940256	LO-BENTOMAT SDN	200825LO	00001534	150	14.5	2175	2540
023940256	LO-BENTOMAT SDN	200825LO	00001536	150	14.5	2175	2520
023940260	LO-BENTOMAT SDN	200825LO	00001537	150	14.5	2175	2515
023940260	LO-BENTOMAT SDN	200825LO	00001540	150	14.5	2175	2520
023940256	LO-BENTOMAT SDN	200825LO	00001541	150	14.5	2175	2530
023940256	LO-BENTOMAT SDN	200825LO	00001542	150	14.5	2175	2525
023940256	LO-BENTOMAT SDN	200825LO	00001543	150	14.5	2175	2515
023940256	LO-BENTOMAT SDN	200825LO	00001548	150	14.5	2175	2610
023940256	LO-BENTOMAT SDN	200825LO	00001549	150	14.5	2175	2605
023940258	LO-BENTOMAT SDN	200825LO	00001550	150	14.5	2175	2605
023940258	LO-BENTOMAT SDN	200825LO	00001551	150	14.5	2175	2615
023940258	LO-BENTOMAT SDN	200825LO	00001552	150	14.5	2175	2630
023940258	LO-BENTOMAT SDN	200825LO	00001553	150	14.5	2175	2675
023940258	LO-BENTOMAT SDN	200825LO	00001554	150	14.5	2175	2590
023940258	LO-BENTOMAT SDN	200825LO	00001555	150	14.5	2175	2595
023940258	LO-BENTOMAT SDN	200825LO	00001556	150	14.5	2175	2595
023940258	LO-BENTOMAT SDN	200825LO	00001557	150	14.5	2175	2615
023940258	LO-BENTOMAT SDN	200825LO	00001558	150	14.5	2175	2615
023940258	LO-BENTOMAT SDN	200825LO	00001559	150	14.5	2175	2620
023940258	LO-BENTOMAT SDN	200825LO	00001560	150	14.5	2175	2635
			Totals:	7650	745.5	111825	130515
						Total Number of Rolls Certified: 51	

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

Geotextiles	GCL		Clay	Geotextiles			Clay
	LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW		LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001411	00001383	2010495074			2010170130	060608C
200825LO	00001414	00001383	2010495085			2010170130	060608C
200825LO	00001427	00001383	2010495094			2010437136	060608D
200825LO	00001430	00001383	2010495070			2010437136	060608D
200825LO	00001458	00001383	2010496877			2010431248	060608D
200825LO	00001476	00001473	2010496888			2010437127	060608E
200825LO	00001479	00001473	2010496888			2010437127	060608E
200825LO	00001486	00001473	2010496878			2010437127	060608E
200825LO	00001494	00001491	2010496887			2010170122	060608E
200825LO	00001497	00001491	2010496885			2010170122	060608E
200825LO	00001499	00001491	2010496885			2010170122	060608E
200825LO	00001501	00001491	2010496885			2010170122	060608E
200825LO	00001503	00001491	2010496885			2010170122	060608E
200825LO	00001504	00001491	200818CV	00001612	00001610	2010170122	060608E
200825LO	00001509	00001508	200818CV	00001612	00001610	2010495964	060608E
200825LO	00001510	00001508	200818CV	00001612	00001610	2010495964	060608E
200825LO	00001511	00001508	200817CV	00001536	00001533	2010495964	060608F
200825LO	00001512	00001508	200817CV	00001536	00001533	2010495964	060608F
200825LO	00001513	00001508	200817CV	00001536	00001533	2010495964	060608F
200825LO	00001514	00001508	200817CV	00001536	00001533	2010495964	060608F
200825LO	00001517	00001508	200817CV	00001536	00001533	2010495964	060608F
200825LO	00001518	00001508	200817CV	00001532	00001523	2010495964	060608F
200825LO	00001519	00001508	200817CV	00001532	00001523	2010495964	060608F
200825LO	00001520	00001508	200817CV	00001532	00001523	2010495964	060608F
200825LO	00001521	00001508	200817CV	00001532	00001523	2010495964	060608F
200825LO	00001522	00001508	200817CV	00001532	00001523	2010496428	060608F
200825LO	00001526	00001526	200817CV	00001535	00001533	2010496428	060608F
200825LO	00001527	00001526	200817CV	00001535	00001533	2010496428	060608F
200825LO	00001528	00001526	200817CV	00001535	00001533	2010496428	060608F

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001530	00001526	200817CV	00001535	00001533	2010496428	060608F
200825LO	00001533	00001526	200817CV	00001534	00001533	2010496428	060608F
200825LO	00001534	00001526	200817CV	00001534	00001533	2010496428	060608F
200825LO	00001536	00001526	200817CV	00001534	00001533	2010496428	060608F
200825LO	00001537	00001526	200817CV	00001534	00001533	2010496428	060608F
200825LO	00001540	00001526	200817CV	00001467	00001467	2010497627	060608F
200825LO	00001541	00001526	200817CV	00001467	00001467	2010497627	060608F
200825LO	00001542	00001526	200817CV	00001467	00001467	2010497627	060608F
200825LO	00001543	00001526	200817CV	00001467	00001467	2010497627	060608F
200825LO	00001548	00001544	200817CV	00001502	00001498	2010497627	060608F
200825LO	00001549	00001544	200817CV	00001502	00001498	2010497627	060608F
200825LO	00001550	00001544	200817CV	00001502	00001498	2010497627	060608F
200825LO	00001551	00001544	200817CV	00001502	00001498	2010496440	060608F
200825LO	00001552	00001544	200817CV	00001473	00001467	2010496440	060608F
200825LO	00001553	00001544	200817CV	00001473	00001467	2010496440	060608F
200825LO	00001554	00001544	200817CV	00001473	00001467	2010496440	060608F
200825LO	00001555	00001544	200817CV	00001473	00001467	2010496440	060608F
200825LO	00001556	00001544	200817CV	00001473	00001467	2010496440	060708A
200825LO	00001557	00001544	200817CV	00001473	00001467	2010496440	060708A
200825LO	00001558	00001544	200817CV	00001473	00001467	2010496440	060708A
200825LO	00001559	00001544	200817CV	00001473	00001467	2010496440	060708A
200825LO	00001560	00001544	200817CV	00001473	00001467	2010496440	060708A

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200825LO	00001383	0.85	30.5	9
LO-BENTOMAT SDN	200825LO	00001473	0.86	44.2	7
LO-BENTOMAT SDN	200825LO	00001491	0.87	44.2	7.4
LO-BENTOMAT SDN	200825LO	00001508	0.89	44.2	6.5
LO-BENTOMAT SDN	200825LO	00001526	0.85	44.2	6.5
LO-BENTOMAT SDN	200825LO	00001544	0.90	30.7	7.2

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200825LO	00001383	47.5	119.4
LO-BENTOMAT SDN	200825LO	00001473	43.7	177.1
LO-BENTOMAT SDN	200825LO	00001491	37.0	177.0
LO-BENTOMAT SDN	200825LO	00001508	32.5	177.0
LO-BENTOMAT SDN	200825LO	00001526	33.6	177.0
LO-BENTOMAT SDN	200825LO	00001544	36.8	123.0

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
060608C	27.0	15.0
060608D	28.0	15.0
060608E	27.0	15.0
060608F	27.0	15.0
060708A	26.0	14.8

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GEOTEXTILE TEST RESULTS FOR RAW MATERIAL SUPPLIED BY A CETCO FACILITY

The GCL in certification package number 000239402 was manufactured using these geotextiles:

Material	Lot #	Roll #	Mass Area	Grab Strenth
CV-NON-WOVEN	200817CV	00001467	6.4	35.9
CV-NON-WOVEN	200817CV	00001498	6.7	42.7
CV-NON-WOVEN	200817CV	00001523	6.8	41.1
CV-NON-WOVEN	200817CV	00001533	6.6	34.7
CV-NON-WOVEN	200818CV	00001610	6.3	42.6

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE			
Material	**Roll Number**	**Mass Area oz/yd2**	**Grab Strenth lbs**
PPX 311	2010170122	3.5	72.9
PPX 311	2010170130	3.7	77.6
PPX 311	2010431248	3.6	68.8
PPX 311	2010437127	3.7	87.8
PPX 311	2010437136	4.0	74.1
PPX 311	2010495964	3.3	74.4
PPX 311	2010496428	3.9	80.4
PPX 311	2010496440	3.1	68.6
PPX 311	2010497626	3.3	72.3
CAP			
Material	**Roll Number**	**Mass Area oz/yd2**	**Grab Strenth lbs**
PPX 650	2010495070	7.2	61.9
PPX 650	2010495074	7.2	83.7
PPX 650	2010495085	7.4	62.8
PPX 650	2010495094	7.4	65.5
PPX 650	2010496877	7.5	75.0
PPX 650	2010496878	7.2	64.1
PPX 650	2010496885	7.0	58.6
PPX 650	2010496887	7.2	61.9
PPX 650	2010496888	7.2	61.9

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 6/21/2008
Purchase Order: 12738-00
ORDER NUMBERS: 023940257, 023940259, 023940261, 023940262, 023940263, 023940264, 023940266

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/20/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBERS: 023940257, 023940259, 023940261, 023940262, 023940263, 023940264, 023940266
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

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CETCO LINING TECHNOLOGIES
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Ship Date: 6/20/2008
Order Numbers: 023940257, 023940259, 023940261, 023940262, 023940263, 023940264, 023940266
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940261	LO-BENTOMAT SDN	200825LO	00001342	150	15	2250	2470
023940261	LO-BENTOMAT SDN	200825LO	00001347	150	15	2250	2470
023940261	LO-BENTOMAT SDN	200825LO	00001348	150	15	2250	2495
023940261	LO-BENTOMAT SDN	200825LO	00001350	150	15	2250	2520
023940262	LO-BENTOMAT SDN	200825LO	00001362	150	14.5	2175	2475
023940266	LO-BENTOMAT SDN	200825LO	00001366	150	14.5	2175	2460
023940266	LO-BENTOMAT SDN	200825LO	00001368	150	14.5	2175	2430
023940266	LO-BENTOMAT SDN	200825LO	00001369	150	15	2250	2450
023940261	LO-BENTOMAT SDN	200825LO	00001372	150	15	2250	2565
023940263	LO-BENTOMAT SDN	200825LO	00001373	150	15	2250	2570
023940266	LO-BENTOMAT SDN	200825LO	00001380	150	15	2250	2560
023940262	LO-BENTOMAT SDN	200825LO	00001388	150	15	2250	2580
023940257	LO-BENTOMAT SDN	200825LO	00001390	150	15	2250	2550
023940261	LO-BENTOMAT SDN	200825LO	00001391	150	15	2250	2565
023940262	LO-BENTOMAT SDN	200825LO	00001392	150	15	2250	2540
023940257	LO-BENTOMAT SDN	200825LO	00001393	150	14.5	2175	2535
023940257	LO-BENTOMAT SDN	200825LO	00001394	150	14.5	2175	2560
023940262	LO-BENTOMAT SDN	200825LO	00001395	150	15	2250	2585
023940259	LO-BENTOMAT SDN	200825LO	00001396	150	15	2250	2595
023940266	LO-BENTOMAT SDN	200825LO	00001397	150	15	2250	2530
023940262	LO-BENTOMAT SDN	200825LO	00001398	150	15	2250	2515
023940266	LO-BENTOMAT SDN	200825LO	00001399	150	15	2250	2510
023940262	LO-BENTOMAT SDN	200825LO	00001400	150	15	2250	2530
023940261	LO-BENTOMAT SDN	200825LO	00001401	150	15	2250	2545
023940259	LO-BENTOMAT SDN	200825LO	00001402	150	15	2250	2505
023940262	LO-BENTOMAT SDN	200825LO	00001403	150	15	2250	2500
023940262	LO-BENTOMAT SDN	200825LO	00001405	150	15	2250	2520

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940262	LO-BENTOMAT SDN	200825LO	00001406	150	15	2250	2540
023940261	LO-BENTOMAT SDN	200825LO	00001407	150	15	2250	2525
023940261	LO-BENTOMAT SDN	200825LO	00001408	150	15	2250	2535
023940266	LO-BENTOMAT SDN	200825LO	00001409	150	15	2250	2545
023940264	LO-BENTOMAT SDN	200825LO	00001410	150	15	2250	2510
023940263	LO-BENTOMAT SDN	200825LO	00001412	150	15	2250	2505
023940261	LO-BENTOMAT SDN	200825LO	00001413	150	15	2250	2535
023940261	LO-BENTOMAT SDN	200825LO	00001415	150	15	2250	2505
023940266	LO-BENTOMAT SDN	200825LO	00001416	150	15	2250	2540
023940266	LO-BENTOMAT SDN	200825LO	00001417	150	15	2250	2510
023940266	LO-BENTOMAT SDN	200825LO	00001418	150	15	2250	2500
023940266	LO-BENTOMAT SDN	200825LO	00001419	150	15	2250	2495
023940261	LO-BENTOMAT SDN	200825LO	00001420	150	15	2250	2485
023940262	LO-BENTOMAT SDN	200825LO	00001421	150	15	2250	2470
023940262	LO-BENTOMAT SDN	200825LO	00001422	150	15	2250	2485
023940262	LO-BENTOMAT SDN	200825LO	00001423	150	15	2250	2490
023940263	LO-BENTOMAT SDN	200825LO	00001425	150	15	2250	2475
023940261	LO-BENTOMAT SDN	200825LO	00001426	150	15	2250	2455
023940259	LO-BENTOMAT SDN	200825LO	00001428	150	14.5	2175	2450
023940257	LO-BENTOMAT SDN	200825LO	00001429	150	14.5	2175	2445
023940261	LO-BENTOMAT SDN	200825LO	00001431	150	14.5	2175	2490
023940266	LO-BENTOMAT SDN	200825LO	00001432	150	14.5	2175	2505
023940266	LO-BENTOMAT SDN	200825LO	00001433	150	14.5	2175	2510
023940266	LO-BENTOMAT SDN	200825LO	00001434	150	14.5	2175	2480
023940261	LO-BENTOMAT SDN	200825LO	00001435	150	14.5	2175	2495
023940262	LO-BENTOMAT SDN	200825LO	00001436	150	14.5	2175	2460
023940259	LO-BENTOMAT SDN	200825LO	00001437	150	14.5	2175	2475
023940263	LO-BENTOMAT SDN	200825LO	00001438	150	14.5	2175	2490
023940263	LO-BENTOMAT SDN	200825LO	00001439	150	14.5	2175	2465
023940261	LO-BENTOMAT SDN	200825LO	00001440	150	14.5	2175	2470
023940266	LO-BENTOMAT SDN	200825LO	00001441	150	14.5	2175	2455
023940259	LO-BENTOMAT SDN	200825LO	00001442	150	14.5	2175	2460

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940266	LO-BENTOMAT SDN	200825LO	00001443	150	14.5	2175	2470
023940264	LO-BENTOMAT SDN	200825LO	00001444	150	14.5	2175	2475
023940262	LO-BENTOMAT SDN	200825LO	00001445	150	14.5	2175	2460
023940259	LO-BENTOMAT SDN	200825LO	00001446	150	14.5	2175	2480
023940263	LO-BENTOMAT SDN	200825LO	00001447	150	14.5	2175	2485
023940266	LO-BENTOMAT SDN	200825LO	00001448	150	14.5	2175	2440
023940259	LO-BENTOMAT SDN	200825LO	00001449	150	14.5	2175	2450
023940259	LO-BENTOMAT SDN	200825LO	00001450	150	14.5	2175	2455
023940263	LO-BENTOMAT SDN	200825LO	00001451	150	14.5	2175	2450
023940264	LO-BENTOMAT SDN	200825LO	00001452	150	14.5	2175	2450
023940261	LO-BENTOMAT SDN	200825LO	00001453	150	14.5	2175	2490
023940262	LO-BENTOMAT SDN	200825LO	00001454	150	14.5	2175	2475
023940259	LO-BENTOMAT SDN	200825LO	00001455	150	14.5	2175	2480
023940259	LO-BENTOMAT SDN	200825LO	00001456	150	14.5	2175	2460
023940259	LO-BENTOMAT SDN	200825LO	00001457	150	14.5	2175	2465
023940264	LO-BENTOMAT SDN	200825LO	00001459	150	14.5	2175	2450
023940259	LO-BENTOMAT SDN	200825LO	00001460	150	14.5	2175	2460
023940259	LO-BENTOMAT SDN	200825LO	00001461	150	14.5	2175	2455
023940259	LO-BENTOMAT SDN	200825LO	00001462	150	14.5	2175	2490
023940264	LO-BENTOMAT SDN	200825LO	00001463	150	14.5	2175	2510
023940263	LO-BENTOMAT SDN	200825LO	00001464	150	14.5	2175	2520
023940259	LO-BENTOMAT SDN	200825LO	00001465	150	14.5	2175	2500
023940263	LO-BENTOMAT SDN	200825LO	00001466	150	14.5	2175	2485
023940262	LO-BENTOMAT SDN	200825LO	00001467	150	14.5	2175	2470
023940262	LO-BENTOMAT SDN	200825LO	00001468	150	14.5	2175	2465
023940259	LO-BENTOMAT SDN	200825LO	00001469	150	14.5	2175	2440
023940259	LO-BENTOMAT SDN	200825LO	00001470	150	14.5	2175	2455
023940263	LO-BENTOMAT SDN	200825LO	00001471	150	14.5	2175	2520
023940264	LO-BENTOMAT SDN	200825LO	00001472	150	14.5	2175	2515
023940264	LO-BENTOMAT SDN	200825LO	00001473	150	14.5	2175	2530
023940264	LO-BENTOMAT SDN	200825LO	00001474	150	15	2250	2545
023940264	LO-BENTOMAT SDN	200825LO	00001475	150	15	2250	2560

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Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940264	LO-BENTOMAT SDN	200825LO	00001477	150	15	2250	2510
023940264	LO-BENTOMAT SDN	200825LO	00001478	150	15	2250	2525
023940257	LO-BENTOMAT SDN	200825LO	00001480	150	15	2250	2500
023940264	LO-BENTOMAT SDN	200825LO	00001481	150	15	2250	2505
023940257	LO-BENTOMAT SDN	200825LO	00001482	150	15	2250	2635
023940257	LO-BENTOMAT SDN	200825LO	00001483	150	15	2250	2620
023940257	LO-BENTOMAT SDN	200825LO	00001484	150	15	2250	2605
023940263	LO-BENTOMAT SDN	200825LO	00001485	150	15	2250	2600
023940263	LO-BENTOMAT SDN	200825LO	00001487	150	15	2250	2605
023940264	LO-BENTOMAT SDN	200825LO	00001489	150	15	2250	2600
023940264	LO-BENTOMAT SDN	200825LO	00001490	150	15	2250	2590
023940264	LO-BENTOMAT SDN	200825LO	00001491	150	15	2250	2545
023940257	LO-BENTOMAT SDN	200825LO	00001492	150	15	2250	2560
023940263	LO-BENTOMAT SDN	200825LO	00001493	150	15	2250	2590
023940264	LO-BENTOMAT SDN	200825LO	00001495	150	15	2250	2555
023940263	LO-BENTOMAT SDN	200825LO	00001496	150	15	2250	2540
023940264	LO-BENTOMAT SDN	200825LO	00001498	150	15	2250	2545
023940257	LO-BENTOMAT SDN	200825LO	00001505	150	14.5	2175	2550
023940263	LO-BENTOMAT SDN	200825LO	00001506	150	14.5	2175	2525
023940257	LO-BENTOMAT SDN	200825LO	00001508	150	14.5	2175	2545
023940263	LO-BENTOMAT SDN	200825LO	00001515	150	14.5	2175	2550
023940257	LO-BENTOMAT SDN	200825LO	00001516	150	14.5	2175	2545
023940263	LO-BENTOMAT SDN	200825LO	00001523	150	14.5	2175	2540
023940257	LO-BENTOMAT SDN	200825LO	00001524	150	14.5	2175	2525
023940257	LO-BENTOMAT SDN	200825LO	00001525	150	14.5	2175	2595
023940257	LO-BENTOMAT SDN	200825LO	00001529	150	14.5	2175	2570
023940257	LO-BENTOMAT SDN	200825LO	00001544	150	14.5	2175	2520
023940257	LO-BENTOMAT SDN	200825LO	00001545	150	14.5	2175	2530
			Totals:	17850	1755	263250	298865
				Total Number of Rolls Certified: 119			

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001342	00001329	2010496879			2010342857	060508C
200825LO	00001347	00001347	2010496546			2010342857	060508C
200825LO	00001348	00001347	2010496546			2010342857	060508C
200825LO	00001350	00001347	2010496546			2010342857	060508C
200825LO	00001362	00001347	2010496551			2010342888	060608B
200825LO	00001366	00001365	2010496551			2010342888	060608B
200825LO	00001368	00001365	2010495066			2010342888	060608B
200825LO	00001369	00001365	2010495066			2010342879	060608B
200825LO	00001372	00001365	2010495066			2010342879	060608B
200825LO	00001373	00001365	2010495066			2010342879	060608B
200825LO	00001380	00001365	2010495082			2010342879	060608C
200825LO	00001388	00001383	2010496567			2010342851	060608C
200825LO	00001390	00001383	2010496876			2010342851	060608C
200825LO	00001391	00001383	2010496876			2010342851	060608C
200825LO	00001392	00001383	2010496876			2010342851	060608C
200825LO	00001393	00001383	2010496876			2010342851	060608C
200825LO	00001394	00001383	2010496876			2010342851	060608C
200825LO	00001395	00001383	2010496876			2010431249	060608C
200825LO	00001396	00001383	2010496876			2010431249	060608C
200825LO	00001397	00001383	2010496876			2010431249	060608C
200825LO	00001398	00001383	2010495058			2010431249	060608C
200825LO	00001399	00001383	2010495058			2010431249	060608C
200825LO	00001400	00001383	2010495058			2010431249	060608C
200825LO	00001401	00001401	2010495058			2010431249	060608C
200825LO	00001402	00001401	2010495058			2010431249	060608C
200825LO	00001403	00001401	2010495058			2010431249	060608C
200825LO	00001405	00001401	2010495058			2010431249	060608C
200825LO	00001406	00001401	2010495074			2010431249	060608C
200825LO	00001407	00001401	2010495074			2010431249	060608C

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001408	00001401	2010495074			2010431249	060608C
200825LO	00001409	00001401	2010495074			2010431249	060608C
200825LO	00001410	00001401	2010495074			2010170130	060608C
200825LO	00001412	00001401	2010495074			2010170130	060608C
200825LO	00001413	00001401	2010495085			2010170130	060608C
200825LO	00001415	00001401	2010495085			2010170130	060608C
200825LO	00001416	00001401	2010495085			2010170130	060608C
200825LO	00001417	00001401	2010495085			2010170130	060608C
200825LO	00001418	00001401	2010495085			2010170130	060608C
200825LO	00001419	00001419	2010495085			2010170130	060608C
200825LO	00001420	00001419	2010495085			2010170130	060608C
200825LO	00001421	00001419	2010495094			2010170130	060608C
200825LO	00001422	00001419	2010495094			2010170130	060608D
200825LO	00001423	00001419	2010495094			2010170130	060608D
200825LO	00001425	00001419	2010495094			2010170130	060608D
200825LO	00001426	00001419	2010495094			2010170130	060608D
200825LO	00001428	00001419	2010495094			2010437136	060608D
200825LO	00001429	00001419	2010495070			2010437136	060608D
200825LO	00001431	00001419	2010495070			2010437136	060608D
200825LO	00001432	00001419	2010495070			2010437136	060608D
200825LO	00001433	00001419	2010495070			2010437136	060608D
200825LO	00001434	00001419	2010495070			2010437136	060608D
200825LO	00001435	00001419	2010495070			2010437136	060608D
200825LO	00001436	00001419	2010495070			2010437136	060608D
200825LO	00001437	00001437	2010495077			2010437136	060608D
200825LO	00001438	00001437	2010495077			2010437136	060608D
200825LO	00001439	00001437	2010495077			2010437136	060608D
200825LO	00001440	00001437	2010495077			2010437136	060608D
200825LO	00001441	00001437	2010495077			2010437136	060608D
200825LO	00001442	00001437	2010495077			2010437136	060608D
200825LO	00001443	00001437	2010495077			2010495959	060608D
200825LO	00001444	00001437	2010496889			2010495959	060608D
200825LO	00001445	00001437	2010496889			2010495959	060608D
200825LO	00001446	00001437	2010496889			2010495959	060608D
200825LO	00001447	00001437	2010496889			2010495959	060608D

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001448	00001437	2010496889			2010495959	060608D
200825LO	00001449	00001437	2010496889			2010495959	060608D
200825LO	00001450	00001437	2010496889			2010495959	060608D
200825LO	00001451	00001437	2010495080			2010495959	060608D
200825LO	00001452	00001437	2010495080			2010431248	060608D
200825LO	00001453	00001437	2010495080			2010431248	060608D
200825LO	00001454	00001437	2010495080			2010431248	060608D
200825LO	00001455	00001455	2010495080			2010431248	060608D
200825LO	00001456	00001455	2010495080			2010431248	060608D
200825LO	00001457	00001455	2010495080			2010431248	060608D
200825LO	00001459	00001455	2010496877			2010431248	060608D
200825LO	00001460	00001455	2010496877			2010431248	060608D
200825LO	00001461	00001455	2010496877			2010431248	060608D
200825LO	00001462	00001455	2010496877			2010431248	060608D
200825LO	00001463	00001455	2010496877			2010431248	060608D
200825LO	00001464	00001455	2010496877			2010431248	060608D
200825LO	00001465	00001455	2010496877			2010431248	060608E
200825LO	00001466	00001455	2010495084			2010431248	060608E
200825LO	00001467	00001455	2010495084			2010431248	060608E
200825LO	00001468	00001455	2010495084			2010431248	060608E
200825LO	00001469	00001455	2010495084			2010431248	060608E
200825LO	00001470	00001455	2010495084			2010431248	060608E
200825LO	00001471	00001455	2010495084			2010431248	060608E
200825LO	00001472	00001455	2010495084			2010431248	060608E
200825LO	00001473	00001473	2010496888			2010437127	060608E
200825LO	00001474	00001473	2010496888			2010437127	060608E
200825LO	00001475	00001473	2010496888			2010437127	060608E
200825LO	00001477	00001473	2010496888			2010437127	060608E
200825LO	00001478	00001473	2010496888			2010437127	060608E
200825LO	00001480	00001473	2010496888			2010437127	060608E
200825LO	00001481	00001473	2010496878			2010437127	060608E
200825LO	00001482	00001473	2010496878			2010437127	060608E
200825LO	00001483	00001473	2010496878			2010437127	060608E
200825LO	00001484	00001473	2010496878			2010437127	060608E
200825LO	00001485	00001473	2010496878			2010437127	060608E

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GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001487	00001473	2010496878			2010437127	060608E
200825LO	00001489	00001473	2010496887			2010170122	060608E
200825LO	00001490	00001473	2010496887			2010170122	060608E
200825LO	00001491	00001491	2010496887			2010170122	060608E
200825LO	00001492	00001491	2010496887			2010170122	060608E
200825LO	00001493	00001491	2010496887			2010170122	060608E
200825LO	00001495	00001491	2010496887			2010170122	060608E
200825LO	00001496	00001491	2010496887			2010170122	060608E
200825LO	00001498	00001491	2010496885			2010170122	060608E
200825LO	00001505	00001491	200818CV	00001612	00001610	2010495964	060608E
200825LO	00001506	00001491	200818CV	00001612	00001610	2010495964	060608E
200825LO	00001508	00001508	200818CV	00001612	00001610	2010495964	060608E
200825LO	00001515	00001508	200817CV	00001536	00001533	2010495964	060608F
200825LO	00001516	00001508	200817CV	00001536	00001533	2010495964	060608F
200825LO	00001523	00001508	200817CV	00001532	00001523	2010496428	060608F
200825LO	00001524	00001508	200817CV	00001532	00001523	2010496428	060608F
200825LO	00001525	00001508	200817CV	00001535	00001533	2010496428	060608F
200825LO	00001529	00001526	200817CV	00001535	00001533	2010496428	060608F
200825LO	00001544	00001544	200817CV	00001467	00001467	2010497627	060608F
200825LO	00001545	00001544	200817CV	00001467	00001467	2010497627	060608F

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200825LO	00001329	0.85	38.7	12.1
LO-BENTOMAT SDN	200825LO	00001347	0.88	38.7	10.5
LO-BENTOMAT SDN	200825LO	00001365	0.94	30.5	7.4
LO-BENTOMAT SDN	200825LO	00001383	0.85	30.5	9
LO-BENTOMAT SDN	200825LO	00001401	1.00	30.5	30.5
LO-BENTOMAT SDN	200825LO	00001419	0.88	30.5	6.9
LO-BENTOMAT SDN	200825LO	00001437	0.93	30.5	6.6
LO-BENTOMAT SDN	200825LO	00001455	0.92	44.2	7.1
LO-BENTOMAT SDN	200825LO	00001473	0.89	44.2	7
LO-BENTOMAT SDN	200825LO	00001491	0.87	44.2	7.4
LO-BENTOMAT SDN	200825LO	00001508	0.89	44.2	6.5
LO-BENTOMAT SDN	200825LO	00001526	0.85	44.2	6.5
LO-BENTOMAT SDN	200825LO	00001544	0.90	30.7	7.2

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200825LO	00001329	60.7	154.9
LO-BENTOMAT SDN	200825LO	00001347	38.7	154.9
LO-BENTOMAT SDN	200825LO	00001365	39.3	119.4
LO-BENTOMAT SDN	200825LO	00001383	47.5	119.4
LO-BENTOMAT SDN	200825LO	00001401	45.4	119.4
LO-BENTOMAT SDN	200825LO	00001419	38.8	119.4
LO-BENTOMAT SDN	200825LO	00001437	37.2	119.4
LO-BENTOMAT SDN	200825LO	00001455	35.3	177.1
LO-BENTOMAT SDN	200825LO	00001473	43.7	177.1
LO-BENTOMAT SDN	200825LO	00001491	37.0	177.0
LO-BENTOMAT SDN	200825LO	00001508	32.5	177.0
LO-BENTOMAT SDN	200825LO	00001526	33.6	177.0
LO-BENTOMAT SDN	200825LO	00001544	36.8	123.0

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
060508C	25.0	17.0
060608B	27.0	15.0
060608C	27.0	15.0
060608D	28.0	15.0
060608E	27.0	15.0
060608F	27.0	15.0

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GEOTEXTILE TEST RESULTS FOR RAW MATERIAL SUPPLIED BY A CETCO FACILITY

The GCL in certification package number 000239402 was manufactured using these geotextiles:

Material	Lot #	Roll #	Mass Area	Grab Strenth
CV-NON-WOVEN	200817CV	00001467	6.4	35.9
CV-NON-WOVEN	200817CV	00001523	6.8	41.1
CV-NON-WOVEN	200817CV	00001533	6.6	34.7
CV-NON-WOVEN	200818CV	00001610	6.3	42.6

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 311	2010170122	3.5	72.9
PPX 311	2010170130	3.7	77.6
PPX 311	2010342851	3.9	92.1
PPX 311	2010342857	3.6	91.5
PPX 311	2010342879	3.6	85.1
PPX 311	2010342888	3.6	85.3
PPX 311	2010431248	3.6	68.8
PPX 311	2010431249	3.6	68.8
PPX 311	2010437127	3.7	87.8
PPX 311	2010437136	4.0	74.1
PPX 311	2010495959	4.1	90.1
PPX 311	2010495964	3.3	74.4
PPX 311	2010496428	3.9	80.4
PPX 311	2010497626	3.3	72.3

CAP

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 650	2010495058	8.0	65.7
PPX 650	2010495066	7.7	70.9
PPX 650	2010495070	7.2	61.9
PPX 650	2010495074	7.2	83.7
PPX 650	2010495077	7.2	83.7
PPX 650	2010495080	8.0	65.5
PPX 650	2010495082	7.4	62.8
PPX 650	2010495084	7.4	62.8
PPX 650	2010495085	7.4	62.8
PPX 650	2010495094	7.4	65.5
PPX 650	2010496546	7.2	69.6
PPX 650	2010496551	6.8	70.0
PPX 650	2010496567	7.9	77.1
PPX 650	2010496876	7.5	75.0
PPX 650	2010496877	7.5	75.0
PPX 650	2010496878	7.2	64.1

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PPX 650	2010496879	7.2	64.1
PPX 650	2010496885	7.0	58.6
PPX 650	2010496887	7.2	61.9
PPX 650	2010496888	7.2	61.9
PPX 650	2010496889	7.2	61.9

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 6/23/2008
Purchase Order: 12738-00
ORDER NUMBER: 023940265

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/22/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBER: 023940265
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

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Ship Date: 6/22/2008
Order Number: 023940265
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940265	LO-BENTOMAT SDN	200825LO	00001340	150	15	2250	2500
023940265	LO-BENTOMAT SDN	200825LO	00001343	150	15	2250	2450
023940265	LO-BENTOMAT SDN	200825LO	00001344	150	15	2250	2490
023940265	LO-BENTOMAT SDN	200825LO	00001349	150	15	2250	2505
023940265	LO-BENTOMAT SDN	200825LO	00001351	150	15	2250	2510
023940265	LO-BENTOMAT SDN	200825LO	00001353	150	15	2250	2470
023940265	LO-BENTOMAT SDN	200825LO	00001354	150	14.5	2175	2460
023940265	LO-BENTOMAT SDN	200825LO	00001355	150	14.5	2175	2455
023940265	LO-BENTOMAT SDN	200825LO	00001356	150	14.5	2175	2440
023940265	LO-BENTOMAT SDN	200825LO	00001357	150	14.5	2175	2490
023940265	LO-BENTOMAT SDN	200825LO	00001358	150	14.5	2175	2485
023940265	LO-BENTOMAT SDN	200825LO	00001364	150	14.5	2175	2485
023940265	LO-BENTOMAT SDN	200825LO	00001370	150	15	2250	2510
023940265	LO-BENTOMAT SDN	200825LO	00001375	150	15	2250	2535
023940265	LO-BENTOMAT SDN	200825LO	00001383	150	15	2250	2570
023940265	LO-BENTOMAT SDN	200825LO	00001424	150	15	2250	2460
023940265	LO-BENTOMAT SDN	200825LO	00001488	150	15	2250	2610
			Totals:	2550	252	37800	42425
				Total Number of Rolls Certified: 17			

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001340	00001329	2010496879			2010342857	060508C
200825LO	00001343	00001329	2010496879			2010342857	060508C
200825LO	00001344	00001329	2010496879			2010342857	060508C
200825LO	00001349	00001347	2010496546			2010342857	060508C
200825LO	00001351	00001347	2010496546			2010342888	060508C
200825LO	00001353	00001347	2010495083			2010342888	060508C
200825LO	00001354	00001347	2010495083			2010342888	060508C
200825LO	00001355	00001347	2010495083			2010342888	060508C
200825LO	00001356	00001347	2010495083			2010342888	060508C
200825LO	00001357	00001347	2010495083			2010342888	060508C
200825LO	00001358	00001347	2010495083			2010342888	060508C
200825LO	00001364	00001347	2010496551			2010342888	060608B
200825LO	00001370	00001365	2010495066			2010342879	060608B
200825LO	00001375	00001365	2010495066			2010342879	060608C
200825LO	00001383	00001383	2010496567			2010342851	060608C
200825LO	00001424	00001419	2010495094			2010170130	060608D
200825LO	00001488	00001473	2010496887			2010170122	060608E

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200825LO	00001329	0.85	38.7	12.1
LO-BENTOMAT SDN	200825LO	00001347	0.88	38.7	10.5
LO-BENTOMAT SDN	200825LO	00001365	0.94	30.5	7.4
LO-BENTOMAT SDN	200825LO	00001383	0.85	30.5	9
LO-BENTOMAT SDN	200825LO	00001419	0.88	30.5	6.9
LO-BENTOMAT SDN	200825LO	00001473	0.89	44.2	7

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200825LO	00001329	60.7	154.9
LO-BENTOMAT SDN	200825LO	00001347	38.7	154.9
LO-BENTOMAT SDN	200825LO	00001365	39.3	119.4
LO-BENTOMAT SDN	200825LO	00001383	47.5	119.4
LO-BENTOMAT SDN	200825LO	00001419	38.8	119.4
LO-BENTOMAT SDN	200825LO	00001473	43.7	177.1

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
060508C	25.0	17.0
060608B	27.0	15.0
060608C	27.0	15.0
060608D	28.0	15.0
060608E	27.0	15.0

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE			
Material	**Roll Number**	**Mass Area oz/yd2**	**Grab Strenth lbs**
PPX 311	2010170122	3.5	72.9
PPX 311	2010170130	3.7	77.6
PPX 311	2010342851	3.9	92.1
PPX 311	2010342857	3.6	91.5
PPX 311	2010342879	3.6	85.1
PPX 311	2010342888	3.6	85.3

CAP			
Material	**Roll Number**	**Mass Area oz/yd2**	**Grab Strenth lbs**
PPX 650	2010495066	7.7	70.9
PPX 650	2010495083	7.4	62.8
PPX 650	2010495094	7.4	65.5
PPX 650	2010496546	7.2	69.6
PPX 650	2010496551	6.8	70.0
PPX 650	2010496567	7.9	77.1
PPX 650	2010496879	7.2	64.1
PPX 650	2010496887	7.2	61.9

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 6/25/2008
Purchase Order: 12738-00
ORDER NUMBER: 023940267

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/24/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBER: 023940267
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
92 Hwy. 37
Lovell, WY 82431

Telephone: 800-322-1149 ext. 413
Fax:
E-Mail: rwilke@cetco.com

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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO
LINING TECHNOLOGIES
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Ship Date: 6/24/2008
Order Number: 023940267
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940267	LO-BENTOMAT SDN	200825LO	00001341	150	15	2250	2485
023940267	LO-BENTOMAT SDN	200825LO	00001345	150	15	2250	2505
023940267	LO-BENTOMAT SDN	200825LO	00001346	150	15	2250	2510
023940267	LO-BENTOMAT SDN	200825LO	00001352	150	15	2250	2510
023940267	LO-BENTOMAT SDN	200825LO	00001359	150	14.5	2175	2510
023940267	LO-BENTOMAT SDN	200825LO	00001360	150	14.5	2175	2475
023940267	LO-BENTOMAT SDN	200825LO	00001376	150	15	2250	2550
023940267	LO-BENTOMAT SDN	200825LO	00001382	150	15	2250	2555
023940267	LO-BENTOMAT SDN	200825LO	00001386	150	15	2250	2590
023940267	LO-BENTOMAT SDN	200825LO	00001500	150	15	2250	2550
023940267	LO-BENTOMAT SDN	200825LO	00001507	150	14.5	2175	2540
023940267	LO-BENTOMAT SDN	200825LO	00001531	150	14.5	2175	2580
023940267	LO-BENTOMAT SDN	200825LO	00001532	150	14.5	2175	2560
023940267	LO-BENTOMAT SDN	200825LO	00001535	150	14.5	2175	2530
023940267	LO-BENTOMAT SDN	200825LO	00001538	150	14.5	2175	2535
023940267	LO-BENTOMAT SDN	200825LO	00001546	150	14.5	2175	2515
023940267	LO-BENTOMAT SDN	200825LO	00001547	150	14.5	2175	2565
			Totals:	2550	250.5	37575	43065
						Total Number of Rolls Certified:	17

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001341	00001329	2010496879			2010342857	060508C
200825LO	00001345	00001329	2010496546			2010342857	060508C
200825LO	00001346	00001329	2010496546			2010342857	060508C
200825LO	00001352	00001347	2010496546			2010342888	060508C
200825LO	00001359	00001347	2010495083			2010342888	060508C
200825LO	00001360	00001347	2010496551			2010342888	060508C
200825LO	00001376	00001365	2010495082			2010342879	060608C
200825LO	00001382	00001365	2010495082			2010342879	060608C
200825LO	00001386	00001383	2010496567			2010342851	060608C
200825LO	00001500	00001491	2010496885			2010170122	060608E
200825LO	00001507	00001491	200818CV	00001612	00001610	2010495964	060608E
200825LO	00001531	00001526	200817CV	00001535	00001533	2010496428	060608F
200825LO	00001532	00001526	200817CV	00001534	00001533	2010496428	060608F
200825LO	00001535	00001526	200817CV	00001534	00001533	2010496428	060608F
200825LO	00001538	00001526	200817CV	00001534	00001533	2010496428	060608F
200825LO	00001546	00001544	200817CV	00001502	00001498	2010497627	060608F
200825LO	00001547	00001544	200817CV	00001502	00001498	2010497627	060608F

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200825LO	00001329	0.85	38.7	12.1
LO-BENTOMAT SDN	200825LO	00001347	0.88	38.7	10.5
LO-BENTOMAT SDN	200825LO	00001365	0.94	30.5	7.4
LO-BENTOMAT SDN	200825LO	00001383	0.85	30.5	9
LO-BENTOMAT SDN	200825LO	00001491	0.87	44.2	7.4
LO-BENTOMAT SDN	200825LO	00001526	0.85	44.2	6.5
LO-BENTOMAT SDN	200825LO	00001544	0.90	30.7	7.2

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200825LO	00001329	60.7	154.9
LO-BENTOMAT SDN	200825LO	00001347	38.7	154.9
LO-BENTOMAT SDN	200825LO	00001365	39.3	119.4
LO-BENTOMAT SDN	200825LO	00001383	47.5	119.4
LO-BENTOMAT SDN	200825LO	00001491	37.0	177.0
LO-BENTOMAT SDN	200825LO	00001526	33.6	177.0
LO-BENTOMAT SDN	200825LO	00001544	36.8	123.0

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
060508C	25.0	17.0
060608C	27.0	15.0
060608E	27.0	15.0
060608F	27.0	15.0

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GEOTEXTILE TEST RESULTS FOR RAW MATERIAL SUPPLIED BY A CETCO FACILITY

The GCL in certification package number 000239402 was manufactured using these geotextiles:

Material	Lot #	Roll #	Mass Area	Grab Strenth
CV-NON-WOVEN	200817CV	00001498	6.7	42.7
CV-NON-WOVEN	200817CV	00001533	6.6	34.7
CV-NON-WOVEN	200818CV	00001610	6.3	42.6

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 311	2010170122	3.5	72.9
PPX 311	2010342851	3.9	92.1
PPX 311	2010342857	3.6	91.5
PPX 311	2010342879	3.6	85.1
PPX 311	2010342888	3.6	85.3
PPX 311	2010495964	3.3	74.4
PPX 311	2010496428	3.9	80.4
PPX 311	2010497626	3.3	72.3

CAP

Material	Roll Number	Mass Area oz/yd2	Grab Strenth lbs
PPX 650	2010495082	7.4	62.8
PPX 650	2010495083	7.4	62.8
PPX 650	2010496546	7.1	61.8
PPX 650	2010496546	7.2	69.6
PPX 650	2010496551	6.8	70.0
PPX 650	2010496551	7.1	61.8
PPX 650	2010496567	7.9	77.1
PPX 650	2010496879	7.2	64.1
PPX 650	2010496885	7.0	58.6

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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Date: 7/1/2008
Purchase Order: 12738-00
ORDER NUMBER: 023940268

Tom Heasley
GSI-Headquarters

Waukesha, WI 53188-6904
theasley@geo-synthetics.com

To Whom it May Concern:

Please find enclosed the MQA/MQC test data package for Geosynthetic Clay Liner shipments to GSI-Headquarters. The shipments left our Lovell, Wyoming plant on 6/30/2008.

If you have any questions regarding this information, please contact me at 800-322-1149 ext. 413.

Sincerely,

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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GEOSYNTHETIC CLAY LINER
MANUFACTURING QUALITY ASSURANCE DATA PACKAGE

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
ORDER NUMBER: 023940268
PREPARED FOR: GSI-Headquarters

CONTENTS:

- Daily production and needle detection certification
- GCL property specifications
- Order packing list
- GCL MQA tracking form
- GCL manufacturing quality control test data
- Bentonite clay certification
- Raw material test results

PREPARED BY: Roger B. Wilkerson
Quality Assurance Coordinator
CETCO
P.O. Box 428
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Telephone: 800-322-1149 ext. 413
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E-Mail: rwilke@cetco.com

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PRODUCTION CERTIFICATION

PROJECT NAME: Ameren Duck Creek
CUSTOMER P.O.: 12738-00
PREPARED FOR: GSI-Headquarters

CETCO affirms that these products meet the physical and chemical criteria listed on the attached GCL property specification sheet.

NEEDLE REMOVAL AND DETECTION PROCEDURE

CETCO hereby affirms that all Bentomat® geosynthetic clay liner material manufactured for this project is continually passed under a magnet for needle removal and then screened with a metal detection device. CETCO certifies Bentomat® to be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product.

Roger B. Wilkerson
Quality Assurance Coordinator
Colloid Environmental Technologies Co. (CETCO)

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Ship Date: 6/30/2008
Order Number: 023940268
Prepared For: GSI-Headquarters

The GCL raw materials and GCL finished product manufactured for the above-referenced order number(s) are hereby certified to achieve the properties listed in the tables below.

GCL PROPERTY SPECIFICATIONS FOR BENTOMAT SDN

Test Method	Test Method Property	Test Frequency	Certified Value
ASTM D 5891	Bentonite Fluid Loss	1 per 50 Tons	18 ml Max
ASTM D 5993	Bentonite Mass/Area	40,000 sq ft (4000 sq m)	0.75 lb /sq ft (3.6 kg/sq m) Min
ASTM D 5890	Bentonite Swell Index	1 per 50 Tons	24 ml/2g Min
ASTM D 4632	GCL Grab Strength	200,000 sq ft (20,000 sq m)	90 lbs (400 N) MARV
ASTM D 6768	GCL Grab Strength	200,000 sq ft (20,000 sq m)	30 lbs/in MARV
ASTM D 5321	GCL Hydrated Internal Shear Strength	Periodic	500 psf (24 kPa) typ @ 200 psf
ASTM D 5887	GCL Hydraulic Conductivity	Weekly	5 x 10^-9 cm/ sec Max
ASTM D 5887	GCL Index Flux	Weekly	1 x 10^-8 m^3/m^2/sec Max
ASTM D 6496	GCL Peel Strength	40,000 sq ft (4000 sq m)	2.5 lbs/in Min
ASTM D 4632	GCL Peel Strength	40,000 sq ft (4000 sq m)	15 lbs (65 N) Min

SPECIALY REQUESTED CERTIFIED PROPERTIES FOR THIS ORDER OF BENTOMAT SDN

Test Method	Test Method Property	Requested Frequency	Requested Value	Requested Conditions
ASTM D 4632	GCL Grab Strength	Standard	Standard	Standard
ASTM D 4632	GCL Peel Strength	Standard	Standard	Standard

Bentonite property tests are performed at a bentonite processing facility before shipment to CETCO's production facility.
All tensile testing is in the machine direction.

FABRIC SUPPLIER REQUIREMENTS FOR BENTOMAT SDN

Raw Material	test method	mass per area	units
Nonwoven Cover Fabric	ASTM D 5261	6.0	oz/yd2
Bentomat SDN Base Nonwoven Fabric	ASTM D 5261	2.7	oz/yd2

Fabric certifications from our raw material suppliers are on file at our production facility.



CETCO's MQA laboratory is GAI-accredited (www.geosynthetic-institute.org/gai/lab.html).

Roger B. Wilkerson
Quality Assurance Coordinator
CETCO Lovell Plant

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CETCO
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GCL ORDER PACKING LIST

GCL shipped for certification package number 000239402

Order #	Product	Lot Number	Roll Number	Length (ft)	Width (ft)	Square Ft	Weight (lbs)
023940268	LO-BENTOMAT SDN	200825LO	00001363	150	14.5	2175	2460
023940268	LO-BENTOMAT SDN	200825LO	00001365	150	14.5	2175	2490
023940268	LO-BENTOMAT SDN	200825LO	00001367	150	14.5	2175	2455
023940268	LO-BENTOMAT SDN	200825LO	00001371	150	15	2250	2530
023940268	LO-BENTOMAT SDN	200825LO	00001374	150	15	2250	2540
023940268	LO-BENTOMAT SDN	200825LO	00001377	150	15	2250	2515
023940268	LO-BENTOMAT SDN	200825LO	00001378	150	15	2250	2520
023940268	LO-BENTOMAT SDN	200825LO	00001379	150	15	2250	2545
023940268	LO-BENTOMAT SDN	200825LO	00001381	150	15	2250	2580
023940268	LO-BENTOMAT SDN	200825LO	00001384	150	15	2250	2565
023940268	LO-BENTOMAT SDN	200825LO	00001385	150	15	2250	2530
023940268	LO-BENTOMAT SDN	200825LO	00001387	150	15	2250	2575
023940268	LO-BENTOMAT SDN	200825LO	00001389	150	15	2250	2570
023940268	LO-BENTOMAT SDN	200825LO	00001404	150	15	2250	2515
023940268	LO-BENTOMAT SDN	200825LO	00001502	150	15	2250	2570
023940268	LO-BENTOMAT SDN	200825LO	00001539	150	14.5	2175	2510
			Totals:	2400	238	35700	40470
				Total Number of Rolls Certified: 16			

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GCL MQA TRACKING FORM

Listing of finished and raw materials used to produce certification package number 000239402

GCL			Geotextiles				Clay
LO-BENTOMAT SDN			LO-N/W-WHITE-DN LW			LO-N/W-BLK-DNLW-2.7	LO-CG 50-DN LWNW
GCL Lot #	GCL Roll #	Roll # Tested	Cap Lot #	Cap Roll #	Roll # Tested	Base Roll #	Clay Lot #
200825LO	00001363	00001347	2010496551			2010342888	060608B
200825LO	00001365	00001365	2010496551			2010342888	060608B
200825LO	00001367	00001365	2010496551			2010342888	060608B
200825LO	00001371	00001365	2010495066			2010342879	060608B
200825LO	00001374	00001365	2010495066			2010342879	060608C
200825LO	00001377	00001365	2010495082			2010342879	060608C
200825LO	00001378	00001365	2010495082			2010342879	060608C
200825LO	00001379	00001365	2010495082			2010342879	060608C
200825LO	00001381	00001365	2010495082			2010342879	060608C
200825LO	00001384	00001383	2010496567			2010342851	060608C
200825LO	00001385	00001383	2010496567			2010342851	060608C
200825LO	00001387	00001383	2010496567			2010342851	060608C
200825LO	00001389	00001383	2010496567			2010342851	060608C
200825LO	00001404	00001401	2010495058			2010431249	060608C
200825LO	00001502	00001491	2010496885			2010170122	060608E
200825LO	00001539	00001526	200817CV	00001467	00001467	2010497627	060608F

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GCL MANUFACTURING QUALITY CONTROL TEST DATA

The following rolls in GCL certification package number 000239402 have been tested in our production facility lab.

Product	Lot # Tested	Roll # Tested	Mass Area	Grab Strength	Peel Strength
		Standard Test Method:	ASTM D 5993	ASTM D 6768	ASTM D 6496
		Standard Specification:	0.75 lb/sq ft MARV	30lbs/in MARV	2.5lbs/in MARV
Non-standard specifications were requested for this order as indicated on the attatched property sheet					
LO-BENTOMAT SDN	200825LO	00001347	0.88	38.7	10.5
LO-BENTOMAT SDN	200825LO	00001365	0.94	30.5	7.4
LO-BENTOMAT SDN	200825LO	00001383	0.85	30.5	9
LO-BENTOMAT SDN	200825LO	00001401	1.00	30.5	30.5
LO-BENTOMAT SDN	200825LO	00001491	0.87	44.2	7.4
LO-BENTOMAT SDN	200825LO	00001526	0.85	44.2	6.5

Product	Lot # Tested	Roll # Tested	PEEL 4632	GRAB 4632
LO-BENTOMAT SDN	200825LO	00001347	38.7	154.9
LO-BENTOMAT SDN	200825LO	00001365	39.3	119.4
LO-BENTOMAT SDN	200825LO	00001383	47.5	119.4
LO-BENTOMAT SDN	200825LO	00001401	45.4	119.4
LO-BENTOMAT SDN	200825LO	00001491	37.0	177.0
LO-BENTOMAT SDN	200825LO	00001526	33.6	177.0

ASTM test methods and property specifications per CETCO standard unless non-standard specifications were requested.
Any non-standard property specifications requested for this order are noted on the attached GCL property specifications sheet.

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BENTONITE CLAY CERTIFICATION

The Bentonite Clay used to produce package 000239402 has been tested by American Colloid Company and yeilded the following test results.

Reference	Swell	Fluid Loss
Test Method:	ASTM D 5890	ASTM D 5891
Specification:	24 Min	18 ml Max
060608B	27.0	15.0
060608C	27.0	15.0
060608E	27.0	15.0
060608F	27.0	15.0

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GEOTEXTILE TEST RESULTS FOR RAW MATERIAL SUPPLIED BY A CETCO FACILITY

The GCL in certification package number 000239402 was manufactured using these geotextiles:

Material	Lot #	Roll #	Mass Area	Grab Strenth
CV-NON-WOVEN	200817CV	00001467	6.4	35.9

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GEOTEXTILE TEST RESULTS FROM MATERIAL SUPPLIERS

The GCL in certification package number 000239402 was manufactured with geotextiles which were tested with the following results.

BASE			
Material	**Roll Number**	**Mass Area oz/yd2**	**Grab Strenth lbs**
PPX 311	2010170122	3.5	72.9
PPX 311	2010342851	3.9	92.1
PPX 311	2010342879	3.6	85.1
PPX 311	2010342888	3.6	85.3
PPX 311	2010431249	3.6	68.8
PPX 311	2010497626	3.3	72.3
CAP			
Material	**Roll Number**	**Mass Area oz/yd2**	**Grab Strenth lbs**
PPX 650	2010495058	8.0	65.7
PPX 650	2010495066	7.7	70.9
PPX 650	2010495082	7.4	62.8
PPX 650	2010496551	6.8	70.0
PPX 650	2010496551	7.1	61.8
PPX 650	2010496567	7.9	77.1
PPX 650	2010496885	7.0	58.6

Certifications from our suppliers are on file at our production facility. An '*' or 'PT' indicates supplier certifications were unavailable prior to shipping so testing was performed at a CETCO lab.

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GEOSYNTHETIC CLAY LINER MANUFACTURER QUALITY CONTROL PERMEABILITY TESTING RESULTS

Electronic Filing: Received, Clerk's Office 06/20/2024

CETCO - 92 HWY 37, Lovell, WY. 82431 Computation Sheet : GRI Accredited ASTM D-5887, Index Flux

Sample: Bentomat SDN
Lot Number: 200820LO
Roll Number: 19
Project Name: Weekly Perm

Permeability equation : ((0.879*Thickness)/(2*Pi*r^2*Time))*ln(Change in Head)

Flux equation : ((Inflow+Outflow)/200)/Pi*r^2/Time

Initial Thickness : 0.835 cm. **Hydration :** 48hrs **Permeant :** De-aired DI Water **Date:** 6/6/2008

Test Position : CET-L-306 **Initial Head :** 2psi 140.6 cm **Analyst :** SW **Date Started:** 5/16/2008

Cell Size : 4 in. **Max. Effective Stress :** 5psi 34.5kPa **Requested by :**

Final Thickness : 0.732 cm.

*** indicates value meets Flux Ratio ASTM termination criteria**

Conversions : 1 psi

Flux (English) = Flux * 9.2366E+10

Date	Time (min)	Reading In	X	Reading Out	Y	X-Y	Head (cm)	H (cm)	Initial K (cm/sec)	Initial Flux ($m^3/m^2/sec$)		Avg Flux ($m^3/m^2/sec$)	Final K (cm/sec)	Final Flux (Gal/Acre /Day)	Inflow to Outflow Ratio
6/2/2008	0	0.0	24.0	24.0	0.0	24.0	140.63	164.63							
	108	0.7	23.3	23.3	0.7	22.6	140.63	163.23	5.97E-09	1.33E-08			5.23E-9		1.00
	490	3.0	21.0	21.1	2.9	18.1	140.63	158.73	5.52E-09	1.21E-08	*		4.84E-9		1.05
	596	3.6	20.4	20.5	3.5	16.9	140.63	157.53	5.40E-09	1.16E-08	*		4.73E-9		1.00
	741	4.5	19.5	19.7	4.3	15.2	140.63	155.83	5.65E-09	1.21E-08	*		4.95E-9		1.13
6/3/2008	1069	6.4	17.6	17.7	6.3	11.3	140.63	151.93	5.83E-09	1.22E-08	*		5.11E-9		0.95
	1170	7.0	17.0	17.1	6.9	10.1	140.63	150.73	5.92E-09	1.22E-08	*		5.19E-9		1.00
	1368	8.2	15.8	16.0	8.0	7.8	140.63	148.43	5.86E-09	1.19E-08	*		5.14E-9		1.09
	1520	9.0	15.0	15.1	8.9	6.1	140.63	146.73	5.72E-09	1.15E-08	*		5.01E-9		0.89
	2020	11.9	12.1	12.3	11.7	0.4	140.63	141.03	5.98E-09	1.17E-08	*		5.24E-9		1.04
	2190	12.8	11.2	11.4	12.6	-1.4	140.63	139.23	5.70E-09	1.09E-08	*		5.00E-9		1.00
6/4/2008	2490	14.4	9.6	9.7	14.3	-4.7	140.63	135.93	6.03E-09	1.13E-08	*		5.29E-9		0.94
	2596	14.9	9.1	9.2	14.8	-5.7	140.63	134.93	5.26E-09	9.70E-09	*		4.61E-9		1.00
	2805	15.8	8.2	8.1	15.9	-7.7	140.63	132.93	5.39E-09	9.84E-09	*	**1.03E-08**	4.73E-9	950	0.82
															-1.95

Final Flux **1.0E-8** $m^3/m^2/sec$

Final Hydraulic Conductivity **4.9E-9** cm/s

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CETCO - 92 HWY 37, Lovell, WY. 82431 Computation Sheet : GRI Accredited ASTM D-5887, Index Flux

Sample: Bentomat SDN
Lot Number: 200821LO
Roll Number: 209
Project Name: Weekly Perm

Permeability equation : ((0.879*Thickness)/(2*Pi*r^2*Time))*ln(Change in Head)

Flux equation : ((Inflow+Outflow)/200)/Pi*r^2/Time

Initial Thickness : 0.832 cm.
Hydration : 48hrs
Permeant : De-aired DI Water
Date: 9/2/2008

Test Position : CET-L-303
Initial Head : 2psi 140.6 cm
Analyst : SW
Date Started: 5/22/2008

Cell Size : 4 in.
Max. Effective Stress : 5psi 34.5kPa
Requested by :

Final Thickness : 0.730 cm.

*** indicates value meets Flux Ratio ASTM termination criteria**

Conversions : 1 psi

Flux (English) = Flux * 9.2366E+10

Date	Time (min)	Reading In	X	Reading Out	Y	X-Y	Head (cm)	H (cm)	Initial K (cm/sec)	Initial Flux ($m^3/m^2/sec$)		Avg Flux ($m^3/m^2/sec$)	Final K (cm/sec)	Final Flux (Gal/Acre /Day)	Inflow to Outflow Ratio
6/30/2008	0	0.0	24.0	24.0	0.0	24.0	140.63	164.63							
	100	0.7	23.3	23.3	0.7	22.6	140.63	163.23	6.42E-09	1.44E-08			5.63E-9		1.00
	237	1.6	22.4	22.4	1.6	20.8	140.63	161.43	6.08E-09	1.35E-08	*		5.34E-9		1.00
	573	3.8	20.2	20.2	3.8	16.4	140.63	157.03	6.18E-09	1.35E-08	*		5.42E-9		1.00
	683	4.6	19.4	19.4	4.6	14.8	140.63	155.43	7.00E-09	1.50E-08	*		6.14E-9		1.00
7/1/2008	1205	7.9	16.1	16.1	7.9	8.2	140.63	148.83	6.25E-09	1.30E-08	*		5.48E-9		1.00
	1351	8.8	15.2	15.3	8.7	6.5	140.63	147.13	5.91E-09	1.20E-08	*		5.19E-9		1.13
	1549	9.9	14.1	14.1	9.9	4.2	140.63	144.83	5.98E-09	1.19E-08	*		5.25E-9		0.92
	1675	10.6	13.4	13.3	10.7	2.7	140.63	143.33	6.21E-09	1.22E-08	*		5.45E-9		0.88
	2151	13.4	10.6	10.6	13.4	-2.8	140.63	137.83	6.18E-09	1.19E-08	*		5.42E-9		1.04
7/2/2008	2642	16.4	7.6	7.6	16.4	-8.8	140.63	131.83	6.81E-09	1.26E-08	*		5.98E-9		1.00
	2767	17.1	6.9	6.9	17.1	-10.2	140.63	130.43	6.42E-09	1.15E-08	*		5.63E-9		1.00
	2998	18.4	5.6	5.6	18.4	-12.8	140.63	127.83	6.55E-09	1.16E-08	*		5.75E-9		1.00
	3118	18.7	5.3	5.3	18.7	-13.4	140.63	127.23	2.95E-09	5.14E-09			2.59E-9		1.00
	3220	19.0	5.0	5.0	19.0	-14.0	140.63	126.63	3.48E-09	6.05E-09	*		3.06E-9		1.00
	3321	19.3	4.7	4.7	19.3	-14.6	140.63	126.03	3.53E-09	6.11E-09	*		3.10E-9		1.00
	3421	19.6	4.4	4.4	19.6	-15.2	140.63	125.43	3.59E-09	6.17E-09	*	6.11E-09	3.15E-9	564	1.00
															-4.45

Final Flux 6.1E-9 $m^3/m^2/sec$

Final Hydraulic Conductivity 3.1E-9 cm/s

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CETCO - 92 HWY 37, Lovell, WY. 82431 Computation Sheet : GRI Accredited ASTM D-6887, Index Flux

Sample: Bentomat SDN
Lot Number: 200822LO
Roll Number: 575
Project Name: Weekly Perm

Permeability equation : ((0 879*Thickness)/(2*Pi*r^2*Time))*ln(Change in Head)

Flux equation : ((Inflow+Outflow)/200)/Pi*r^2/Time

Initial Thickness : 0.832 cm. **Hydration :** 48hrs **Permeant :** De-aired DI Water **Date:** 9/2/2008

Test Position : CET-L-303 **Initial Head :** 2psi 140 6 cm. **Analyst :** SW **Date Started:** 5/30/2008

Cell Size : 4 in. **Max. Effective Stress :** 5psi 34.5kPa **Requested by :**

Final Thickness : 0.730 cm.

* indicates value meets Flux Ratio ASTM termination criteria

Conversions : 1 psi

Flux (English) = Flux * 9.2366E+10

Date	Time (min)	Reading In	X	Reading Out	Y	X-Y	Head (cm)	H (cm)	Initial K (cm/sec)	Initial Flux ($m^3/m^2/sec$)		Avg Flux ($m^3/m^2/sec$)	Final K (cm/sec)	Final Flux (Gal/Acre /Day)	Inflow to Outflow Ratio
6/30/2008	0	0.0	24 0	24.0	0.0	24 0	140.63	164 63							
	100	0.7	23 3	23.4	0.6	22.7	140.63	163.33	5.96E-09	1.34E-08			5.23E-9		1.17
	237	1.5	22 5	22.6	1.4	21.1	140.63	161.73	5.40E-09	1.20E-08	*		4 74E-9		1 00
	573	3.5	20 5	20.6	3.4	17.1	140.63	157.73	5.60E-09	1.22E-08	*		4.92E-9		1 00
	683	4.2	19 8	19 9	4.1	15.7	140.63	156.33	6.09E-09	1 31E-08	*		5.35E-9		1 00
7/1/2008	1205	7 2	16.8	16.9	7 1	9 7	140.63	150.33	5.64E-09	1.18E-08	*		4.94E-9		1 00
	1351	8.0	16 0	16.1	7.9	8 1	140.63	148.73	5.51E-09	1.13E-08	*		4 83E-9		1.00
	1549	9.1	14 9	15.1	8.9	6.0	140.63	146.63	5.40E-09	1.09E-08	*		4.74E-9		1.10
	1675	9.7	14.3	14.4	9.6	4.7	140 63	145 33	5.31E-09	1.06E-08	*		4 66E-9		0.86
	2151	12.3	11.7	11.8	12.2	-0.5	140 63	140 13	5.75E-09	1.12E-08	*		5.05E-9		1.00
7/2/2008	2642	15.0	9.0	9.0	15.0	-6 0	140.63	134.63	6.13E-09	1.15E-08	*		5.38E-9		0 96
	2767	15.7	8.3	8 4	15 6	-7.3	140.63	133.33	5.83E-09	1.07E-08	*		5 12E-9		1 17
	2998	16.9	7.1	7.2	16.8	-9.7	140.63	130.93	5.91E-09	1.07E-08	*		5.19E-9		1 00
	3118	17.2	6.8	6 9	17.1	-10.3	140.63	130.33	2.88E-09	5.14E-09			2.52E-9		1.00
	3220	17.5	6.5	6 6	17.4	-10.9	140.63	129.73	3.40E-09	6.05E-09	*		2.98E-9		1.00
	3321	17.8	6.2	6 3	17.7	-11.5	140.63	129.13	3.45E-09	6.11E-09	*		3.03E-9		1.00
	3421	18.1	5 9	6 0	18.0	-12.1	140.63	128 53	3.50E-09	6.17E-09	*	6.11E-09	3.07E-9	564	1.00
							Final Flux	**6.1E-9**	**$m^3/m^2/sec$**						-3 02
							Final Hydraulic Conductivity	**3.0E-9**	**cm/s**						

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CETCO - 92 HWY 37, Lovell, WY. 82431 Computation Sheet : GRI Accredited ASTM D-5887, Index Flux

Sample: Bentomat SDN
Lot Number: 200823LO
Roll Number: 890
Project Name: Weekly Perm

Permeability equation : ((0.879*Thickness)/(2*Pi*r^2*Time))*ln(Change in Head)

Flux equation : ((Inflow+Outflow)/200)/Pi*r^2/Time

Initial Thickness : 0.826 cm. **Hydration :** 48hrs **Permeant :** De-aired DI Water **Date:** 6/18/2008

Test Position : CET-L-302 **Initial Head :** 2psi 140.6 cm **Analyst :** SW **Date Started:** 6/6/2008

Cell Size : 4 in. **Max. Effective Stress :** 5psi 34.5kPa **Requested by :**

Final Thickness : 0.727 cm.

* indicates value meets Flux Ratio ASTM termination criteria

Conversions : 1 psi

Flux (English) = Flux * 9.2366E+10

Date	Time (min)	Reading In	X	Reading Out	Y	X-Y	Head (cm)	H (cm)	Initial K (cm/sec)	Initial Flux ($m^3/m^2/sec$)		Avg Flux ($m^3/m^2/sec$)	Final K (cm/sec)	Final Flux (Gal/Acre /Day)	Inflow to Outflow Ratio
6/16/2008	0	0.0	24.0	24.0	0.0	24.0	140.63	164.63							
	168	1.0	23.0	23.2	0.8	22.2	140.63	162.83	4.88E-09	1.10E-08			4.30E-9		1.25
	274	1.5	22.5	22.7	1.3	21.2	140.63	161.83	4.34E-09	9.70E-09	*		3.82E-9		1.00
	368	2.0	22.0	22.2	1.8	20.2	140.63	160.83	4.92E-09	1.09E-08	*		4.33E-9		1.00
	505	2.7	21.3	21.5	2.5	18.8	140.63	159.43	4.76E-09	1.05E-08	*		4.19E-9		1.00
	658	3.5	20.5	20.8	3.2	17.3	140.63	157.93	4.61E-09	1.01E-08	*		4.06E-9		1.14
	789	4.3	19.7	20.1	3.9	15.8	140.63	156.43	5.44E-09	1.18E-08	*		4.78E-9		1.14
6/17/2008	1372	7.3	16.7	17.2	6.8	9.9	140.63	150.53	4.92E-09	1.04E-08	*		4.33E-9		1.03
	1497	7.9	16.1	16.6	7.4	8.7	140.63	149.33	4.78E-09	9.87E-09	*		4.21E-9		1.00
	1645	8.7	15.3	15.9	8.1	7.2	140.63	147.83	5.09E-09	1.04E-08	*		4.48E-9		1.14
	1889	10.0	14.0	14.6	9.4	4.6	140.63	145.23	5.43E-09	1.10E-08	*		4.78E-9		1.00
	2006	10.6	13.4	14.0	10.0	3.4	140.63	144.03	5.29E-09	1.05E-08	*		4.66E-9		1.00
	2100	11.0	13.0	13.6	10.4	2.6	140.63	143.23	4.42E-09	8.75E-09	*		3.89E-9		1.00
	2229	11.7	12.3	12.9	11.1	1.2	140.63	141.83	5.68E-09	1.12E-08			5.00E-9		1.00
6/18/2008	2740	14.3	9.7	10.5	13.5	-3.8	140.63	136.83	5.24E-09	1.01E-08	*		4.61E-9		1.08
	2856	14.8	9.2	10.0	14.0	-4.8	140.63	135.83	4.72E-09	8.86E-09	*		4.15E-9		1.00
	2980	15.4	8.6	9.4	14.6	-6.0	140.63	134.63	5.34E-09	9.95E-09	*	9.62E-09	4.70E-9	889	1.00
															-1.64

Final Flux 9.6E-9 $m^3/m^2/sec$

Final Hydraulic Conductivity 4.5E-9 cm/s

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CETCO - 92 HWY 37, Lovell, WY. 82431 Computation Sheet : GRI Accredited ASTM D-5887, Index Flux

Sample: Bentomat SDN
Lot Number: 200824LO
Roll Number: 945
Project Name: Weekly Perm

Permeability equation : ((0.879*Thickness)/(2*Pi*r^2*Time))*ln(Change in Head)

Flux equation : ((Inflow+Outflow)/200)/Pi*r^2/Time

Initial Thickness : 0.861 cm. **Hydration :** 48hrs **Permeant :** De-aired DI Water **Date:** 9/2/2008

Test Position : CET-L-301 **Initial Head :** 2psi 140.6 cm **Analyst :** SW **Date Started:** 6/27/2008

Cell Size : 4 in. **Max. Effective Stress :** 5psi 34.5kPa **Requested by :**

Final Thickness : 0.778 cm.

*** indicates value meets Flux Ratio ASTM termination criteria**

Conversions : 1 psi

Flux (English) = Flux * 9.2366E+10

Date	Time (min)	Reading In	X	Reading Out	Y	X-Y	Head (cm)	H (cm)	Initial K (cm/sec)	Initial Flux ($m^3/m^2/sec$)		Avg Flux ($m^3/m^2/sec$)	Final K (cm/sec)	Final Flux (Gal/Acre/Day)	Inflow to Outflow Ratio
7/7/2008	0	0.0	24.0	24.0	0.0	24.0	140.63	164.63							
	101	0.5	23.5	23.8	0.2	23.3	140.63	163.93	3.28E-09	7.12E-09			2.97E-9		2.50
	203	0.9	23.1	23.2	0.8	22.3	140.63	162.93	4.67E-09	1.01E-08			4.22E-9		0.67
	373	1.7	22.3	22.4	1.6	20.7	140.63	161.33	4.52E-09	9.67E-09	*		4.08E-9		1.00
7/8/2008	1334	6.5	17.5	17.9	6.1	11.4	140.63	152.03	4.81E-09	9.95E-09	*		4.34E-9		1.07
	1449	7.0	17.0	17.4	6.6	10.4	140.63	151.03	4.46E-09	8.94E-09	*		4.03E-9		1.00
	1695	8.3	15.7	16.3	7.7	8.0	140.63	148.63	5.07E-09	1.00E-08	*		4.58E-9		1.18
	1815	8.8	15.2	15.7	8.3	6.9	140.63	147.53	4.82E-09	9.42E-09	*		4.35E-9		0.83
7/9/2008	2799	13.5	10.5	11.2	12.8	-2.3	140.63	138.33	5.09E-09	9.61E-09	*		4.60E-9		1.04
	2947	14.2	9.8	10.5	13.5	-3.7	140.63	136.93	5.35E-09	9.72E-09	*		4.83E-9		1.00
	3060	14.7	9.3	10.0	14.0	-4.7	140.63	135.93	5.05E-09	9.10E-09	*	9.48E-09	4.56E-9	875	1.00
							Final Flux		**9.5E-9**	**$m^3/m^2/sec$**					-1.47
							Final Hydraulic Conductivity		**4.7E-9**	**cm/s**					

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INDEX FLUX AND PERMEABILITY OF GCL's
TEST RESULTS
ASTM D-5887 / D-5084

JLT

Client	: CETCO		Date	:	07/09/2008
Project Location	: Weekly Perm		Job No.	:	08LG1342.01
Sample Number	: Roll 1455	Lot: 200825LO	Tested By	:	RL
Description	: Bentomat SDN		Checked By	:	JB
Permeant Fluid	: De-Aired Water				

Physical Property Data

		Total Sample			Total Sample
Initial Clay Height (in)	:	0.17	Final Height of Clay (in)	:	0.19
Initial Diameter (in)	:	4.00	Final Diameter of Clay (in)	:	4.00
Initial Wet Weight (g)	:	42.30	Final Wet Weight(Clay) (g)	:	65.50
Wet Density (pcf)	:	75.37	Wet Density (pcf)	:	104.42
Moisture Content %	:	33.80	Moisture Content %	:	107.20
Dry Density (pcf)	:	56.33	Dry Density (pcf)	:	50.39

Test Parameters

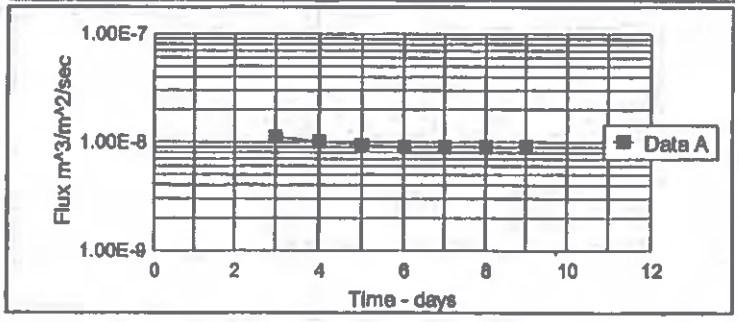
Fluid	:	De-Aired Water	Average Effective		
Cell Pressure psi)	:	80.00	Confining Pressure (psi)	:	4
Head Water psi)	:	77.00	Gradient	:	290.53
Tail Water psi)	:	75.00	Effective Stress at Base	:	5

Flux and Permeability Input Data

Minimum Saturation Time is 48 hours

Area, A = 0.00811 m^2
Thickness, t = 0.19 in

Days	Date	Flow	Time	Elapsed	Flux	k
		cc	min	Time (sec)	(m^3/m^2)/sec	cm/sec
1	06/30/2008	48 hours of hydration per ASTM				
2	07/01/2008					
3	07/02/2008	7.90	1441	86460	1.13E-008	3.86E-009
4	07/03/2008	7.10	1440	86400	1.01E-008	3.49E-009
5	07/04/2008	6.60	1440	86400	9.42E-009	3.24E-009
6	07/05/2008	6.40	1442	86520	9.12E-009	3.14E-009
7	07/06/2008	6.40	1439	86340	9.14E-009	3.15E-009
8	07/07/2008	6.40	1439	86340	9.14E-009	3.15E-009
9	07/08/2008	6.40	1441	86460	9.13E-009	3.14E-009



JLT Laboratories, Inc. 938 S Central Ave, Canonsburg, Pa. 15317 Tel 724-745-4441 , Fax 724-745-4261

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APPENDIX B
SUPPORTING AQUEOUS ANALYTICAL DATA

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APPENDIX B.
SUPPORTING AQUEOUS ANALYTICAL DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
DUCK CREEK POWER PLANT
GMF POND
CANTON, IL

Well ID	Well Type	Date	Parameter	Result	Unit
X301	Leachate	06/09/2020	Boron, total	19.0	mg/L
X301	Leachate	11/19/2020	Boron, total	93.0	mg/L
X301	Leachate	02/24/2021	Boron, total	29.0	mg/L
X301	Leachate	04/14/2021	Boron, total	97.0	mg/L
X301	Leachate	04/29/2021	Boron, total	88.0	mg/L
X301	Leachate	05/12/2021	Boron, total	84.0	mg/L
X301	Leachate	06/01/2021	Boron, total	98.0	mg/L
X301	Leachate	07/26/2021	Boron, total	85.0	mg/L
X301	Leachate	08/12/2021	Boron, total	85.0	mg/L
X301	Leachate	11/19/2021	Boron, total	87.0	mg/L
X301	Leachate	02/21/2022	Boron, total	2.00	mg/L
X301	Leachate	05/10/2023	Boron, total	76.0	mg/L
XTPW02	Porewater	06/23/2021	Boron, total	63.0	mg/L

Notes:
mg/L = milligrams per liter

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APPENDIX C
TECHNICAL MEMORANDUM: DRAFT GEOCHEMICAL ANALYSIS OF DUCK CREEK GROUNDWATER IN SUPPORT OF AN ALTERNATIVE SOURCE DEMONSTRATION (ASD)

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TECHNICAL MEMORANDUM

DATE November 8, 2023 **Reference No.** 23RAM01-1

TO Brian G. Hennings - Ramboll
Eric Tlachac - Ramboll

CC Stu Cravens - Vistra

FROM Shannon Zahuranec, Allie Wyman, and Tom Meuzelaar **EMAIL:** shannon@lifecyclegeo.com

GEOCHEMICAL ANALYSIS OF DUCK CREEK GMF POND GROUNDWATER IN SUPPORT OF AN ALTERNATE SOURCE DEMONSTRATION (ASD)

1.0 EXECUTIVE SUMMARY

This document serves as an Appendix to the November 11, 2023, Alternative Source Demonstration (ASD) for Duck Creek Power Plant (DC) Gypsum Management Facility Pond (GMF Pond) for monitoring Event 1 (E001) (referred to as the E001 ASD), completed to fulfill the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.650(e). Life Cycle Geo, LLC (LCG) has completed a review of geochemical conditions to evaluate the feasibility of an ASD at monitoring well G60L associated with the DC GMF Pond. Compliance well G60L monitors conditions in the Uppermost Aquifer (UA) to the east of the GMF Pond and currently exhibits pH levels lower than the groundwater protection standard (GWPS) range for pH. This technical review considered all available groundwater and solid-phase chemical analysis and empirical field observations, and utilized multivariate statistical analysis to conclude the low pH levels at G60L is due to an alternate source and is unrelated to the GMF Pond. Further, information pertaining to flow conditions, lithology, and solid-phase geochemistry are utilized to conclude that the likely source of low pH is a localized pocket of native peat identified in boring logs immediately upgradient of G60L. This scope of work was executed by subcontract to Ramboll Americas Engineering Solutions, Inc. (Ramboll) on behalf of Electric Energy Inc (EEI).

2.0 GROUNDWATER CONDITIONS

Monitoring well G60L is located on the eastern side and downgradient of the GMF Pond (Attachment 1). From 2021 through May 2023 (the period of groundwater monitoring at this well for the 35 I.A.C. § 845 monitoring program), pH at G60L is consistently lower than the GWPS (Table 1).

Table 1: Concentration Ranges for Select Constituents in Compliance Well G60L and Background Groundwater. Data in Appendix B-1

	pH	Sulfate, total (mg/L)	TDS (mg/L)
G60L	5.90-6.42	150-180	510-630
Background	6.42-7.26	ND-56	290-490

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3.0 MULTIVARIATE PRINCIPAL COMPONENTS ANALYSIS

3.1 APPROACH

Groundwater chemistry data are by nature multivariate datasets given the high number of parameters observed per sampling location and date. With such a large number of variables, advanced statistical analysis of multivariate groundwater data can provide important insights into spatial and chemical relationships influencing constituent distribution and compliance in groundwater. The multivariate technique Principal Components Analysis (PCA) is used to interrogate the groundwater chemistry around the GMF Pond.

PCA is a multivariate technique that reduces dataset dimensionality to its principal, independent components thereby revealing the inner structure of the dataset. Multivariate techniques such as PCA are valuable because they identify variables that are highly dependent on each other but do not inherently provide insights into water origin, type, or evolution. As an example, calcium, magnesium, and hardness are typically highly correlated in groundwater datasets, but this relationship is known and does not provide additional insight towards the identification of water types and geochemical processes that describe water quality changes. Reducing multivariate data dimensionality reduces redundant information, revealing inner structures in the data that might otherwise be obscured by these dependencies. These structures might include revealing groups of related variables, changing chemical evolution through time, or spatial locations with similar chemical signatures.

PCA results are most easily viewed on biplots, which depict the sample population plotted on two axes, each representing a principal component. The principal components are created from a linear combination of the original variables in the dataset and variance in the data. For natural compositional datasets, the population variance can often be expressed as six or seven principal components (in some cases less and in others, more), each representing decreasing amounts of variance in the data while remaining uncorrelated to previous principal components. Typically, the first few principal components represent significant dataset variance and include a larger number of variables. The principal components are visualized using biplots with the variables expressed as vectors; the location of groups of samples relative to component vectors provides insight into geochemical relationships among groups of variables and samples.

3.2 DATA PREPARATION

In order to perform multivariate analysis, it is first necessary to prepare the dataset. Raw chemical data requires preparation prior to analysis because the data often contains values in two forms unsuitable for advanced analytics: 1) measurements reported below a method detection limit (MDL), referred to as censored data, and 2) missing values. For this work any sample or analyte with a high percentage (≥40%) of missing and/or censored data was assessed for meaningful statistical variance. If variance was determined to be low, the sample or analyte was removed, otherwise data was included in the analysis. Any remaining censored data was converted to half the MDL. Remaining missing values were imputed, a method of assigning an estimated value that accounts for the entire distribution of the material's composition (Sanford et al., 1993) and also takes into consideration the values associated with samples of similar composition. Imputation was done with a nearest neighbor algorithm and resulting values were checked against the overall data distribution for both the analyte and sample to ensure representative results. The resulting

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dataset includes both compliance wells and other monitoring wells, incorporates data from multiple lithologic units, and spans sampling events from 2014 through 2023. The dataset contains 15 measured analytes, including the hydrogen ion (H+), which represents acidity in groundwater and is proportional to pH. The final dataset contained 1425 values, 54 of which were imputed. This data represents both the most recent data measured at the GMF Pond as well as the most complete set of regularly measured and detectable analytes. All data used in PCA analysis is presented in Electronic Attachment 1.

PCA also requires transformation of the dataset to address the numeric closure problem inherent within chemical compositional datasets (Aitchison, 1986). Numeric closure can often occur in water quality data since water quality concentrations are not completely independent. To address this issue, all data was converted to the same units and the centered-log ratio transformation (CLR; Aitchison 1986; Egozcue et al. 2011) was applied to the prepared dataset. In practice, closure only significantly affects elements present in large concentrations (e.g., major ions in typical water quality samples), but for consistency the entire dataset (i.e., including trace metals) was CLR-transformed.

All data preparation was conducted using python programming language. Only total (i.e., unfiltered) concentrations of major ions and metals were used in this analysis as those data are both relatively complete and consistent across the wells around the GMF Pond and are the parameters of interest for regulatory purposes.

3.3 FINDINGS

A biplot for principal components 1 and 2 (PC1 and PC2) is provided in Attachment 2. PC1 explains approximately 53% of the statistical variance in the entire water quality dataset, and imposes the dominant compositional structure observed in the biplot. PC2 explains approximately 14% of the variability in the dataset.

The compositional vectors on the biplot and their position/spacing reveal the following key insights into groundwater geochemistry at the GMF Pond:

1) Groundwater samples plot along a linear trend from the upper left quadrant toward the lower left quadrant, with significant overlap between background, compliance, and monitoring wells. This suggests overall groundwater chemistry at compliance wells and monitoring wells is compositionally similar to background conditions.
2) Data from G60L plots between H+, calcium, sodium, and sulfate vectors, indicating in this case the concentrations are relatively high compared with other locations consistent with the pH exceedance at this location. Monitoring well G50L also plots between these vectors, suggesting possible compositional end members distinct from the main cluster of background and compliance wells.
3) The majority of porewater and leachate samples plot in the upper right quadrant of the biplot, near the boron, fluoride, and molybdenum vectors. These samples plot far from the groundwater samples, indicating the chemistry of the porewater and leachate is distinct from the chemistry of the groundwater. There are three leachate samples that plot away from the main body of leachate data, with one plotting in the lower right quadrant near the magnesium and chloride vectors. These three samples are (1) chemically distinct from the groundwater samples, (2) irregularly spaced in time, and (3) likely represent anomalous conditions unique to the GMF Pond. These samples are discussed further in Section 4.2.

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4.0 MAJOR ION DISTRIBUTION

4.1 APPROACH

Piper diagrams are a useful way to classify water samples based on major ion chemistry. The diagrams include separate ternary anion and cation proportion plots and a central diamond plot for classifying combined cation/anion predominance for overall classification. Piper diagrams account for major ion proportionality, but not for actual concentrations nor trace element chemistry, an important contrast and complement to PCA.

The Piper diagram for the GMF Pond is provided in Attachment 3. Given the large number of sampling locations and sampling instances, the data plotted here is limited to background, leachate, and groundwater wells in the immediate vicinity of G60L over the same time period as the samples included in the PCA. This provides the clearest depiction of both the site-wide data and localized geochemistry around G60L and allows for ease of comparison to the PCA. To provide a more robust evaluation of the local geochemistry in the area of the GMF Pond and to increase the density of datapoints at wells near G60L, the groundwater wells immediately adjacent to G60L are presented as a combination of dissolved and total major ions, rather than exclusively total ions. The difference between total and dissolved major ions was determined qualitatively through comparison of values when both total and dissolved were measured. No major differences were observed, therefore when total phase data was not available, dissolved data was used in place. All data used in the Piper diagram is presented in Appendix B-2.

4.2 FINDINGS

The primary finding from the Piper diagram is that groundwater at G60L exhibits a major ion composition that is distinct from the GMF Pond leachate. The groundwater samples near G60L all have consistent cation proportions with almost equal distributions of calcium and magnesium, consistent with other compliance groundwater wells around the GMF Pond (Ramboll 2023). The leachate samples differ in that they primarily show a more magnesium-dominant signature. Similarly, the anion proportions of groundwater are distinct from leachate, particularly with respect to chloride. The groundwater samples all show low chloride proportion but exhibit a wide range of sulfate proportion. In contrast, the leachate shows a more consistent composition of anions with a substantial proportion of chloride. The chloride-rich signature of the leachate samples provides critical evidence of chemical separation between leachate and G60L groundwater. Chloride is a conservative ion with regard to groundwater transport, such that it does not tend to interact with the solid phase once dissolved into solution. Therefore, groundwater impacted by GMF Pond leachate should contain a chloride proportion similar to the leachate, or at a proportion falling along a mixing line between the groundwater and leachate. Such a mixing signal is not observed, which paired with low chloride proportion in the groundwater (Attachment 5), is strong evidence that the groundwater at G60L is not influenced by the GMF Pond. This is consistent with the PCA results, which showed both the variability in the groundwater composition and the clear distinction between groundwater and leachate.

Notable distinctions on the Piper diagram are leachate samples from Q2 2020, Q2 2022, and Q1 2023, which correspond to the anomalous leachate samples in the PCA. These samples plot between the groundwater data and the main cluster of leachate data in the cation space. These instances are irregularly spaced

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through time and do not have a temporal trend in concentration nor overall major ion composition. This suggests changes are not related to seasonal changes at the site but rather indicates a more random control, such as operational influences on concentrations (*e.g.*, variable proportions of porewater and surface water passing into the leachate collection system or inconsistencies in sample collection).

5.0 IDENTIFIED PROBABLE ALTERNATE SOURCE

Empirical field observations revealed a localized peat unit in boring B-55 and monitoring well P-60 (Attachment 4), both located immediately upgradient of G60L (Attachment 1). Peat-rich soils in connection with groundwater are known to produce water chemistries with lower pH and higher sulfate concentrations (Bourbonniere, 2009), such as those consistently observed at G60L (Table 1). The peat unit ranges in elevation from 593.2 to 600.6 feet (ft) mean sea level (msl), approximately the same elevation as the top of the filter pack (594.8 ft msl) and just above the elevation of the screened interval (587.4 to 592.4 ft msl) of G60L. The hydraulic conductivity of the filter pack is higher than the surrounding native material and would intercept flow from groundwater under the influence of the local peat. There is a downward vertical component to the hydraulic gradient in this area (Ramboll, 2021), which is consistent with a flow path from the peat unit downgradient horizontally and vertically towards the well screen of G60L.

Other monitoring wells near the local peat unit also exhibit higher sulfate concentrations than background and are stable over time (Attachment 5; Appendix B-1), supporting the conclusion that this region is influenced by an alternate source of sulfate, the local native peat, rather than the GMF Pond. This is particularly meaningful when considered contextually with boron and chloride concentrations, conservative tracers of CCR-related influence. Sulfate, chloride (Attachment 5), and boron (Ramboll 2023, LOE #2) are all elevated in the leachate while only sulfate is elevated above background in the groundwater. The low concentrations of boron and chloride in the groundwater at G60L are a strong indicator that sulfate concentrations originate from an alternate source unrelated to the GMF Pond.

While the local peat is the interpreted source of sulfate (and therefore TDS also), it is notable that other wells in the vicinity of G60L do not reflect the same low pH as G60L. In addition to the peat content of the aquifer solids, carbonate content also influences groundwater pH, with higher proportions of carbonate minerals calcite and dolomite present in the aquifer solids resulting in a higher, or more neutral, pH. Therefore, variation in groundwater pH is a function of variability in both peat and carbonate content in the aquifer solids. Carbonate mineralization is known to buffer against pH changes associated with peat. Solid phase mineralogy analysis including X-ray diffraction (XRD; Attachment 6) and sequential extraction (SEP; Attachment 7) data both show variable carbonate content across the site, indicating that some locations have higher pH buffering capacity than others. Aqueous alkalinity concentration, a contributor of aqueous phase pH buffering capacity, is lower at G60L than at surrounding wells (Attachment 5). These data in combination suggest the presence of peat immediately upgradient with the relatively low buffering capacity of the groundwater observed for monitoring well G60L have naturally resulted in a groundwater pH that is lower than the pH of the surrounding site groundwater.

6.0 CONCLUSIONS

This technical review presents empirical evidence and analysis that demonstrates the GMF Pond is not the source of low pH at compliance well G60L. The PCA identified a geochemical signature in the GMF Pond leachate that is different from groundwater and simultaneously demonstrates that geochemistry at G60L is

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far more similar to background/compliance wells than to the GMF Pond leachate. This analysis was supported by evaluation of the major ion distribution, which showed a sulfate-chloride leachate signature not evident in the groundwater. The absence of boron and chloride (both conservative tracers) from groundwater further demonstrates the GMF Pond is not impacting G60L. Soil boring logs revealed a localized pocket of native peat immediately upgradient of G60L. The combination of hydraulic gradients, aqueous and solid phase geochemistry, and empirical field observations at this location supports the conclusion that local peat is likely the source of the low pH at G60L.

7.0 ABBREVIATIONS

Alk, bicarb	Alkalinity measured as bicarbonate, also shown as HCO_3^-
As	Arsenic
ASD	Alternative Source Demonstration
B	Boron
Ba	Barium
Ca	Calcium
CCR	Coal combustion residual
Cl	Chloride
CO_3^{2-}	Carbonate ion
DC	Duck Creek
F	Fluoride
Fe	Iron
ft	feet
GMF Pond	Gypsum Management Facility Pond
GWPS	Groundwater Protection Standard
H+	Hydrogen ion, represents acidity in groundwater
HCO3	Bicarbonate alkalinity
K	Potassium
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
msl	mean sea level
Na	Sodium
SO4	Sulfate
TDS	Total dissolved solids

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8.0 REFERENCES

Aitchison, J. 1986. The Statistical Analysis of Compositional Data. Chapman and Hall. London

Bourbonniere, R. A. 2009. Review of water chemistry research in natural and disturbed peatland. Canadian Water Resources Journal, 34:4, 393-414.

Egozcue J.J. and V. Pawlowsky-Glahn. 2011. Basic concepts and procedures. In: Pawlowsky-Glahn V, Buccianti A, editors. Compositional data analysis: theory and applications. Chichester: Wiley; 2011. pp. 12–28.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. Hydrogeologic Site Characterization Report. Gypsum Management Facility Pond. Duck Creek Power Plant. Canton, Illinois.

Ramboll, 2023. Alternate Source Demonstration: Duck Creek Gypsum Management Facility Pond. August.

Sandford, R. F., C.T. Pierson, and R.A. Crovelli. 1993. An objective replacement method for censored geochemical data: Math. Geol., 25(1), p. 59–80.

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COMPLIANCE WELL
BACKGROUND WELL
PORE WATER WELL
CCR SOURCE WATER SAMPLE
MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

GROUNDWATER ELEVATION CONTOUR (5-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION

0 150 300 Feet

NOTES:
1. PARENTHESES INDICATES WELL NOT USED FOR CONTOURING
2.ELEVATION CONTOURS SHOWN IN FEET.
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

POTENTIOMETRIC SURFACE MAP
JANUARY 9 AND 16, 2023

Attachment 1

ALTERNATE SOURCE DEMONSTRATION
GMF POND (UNIT ID: 203)
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

RAMBOLL

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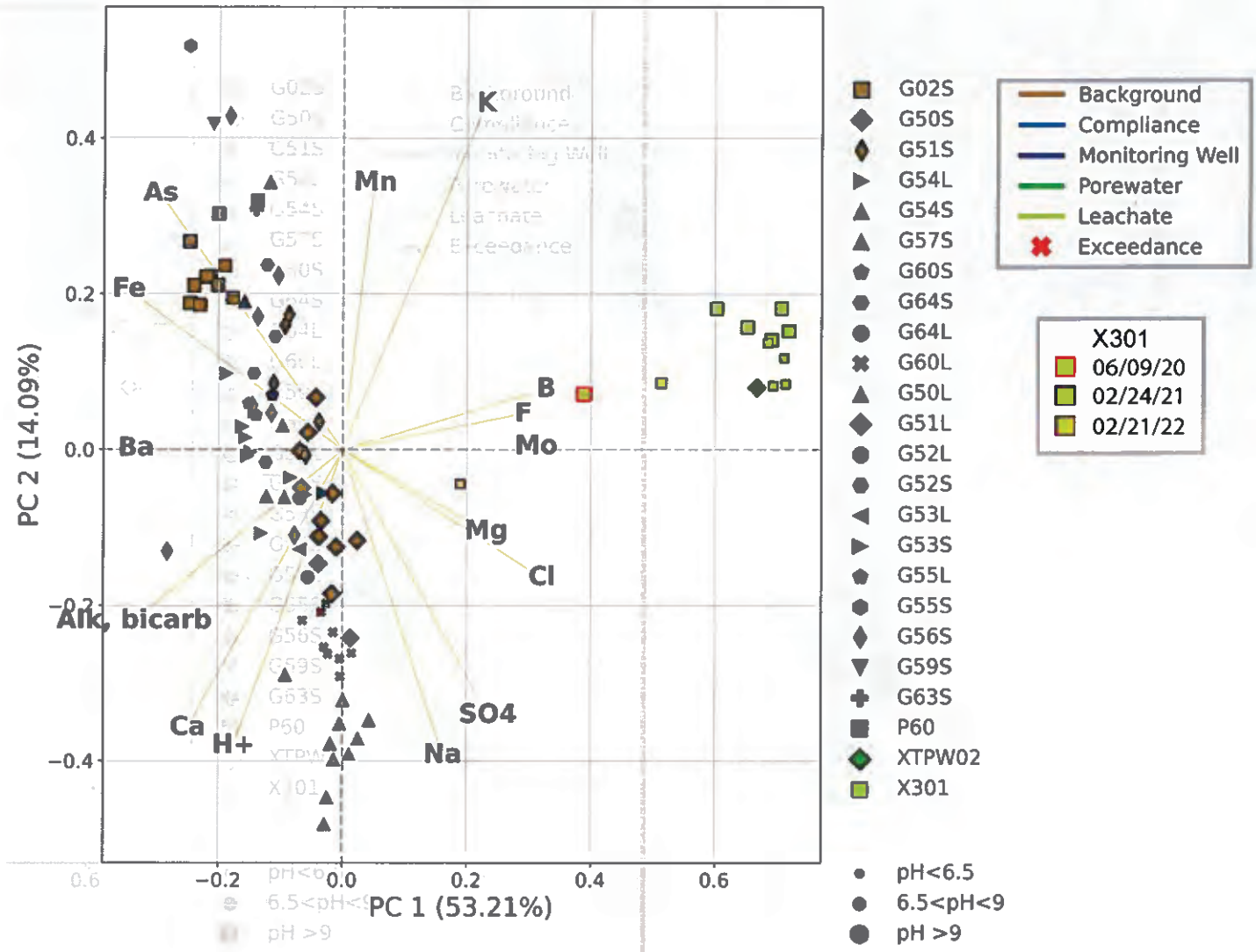

Principal Components Analysis (PCA) results for Duck Creek Gypsum Management Facility (GMF) Pond. Data is colored according to well classification and sized according to pH. See abbreviations list for complete analyte names.

LIFECYCLEGEO	Title: Duck Creek Principal Components Analysis Results		
	Project Name: Duck Creek - GMFP ASD	Project Number: [23RAM01-1] Vistra CCR	Attachment: 2
	Client Name: Ramboll Americas Engineering Solutions, Inc.	Date: 8/01/2023	

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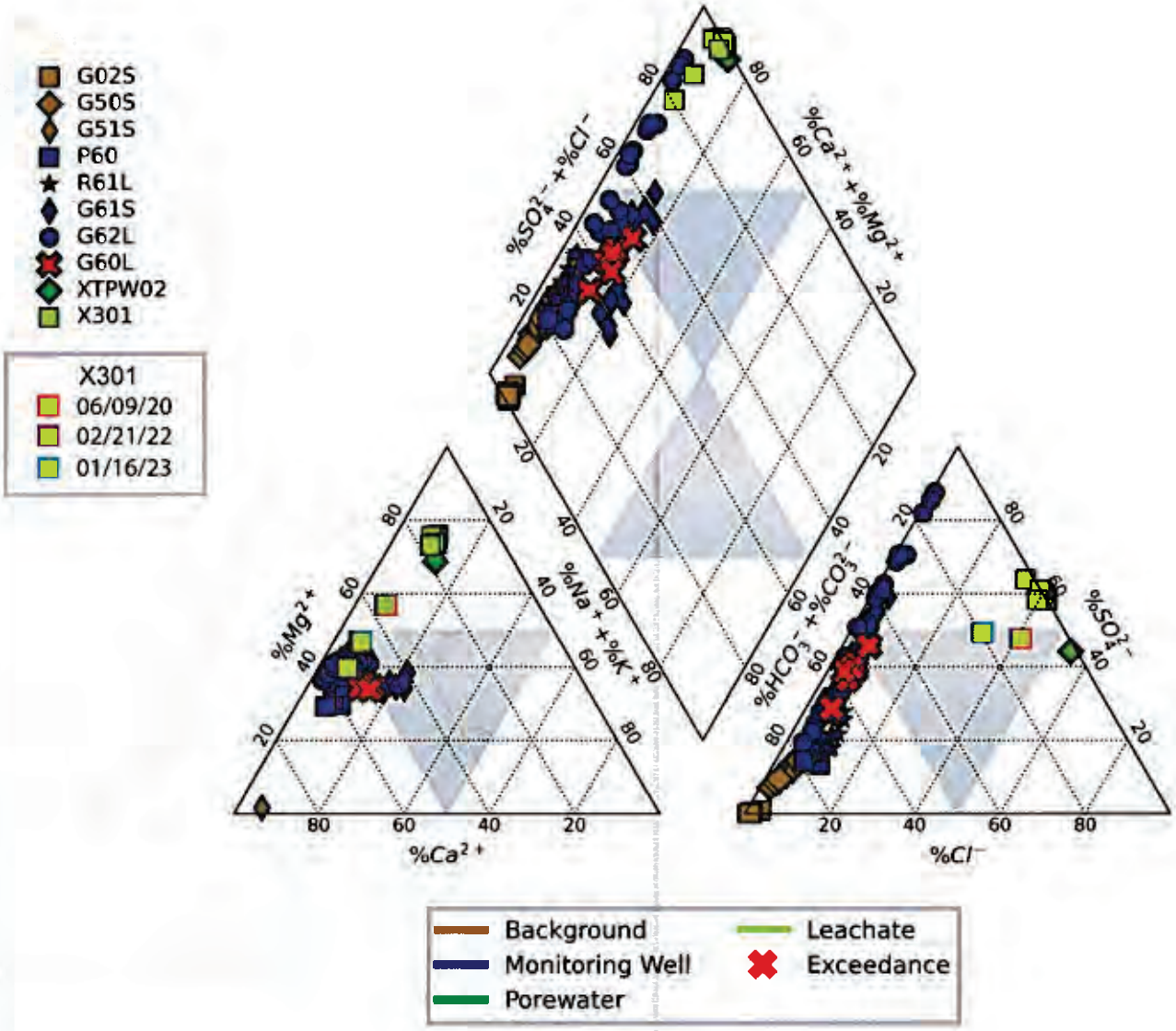

Piper diagram depicting major ion concentrations for background, leachate, and area around G60L. Total ion concentrations were used for all wells except P60, R61L, G61S, and G62L, which are a combination of dissolved and total ions. Dissolved ions used to improve analysis of local geochemistry near G60L when total phase was not measured.

LIFECYCLEGEO	Title: Piper Diagram		
	Project Name: Duck Creek - GMFP ASD	Project Number: [23RAM01-1] Vistra CCR	Attachment: 3
	Client Name: Ramboll Americas Engineering Solutions, Inc.	Date: 8/01/2023	

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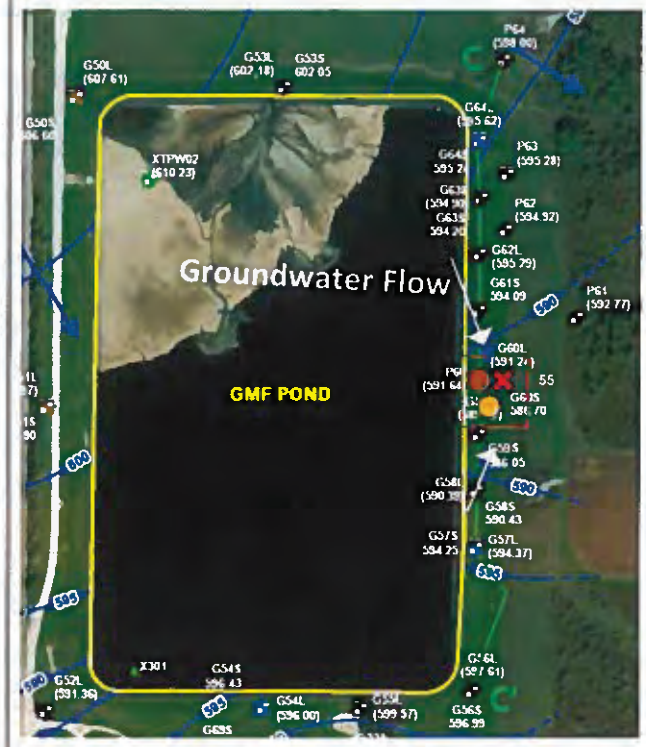

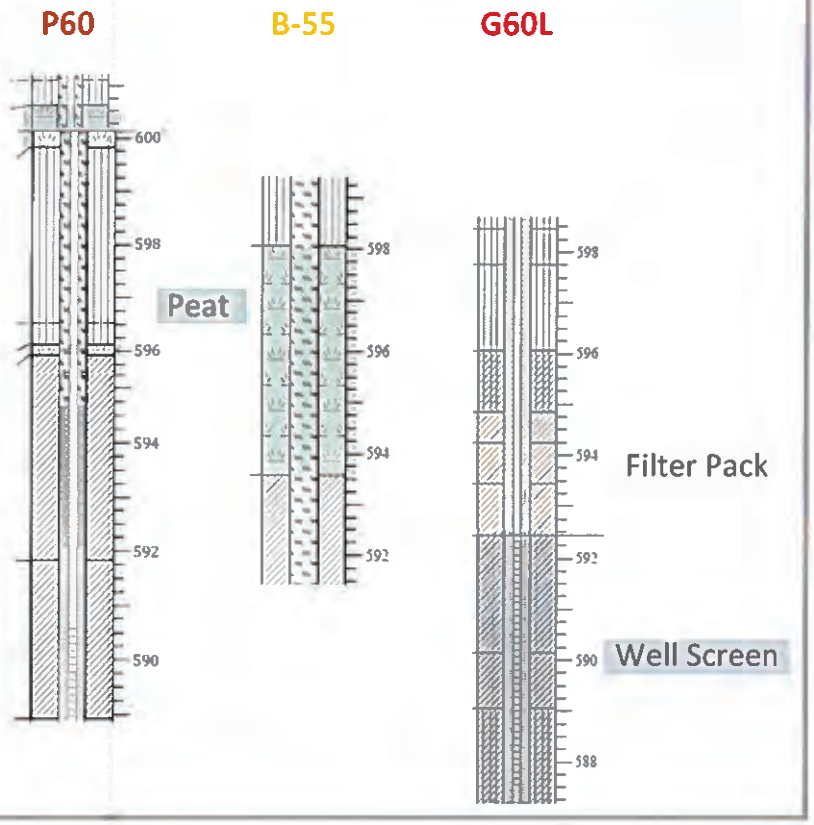

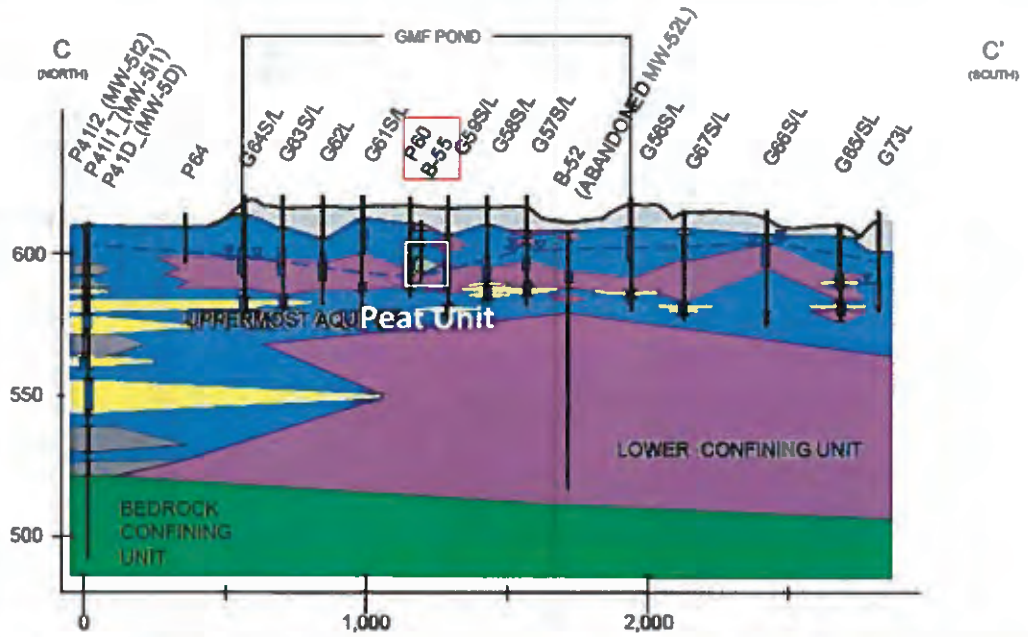

Top) Peat unit relative to filter pack and well screen of G60L. Groundwater contours from January 2023. Boring logs modifed from logs collected by Hanson. Groundwater map modified from Attachment 1. Bottom) Cross-section depicting local peat unit. Cross-section transect shown in top inset. All elevations in feet mean sea level. Cross-section modifed from Ramboll, 2021.

LIFECYCLEGEO	Title: Peat unit relative to G60L		
	Project Name: Duck Creek - GMFP ASD	Project Number: [23RAM01-1] Vistra CCR	Attachment: 4
	Client Name: Ramboll Americas Engineering Solutions, Inc.	Date: 8/02/2023	

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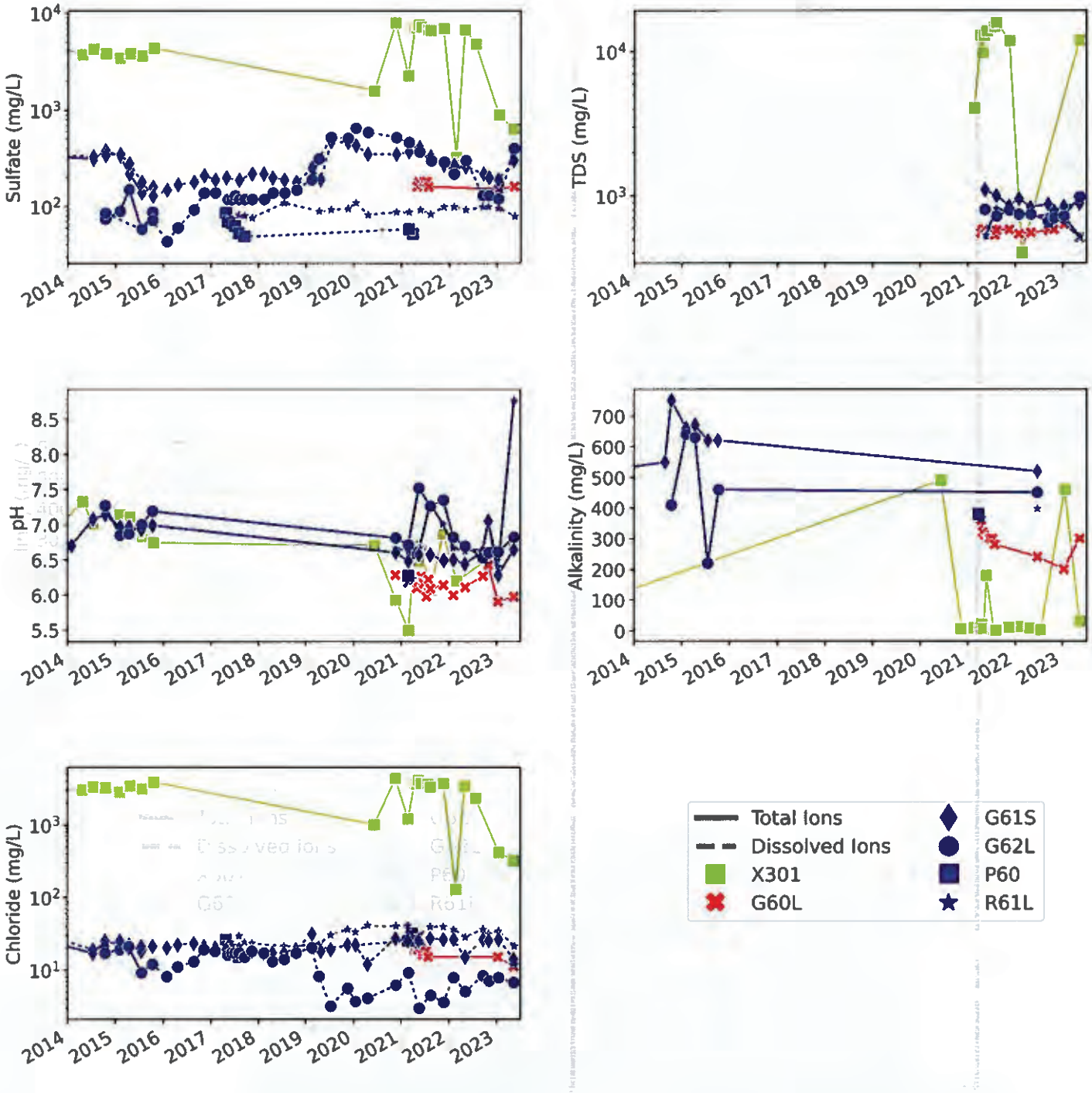

Time series depicting sulfate, TDS (total dissolved solids), pH, and alkalinity as bicarbonate concentrations for leachate, G60L, and wells adjacent to G60L. Concentrations for sulfate and TDS are plotted on a log scale.

LIFECYCLEGEO

Title: Geochemical Parameters Associated with Peat			
Project Name: Duck Creek - GMFP ASD		Project Number: [23RAM01-1] Vistra CCR	Attachment: 5
Client Name: Ramboll Americas Engineering Solutions, Inc.		Date: 8/01/2023	

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LIFECYCLEGEO

Attachment 6. X-ray diffraction results at Duck Creek Gypsum Management Pond.

Mineral/Compound	B-G52S (wt %)	B-G54L (wt %)	B-G57L (wt %)	B-G57S (wt %)	B-G62L (wt %)	B-G63S (wt %)	B-G02S (wt %)	B-G02L (wt %)
Quartz	48.4	57.6	51.2	59.9	61.7	51.1	61.1	49.2
Hornblende	3.7	1.4	2.4	-	-	-	-	-
Gypsum	-	-	-	-	-	-	-	-
Dolomite	**23.7**	**11.7**	**2.5**	**12.8**	**-**	**23.8**	**-**	**9.2**
Calcite	**6.7**	**0.8**	**0.1**	**0.3**	**-**	**4.1**	**-**	**-**
Albite	6.7	8.1	17.4	8.2	8.6	5.5	9.9	12.2
Chlorite	0.8	0.3	0.3	0.2	0.4	2.4	5.4	6.0
Muscovite	3.3	13.8	8.8	11.7	18.7	6.7	15.4	12.3
Rhodochrosite	3.2	-	-	-	-	-	0.4	-
Microcline	2.9	5.5	9.4	5.9	10.7	5.7	7.5	9.3
Pyrite	0.4	-	0.3	-	-	-	-	0.3
Halite	-	0.7	-	-	-	-	-	-
Montmorillonite	-	-	5.1	-	-	-	-	-
Goethite	-	-	1.1	-	-	-	-	-
Diaspore	-	-	0.3	-	-	-	-	-
Magnetite	-	-	0.4	-	-	-	-	0.4
Diopside	-	-	1.0	0.5	-	-	0.2	1.0
Actinolite	-	-	-	0.5	-	0.6	0.2	0.3

wt % - weight percent; bolded - carbonate minerals, buffers of groundwater pH

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LIFECYCLEGEO

Attachment 7. Calcium sequential extraction (SEP) results at Duck Creek Gypsum Management Pond.

Calcium (mg/kg)		
Sample ID	[1] Step 2: Carbonate Phase	[2] Sum: Steps 1-7
B-G52S	18,000	90,000
B-G54L	2,300	23,000
B-G57L	730	11,000
B-G57S	3,600	39,000
B-G62L	600	3,200
B-G53S	13,000	80,000
B-G02S	210	4,900
B-G02L	2,400	24,000

[1] Step 2 represents the carbonate phase in the tested material.

[2] The sum of all seven SEP steps shows how much calcium was produced throughout testing.

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LIFECYCLEGEO

Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

Well	Date	HSU	Well Type	pH (field) (SU)	Alkalinity, bicarbonate (mg/L)	Total Dissolved Solids (mg/L)	Chloride, total (mg/L)	Chloride, dissolved (mg/L)	Sulfate, total (mg/L)	Sulfate, dissolved (mg/L)
G51S	1/12/2023	UA	Background	6.42	160	440	13.0	17.0	51.0	52.0
G02S	8/9/2021	UA	Background	6.43	420	460	2.70	--	<1.0	--
G02S	1/31/2022	UA	Background	6.60	410	400	1.90	--	<1.0	--
G02S	7/21/2022	UA	Background	6.63	440	410	1.60	--	<1.0	--
G02S	1/11/2023	UA	Background	6.63	250	490	<4.8	--	<0.18	--
G02S	5/12/2021	UA	Background	6.65	820	290	2.50	--	<1.0	--
G02S	7/12/2021	UA	Background	6.68	410	420	1.90	--	<1.0	--
G02S	6/1/2021	UA	Background	6.77	400	450	8.20	--	2.70	--
G02S	6/15/2021	UA	Background	6.80	410	390	4.00	--	2.10	--
G50S	1/12/2023	UA	Background	6.80	190	410	11.0	14.0	38.0	36.0
G02S	6/21/2021	UA	Background	6.84	400	440	3.50	--	1.10	--
G02S	5/15/2023	UA	Background	6.85	420	430	2.60	2.30	<1.0	<1.0
G50S	7/19/2022	UA	Background	6.88	310	430	13.0	--	41.0	--
G50S	1/31/2022	UA	Background	6.92	300	340	8.60	10.0	30.0	30.0
G50S	5/2/2022	UA	Background	6.93	--	310	--	9.70	--	30.0
G51S	7/20/2022	UA	Background	6.93	390	480	12.0	--	55.0	--
G02S	7/28/2021	UA	Background	6.94	410	440	1.40	--	<1.0	--
G51S	11/17/2021	UA	Background	6.95	--	370	--	15.0	--	52.0
G51S	7/12/2021	UA	Background	6.98	320	460	16.0	--	51.0	--
G51S	1/31/2022	UA	Background	7.00	310	360	17.0	13.0	52.0	54.0
G51S	8/10/2021	UA	Background	7.01	340	440	17.0	12.0	51.0	51.0
G50S	11/17/2021	UA	Background	7.03	--	370	--	12.0	--	34.0
G51S	6/15/2021	UA	Background	7.03	320	410	12.0	--	54.0	--
G50S	6/1/2021	UA	Background	7.04	300	410	12.0	--	49.0	--
G50S	8/10/2021	UA	Background	7.06	340	450	14.0	11.0	46.0	46.0
G50S	7/28/2021	UA	Background	7.07	310	390	13.0	--	46.0	--
G50S	6/21/2021	UA	Background	7.08	320	430	11.0	--	44.0	--
G50S	9/13/2022	UA	Background	7.08	--	390	--	12.0	--	45.0
G51S	7/27/2021	UA	Background	7.09	340	360	14.0	--	51.0	--
G51S	5/15/2023	UA	Background	7.12	290	430	12.0	13.0	56.0	56.0
G51S	9/13/2022	UA	Background	7.13	--	430	--	13.0	--	58.0
G51S	10/27/2022	UA	Background	7.13	--	420	--	11.0	--	52.0

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Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

Well	Date	HSU	Well Type	pH (field) (SU)	Alkalinity, bicarbonate (mg/L)	Total Dissolved Solids (mg/L)	Chloride, total (mg/L)	Chloride, dissolved (mg/L)	Sulfate, total (mg/L)	Sulfate, dissolved (mg/L)
G51S	6/21/2021	UA	Background	7.14	320	410	14.0	--	53.0	--
G50S	7/13/2021	UA	Background	7.15	300	420	13.0	--	46.0	--
G51S	5/13/2021	UA	Background	7.15	320	350	15.0	15.0	55.0	52.0
G50S	10/27/2022	UA	Background	7.16	--	340	--	9.00	--	40.0
G50S	6/10/2021	UA	Background	7.18	320	390	16.0	--	48.0	--
G51S	4/28/2022	UA	Background	7.21	--	410	--	16.0	--	59.0
G51S	6/1/2021	UA	Background	7.22	340	400	17.0	--	51.0	--
G50S	5/13/2021	UA	Background	7.25	310	380	13.0	13.0	47.0	51.0
G50S	5/15/2023	UA	Background	7.26	460	380	9.50	10.0	40.0	39.0
G50S	6/20/2022	UA	Background	--	290	--	--	--	--	--
G51S	6/20/2022	UA	Background	--	310	--	--	--	--	--
G60L	4/22/2016	UA/PMP	Exceedance	--	--	--	--	11.0	--	800
G60L	8/25/2016	UA/PMP	Exceedance	--	--	--	--	12.0	--	1200
G60L	11/7/2016	UA/PMP	Exceedance	--	--	--	--	12.0	--	1500
G60L	2/3/2017	UA/PMP	Exceedance	--	--	--	--	12.0	--	1600
G60L	4/24/2017	UA/PMP	Exceedance	--	--	--	--	--	--	--
G60L	5/11/2017	UA/PMP	Exceedance	--	--	--	--	12.0	--	2100
G60L	6/8/2017	UA/PMP	Exceedance	--	--	--	--	12.0	--	2100
G60L	7/3/2017	UA/PMP	Exceedance	--	--	--	--	12.0	--	2200
G60L	8/3/2017	UA/PMP	Exceedance	--	--	--	--	12.0	--	2200
G60L	9/15/2017	UA/PMP	Exceedance	--	--	--	--	13.0	--	2100
G60L	11/9/2017	UA/PMP	Exceedance	--	--	--	--	13.0	--	2300
G60L	1/19/2018	UA/PMP	Exceedance	--	--	--	--	14.0	--	2000
G60L	4/28/2018	UA/PMP	Exceedance	--	--	--	--	12.0	--	2300
G60L	7/18/2018	UA/PMP	Exceedance	--	--	--	--	13.0	--	2200
G60L	10/17/2018	UA/PMP	Exceedance	--	--	--	--	16.0	--	2200
G60L	2/15/2019	UA/PMP	Exceedance	--	--	--	--	19.0	--	2700
G60L	4/8/2019	UA/PMP	Exceedance	--	--	--	--	16.0	--	1900
G60L	7/19/2019	UA/PMP	Exceedance	--	--	--	--	17.0	--	1500
G60L	11/13/2019	UA/PMP	Exceedance	--	--	--	--	20.0	--	650
G60L	1/14/2020	UA/PMP	Exceedance	--	--	--	--	20.0	--	370
G60L	4/14/2020	UA/PMP	Exceedance	--	--	--	--	18.0	--	1500

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Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

Well	Date	HSU	Well Type	pH (field) (SU)	Alkalinity, bicarbonate (mg/L)	Total Dissolved Solids (mg/L)	Chloride, total (mg/L)	Chloride, dissolved (mg/L)	Sulfate, total (mg/L)	Sulfate, dissolved (mg/L)
G60L	11/17/2020	UA/PMP	Exceedance	6.28	--	--	--	18.0	--	220
G60L	2/23/2021	UA/PMP	Exceedance	6.18	--	--	--	23.0	--	190
G60L	4/14/2021	UA/PMP	Exceedance	6.20	360	550	19.0	--	<250.0	--
G60L	4/29/2021	UA/PMP	Exceedance	6.10	320	580	19.0	--	160	--
G60L	5/13/2021	UA/PMP	Exceedance	6.19	310	580	19.0	19.0	180	180
G60L	6/1/2021	UA/PMP	Exceedance	6.26	300	560	20.0	--	170	--
G60L	6/15/2021	UA/PMP	Exceedance	6.18	300	530	16.0	--	180	--
G60L	6/21/2021	UA/PMP	Exceedance	6.16	300	580	18.0	--	180	--
G60L	7/12/2021	UA/PMP	Exceedance	5.98	300	580	18.0	--	180	--
G60L	7/28/2021	UA/PMP	Exceedance	6.22	280	530	15.0	--	160	--
G60L	8/12/2021	UA/PMP	Exceedance	6.09	--	570	--	18.0	--	170
G60L	11/18/2021	UA/PMP	Exceedance	6.14	--	580	--	16.0	--	180
G60L	1/31/2022	UA/PMP	Exceedance	6.00	--	540	--	15.0	--	170
G60L	5/2/2022	UA/PMP	Exceedance	6.11	--	550	--	11.0	--	170
G60L	6/22/2022	UA/PMP	Exceedance	--	240	--	--	--	--	--
G60L	9/15/2022	UA/PMP	Exceedance	6.27	--	570	--	15.0	--	170
G60L	10/28/2022	UA/PMP	Exceedance	6.42	--	580	--	14.0	--	160
G60L	1/12/2023	UA/PMP	Exceedance	5.90	200	630	15.0	19.0	150	170
G60L	5/12/2023	UA/PMP	Exceedance	5.97	300	510	11.0	15.0	160	170
G61S	1/31/2014	UA	Other	6.70	--	--	--	--	--	--
G61S	7/16/2014	UA	Other	7.08	--	--	17.0	19.0	310	330
G61S	8/26/2014	UA	Other	--	550	--	--	--	--	--
G61S	10/15/2014	UA	Other	7.14	750	--	25.0	21.0	380	340
G61S	2/4/2015	UA	Other	6.97	660	--	22.0	25.0	330	350
G61S	4/15/2015	UA	Other	6.97	670	--	22.0	20.0	220	280
G61S	7/21/2015	UA	Other	6.93	620	--	18.0	21.0	140	180
G61S	10/13/2015	UA	Other	6.99	620	--	20.0	21.0	160	130
G61S	1/28/2016	UA	Other	--	--	--	--	20.0	--	150
G61S	4/21/2016	UA	Other	--	--	--	--	22.0	--	170
G61S	8/22/2016	UA	Other	--	--	--	--	23.0	--	180
G61S	11/8/2016	UA	Other	--	--	--	--	21.0	--	210
G61S	2/1/2017	UA	Other	--	--	--	--	20.0	--	190
G61S	4/26/2017	UA	Other	--	--	--	--	19.0	--	200

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Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

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G61S	8/3/2017	UA	Other	--	--	--	--	19.0	--	190
G61S	11/9/2017	UA	Other	--	--	--	--	18.0	--	220
G61S	2/8/2018	UA	Other	--	--	--	--	17.0	--	220
G61S	4/18/2018	UA	Other	--	--	--	--	17.0	--	200
G61S	7/17/2018	UA	Other	--	--	--	--	17.0	--	190
G61S	10/17/2018	UA	Other	--	--	--	--	19.0	--	180
G61S	2/15/2019	UA	Other	--	--	--	--	31.0	--	250
G61S	4/24/2019	UA	Other	--	--	--	--	18.0	--	190
G61S	7/10/2019	UA	Other	--	--	--	--	19.0	--	470
G61S	11/13/2019	UA	Other	--	--	--	--	22.0	--	460
G61S	1/14/2020	UA	Other	--	--	--	--	22.0	--	430
G61S	4/14/2020	UA	Other	--	--	--	--	12.0	--	350
G61S	11/18/2020	UA	Other	6.60	--	--	--	27.0	--	350
G61S	2/23/2021	UA	Other	6.48	--	--	--	25.0	--	370
G61S	5/14/2021	UA	Other	6.57	--	1100	--	25.0	--	410
G61S	8/9/2021	UA	Other	6.57	--	1000	--	27.0	--	330
G61S	11/16/2021	UA	Other	6.49	--	850	--	26.0	--	270
G61S	1/31/2022	UA	Other	6.50	--	950	--	26.0	--	270
G61S	4/28/2022	UA	Other	6.44	--	830	--	15.0	--	260
G61S	6/21/2022	UA	Other	--	520	--	--	--	--	--
G61S	9/14/2022	UA	Other	6.61	--	870	--	26.0	--	220
G61S	10/28/2022	UA	Other	7.05	--	780	--	25.0	--	200
G61S	1/11/2023	UA	Other	6.28	--	840	--	26.0	--	190
G61S	5/9/2023	UA	Other	6.64	--	880	--	14.0	--	300
G62L	10/15/2014	UA/PMP	Other	7.27	410	--	17.0	17.0	74.0	85.0
G62L	2/4/2015	UA/PMP	Other	6.85	640	--	19.0	--	89.0	--
G62L	4/15/2015	UA/PMP	Other	6.87	630	--	20.0	21.0	150	--
G62L	7/22/2015	UA/PMP	Other	7.00	220	--	9.20	9.20	57.0	58.0
G62L	10/13/2015	UA/PMP	Other	7.19	460	--	12.0	12.0	87.0	72.0
G62L	1/28/2016	UA/PMP	Other	--	--	--	--	8.10	--	44.0
G62L	4/21/2016	UA/PMP	Other	--	--	--	--	11.0	--	61.0
G62L	8/22/2016	UA/PMP	Other	--	--	--	--	13.0	--	93.0
G62L	11/8/2016	UA/PMP	Other	--	--	--	--	19.0	--	140

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Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

Well	Date	HSU	Well Type	pH (field) (SU)	Alkalinity, bicarbonate (mg/L)	Total Dissolved Solids (mg/L)	Chloride, total (mg/L)	Chloride, dissolved (mg/L)	Sulfate, total (mg/L)	Sulfate, dissolved (mg/L)
G62L	2/1/2017	UA/PMP	Other	--	--	--	--	18.0	--	140
G62L	4/25/2017	UA/PMP	Other	--	--	--	--	--	--	--
G62L	5/11/2017	UA/PMP	Other	--	--	--	--	16.0	--	120
G62L	6/8/2017	UA/PMP	Other	--	--	--	--	17.0	--	120
G62L	7/3/2017	UA/PMP	Other	--	--	--	--	17.0	--	130
G62L	8/3/2017	UA/PMP	Other	--	--	--	--	17.0	--	120
G62L	9/14/2017	UA/PMP	Other	--	--	--	--	15.0	--	120
G62L	11/9/2017	UA/PMP	Other	--	--	--	--	18.0	--	120
G62L	2/12/2018	UA/PMP	Other	--	--	--	--	17.0	--	120
G62L	4/19/2018	UA/PMP	Other	--	--	--	--	13.0	--	140
G62L	7/18/2018	UA/PMP	Other	--	--	--	--	14.0	--	140
G62L	10/19/2018	UA/PMP	Other	--	--	--	--	17.0	--	150
G62L	2/15/2019	UA/PMP	Other	--	--	--	--	20.0	--	190
G62L	4/10/2019	UA/PMP	Other	--	--	--	--	8.20	--	310
G62L	7/9/2019	UA/PMP	Other	--	--	--	--	3.20	--	520
G62L	11/13/2019	UA/PMP	Other	--	--	--	--	5.60	--	510
G62L	1/14/2020	UA/PMP	Other	--	--	--	--	3.70	--	650
G62L	4/16/2020	UA/PMP	Other	--	--	--	--	4.10	--	590
G62L	11/18/2020	UA/PMP	Other	6.81	--	--	--	6.20	--	520
G62L	2/24/2021	UA/PMP	Other	6.71	--	--	--	9.20	--	460
G62L	5/14/2021	UA/PMP	Other	7.52	--	800	--	3.00	--	370
G62L	8/12/2021	UA/PMP	Other	7.26	--	720	--	4.50	--	300
G62L	11/18/2021	UA/PMP	Other	7.35	--	790	--	3.60	--	290
G62L	1/31/2022	UA/PMP	Other	6.82	--	740	--	7.80	--	220
G62L	5/2/2022	UA/PMP	Other	6.69	--	740	--	5.10	--	300
G62L	6/20/2022	UA/PMP	Other	--	450	--	--	--	--	--
G62L	9/15/2022	UA/PMP	Other	6.53	--	660	--	8.30	--	130
G62L	10/31/2022	UA/PMP	Other	6.60	--	700	--	7.10	--	130
G62L	1/12/2023	UA/PMP	Other	6.61	--	720	--	7.80	--	120
G62L	5/11/2023	UA/PMP	Other	6.82	--	980	--	6.70	--	400
P60	4/24/2017	UA/PMP	Other	--	--	--	--	26.0	--	85.0
P60	5/11/2017	UA/PMP	Other	--	--	--	--	21.0	--	70.0
P60	6/8/2017	UA/PMP	Other	--	--	--	--	19.0	--	68.0

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Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

Well	Date	HSU	Well Type	pH (field) (SU)	Alkalinity, bicarbonate (mg/L)	Total Dissolved Solids (mg/L)	Chloride, total (mg/L)	Chloride, dissolved (mg/L)	Sulfate, total (mg/L)	Sulfate, dissolved (mg/L)
P60	7/3/2017	UA/PMP	Other	--	--	--	--	18.0	--	63.0
P60	8/2/2017	UA/PMP	Other	--	--	--	--	15.0	--	53.0
P60	9/14/2017	UA/PMP	Other	--	--	--	--	16.0	--	49.0
P60	2/24/2021	UA/PMP	Other	6.28	--	--	--	25.0	--	59.0
P60	3/24/2021	UA/PMP	Other	6.60	380	--	32.0	--	53.0	--
R61L	8/3/2017	PMP	Other	--	--	--	--	29.0	--	82.0
R61L	9/14/2017	PMP	Other	--	--	--	--	24.0	--	80.0
R61L	11/9/2017	PMP	Other	--	--	--	--	23.0	--	77.0
R61L	7/17/2018	PMP	Other	--	--	--	--	21.0	--	110.0
R61L	4/10/2019	PMP	Other	--	--	--	--	22.0	--	90.0
R61L	7/9/2019	PMP	Other	--	--	--	--	30.0	--	93.0
R61L	11/13/2019	PMP	Other	--	--	--	--	36.0	--	96.0
R61L	1/14/2020	PMP	Other	--	--	--	--	33.0	--	110
R61L	4/16/2020	PMP	Other	--	--	--	--	41.0	--	83.0
R61L	11/18/2020	PMP	Other	6.67	--	--	--	40.0	--	88.0
R61L	2/23/2021	PMP	Other	6.61	--	--	--	41.0	--	88.0
R61L	5/21/2021	PMP	Other	6.67	--	530	--	30.0	--	93.0
R61L	8/9/2021	PMP	Other	7.29	--	810	--	39.0	--	84.0
R61L	11/16/2021	PMP	Other	7.01	--	770	--	39.0	--	100
R61L	1/31/2022	PMP	Other	6.67	--	730	--	36.0	--	100
R61L	5/2/2022	PMP	Other	6.62	--	710	--	28.0	--	93.0
R61L	6/21/2022	PMP	Other	--	400	--	--	--	--	--
R61L	9/14/2022	PMP	Other	6.65	--	730	--	36.0	--	99.0
R61L	10/28/2022	PMP	Other	7.04	--	720	--	31.0	--	99.0
R61L	1/12/2023	PMP	Other	6.40	--	710	--	34.0	--	96.0
R61L	5/11/2023	PMP	Other	8.76	--	520	--	21.0	--	80.0
X301	4/22/2014	S	Leachate	7.33	--	--	3100	3100	3800	3800
X301	7/15/2014	S	Leachate	7.01	--	--	3400	3300	4300	4100
X301	10/14/2014	S	Leachate	7.24	--	--	3300	3400	3900	4100
X301	1/30/2015	S	Leachate	7.14	--	--	2900	2800	3500	3500
X301	4/17/2015	S	Leachate	7.11	--	--	3500	3500	3900	3900
X301	7/21/2015	S	Leachate	6.84	--	--	3200	3200	3700	3700
X301	10/15/2015	S	Leachate	6.75	--	--	3900	3700	4400	4200

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Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

Well	Date	HSU	Well Type	pH (field) (SU)	Alkalinity, bicarbonate (mg/L)	Total Dissolved Solids (mg/L)	Chloride, total (mg/L)	Chloride, dissolved (mg/L)	Sulfate, total (mg/L)	Sulfate, dissolved (mg/L)
X301	2/1/2016	S	Leachate	--	--	--	--	3600	--	4100
X301	4/19/2016	S	Leachate	--	--	--	--	3700	--	4000
X301	8/16/2016	S	Leachate	--	--	--	--	3800	--	4500
X301	10/22/2016	S	Leachate	--	--	--	--	2600	--	3300
X301	1/20/2017	S	Leachate	--	--	--	--	3300	--	4200
X301	4/5/2017	S	Leachate	--	--	--	--	3700	--	4600
X301	8/14/2017	S	Leachate	--	--	--	--	4000	--	5300
X301	10/6/2017	S	Leachate	--	--	--	--	4000	--	5600
X301	1/8/2018	S	Leachate	--	--	--	--	4000	--	6600
X301	4/20/2018	S	Leachate	--	--	--	--	4400	--	7300
X301	10/10/2018	S	Leachate	--	--	--	--	3600	--	5700
X301	1/8/2019	S	Leachate	--	--	--	--	4500	--	7200
X301	4/10/2019	S	Leachate	--	--	--	--	4100	--	7100
X301	11/15/2019	S	Leachate	--	--	--	--	4600	--	8200
X301	4/16/2020	S	Leachate	--	--	--	--	4200	--	7900
X301	6/9/2020	S	Leachate	6.70	490	--	1000	--	1600	--
X301	11/19/2020	S	Leachate	5.93	7.50	--	4300	4100	8100	7600
X301	2/24/2021	S	Leachate	5.50	10.0	4100	1200	690	2300	1300
X301	4/14/2021	S	Leachate	6.70	12.0	13000	3700	--	7300	--
X301	4/29/2021	S	Leachate	6.60	22.0	9800	3600	--	7200	--
X301	5/12/2021	S	Leachate	6.48	8.00	13000	4100	4500	7700	7700
X301	6/1/2021	S	Leachate	6.64	180	14000	3700	--	7300	--
X301	6/10/2021	S	Leachate	--	--	--	--	--	--	--
X301	7/26/2021	S	Leachate	6.22	3.50	15000	3600	--	6900	--
X301	8/12/2021	S	Leachate	6.07	3.00	16000	3300	3700	6800	7200
X301	11/19/2021	S	Leachate	6.87	12.0	12000	3700	3700	7100	7100
X301	2/21/2022	S	Leachate	6.20	14.0	410	130	140	330	430
X301	4/28/2022	S	Leachate	--	9.00	--	3400	--	6900	--
X301	7/20/2022	S	Leachate	--	4.00	--	2300	--	4900	--
X301	1/16/2023	S	Leachate	--	460	--	420	--	910	--
X301	5/10/2023	S	Leachate	6.76	30.0	12000	320	3200	640	6400

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Appendix B-1. Supporting analytical data for Attachment 5 and inline Table 1

Notes:
mg/L = milligrams per liter
SU= standard units
< = less than analytical detection limit; data not included in Attachment 3 and 4 analyses.
-- = data not measured
Table 1: Background wells are G02S, G50S, and G51S. Data from these wells determined the range for pH, TDS, and total sulfate in Table 1.
Data from 2021 through May 2023 for G60L was used for Table 1
Attachment 5: Data from G60L, G61S, G62L, P60, R61L, and X301 were used for Attachment 5.
HSU = hydrostratigraphic unit
CCR = coal combustion residual
UA = uppermost aquifer
PMP = potential migration pathway
S= source water
DC= Duck Creek

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Appendix B-2. Supporting groundwater analytical data for Attachment 3

Well	Date	Well Type	pH (field) (SU)	Alkalinity as bicarbonate (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)
G02S	6/28/2017	Background	6.8	440	89	2.6	35	0.77	14	0.50
G02S	2/19/2021	Background	6.5	410	95	2.6	37	0.97	14	0.50
G02S	4/14/2021	Background	6.7	440	89	2.3	34	0.73	14	0.50
G02S	4/29/2021	Background	6.8	410	96	1.6	36	0.70	15	0.50
G02S	5/12/2021	Background	6.65	820	96	2.5	36	0.61	15	0.50
G02S	6/1/2021	Background	6.77	400	94	8.2	36	0.65	14	2.7
G02S	6/15/2021	Background	6.8	410	100	4.0	38	0.83	15	2.1
G02S	6/21/2021	Background	6.84	400	98	3.5	38	0.74	13	1.1
G02S	7/12/2021	Background	6.68	410	96	1.9	37	0.67	12	0.50
G02S	7/28/2021	Background	6.94	410	99	1.4	38	1.1	14	0.50
G02S	8/9/2021	Background	6.43	420	95	2.7	37	0.69	14	0.50
G02S	1/31/2022	Background	6.6	410	94	1.9	36	1.2	14	0.50
G02S	7/21/2022	Background	6.63	440	100	1.6	39	0.71	13	0.50
G02S	1/11/2023	Background	6.63	250	97	2.4	36	1.0	14	0.09
G50S	1/22/2014	Background	7.35	350	85	4.8	36	0.47	7.6	22
G50S	6/28/2017	Background	7.1	340	75	6.6	37	0.51	7.8	26
G50S	1/13/2020	Background	6.93	330	97	8.6	38	0.44	9.0	30
G50S	8/10/2020	Background	6.82	300	91	8.5	36	0.41	9.8	38
G50S	2/19/2021	Background	7	320	95	12	41	1.0	9.4	41
G50S	4/14/2021	Background	7.2	340	88	15	36	0.43	11	52
G50S	4/29/2021	Background	7.1	290	98	14	39	0.46	11	50
G50S	5/13/2021	Background	7.25	310	95	13	40	0.60	11	47
G50S	6/1/2021	Background	7.04	300	93	12	38	0.40	11	49
G50S	6/10/2021	Background	7.18	320	93	16	37	0.40	10	48
G50S	6/21/2021	Background	7.08	320	94	11	39	0.32	9.6	44
G50S	7/13/2021	Background	7.15	300	92	13	39	0.56	10	46
G50S	7/28/2021	Background	7.07	310	95	13	38	0.33	9.9	46
G50S	8/10/2021	Background	7.06	340	98	14	38	0.74	13	46
G50S	1/31/2022	Background	6.92	300	86	8.6	35	0.61	6.9	30
G50S	7/19/2022	Background	6.88	310	91	13	37	0.28	8.9	41
G51S	1/22/2014	Background	7.12	360	98	11	41	1.0	8.8	35

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Appendix B-2. Supporting groundwater analytical data for Attachment 3

Well	Date	Well Type	pH (field) (SU)	Alkalinity as bicarbonate (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)
G51S	6/28/2017	Background	6.8	370	82	14	39	0.48	7.0	41
G51S	1/14/2020	Background	7.08	340	100	13	41	0.55	8.0	53
G51S	8/10/2020	Background	6.88	330	99	8.2	40	0.39	7.4	26
G51S	2/19/2021	Background	7.2	340	100	19	43	1.1	6.9	52
G51S	4/14/2021	Background	7.1	350	88	14	38	0.62	7.3	51
G51S	4/29/2021	Background	7.1	310	100	15	44	0.91	7.6	51
G51S	5/13/2021	Background	7.15	320	94	15	41	0.29	7.6	55
G51S	6/1/2021	Background	7.22	340	94	17	41	0.42	7.5	51
G51S	6/15/2021	Background	7.03	320	110	12	1.2	0.05	7.9	54
G51S	6/21/2021	Background	7.14	320	96	14	41	0.32	7.2	53
G51S	7/12/2021	Background	6.98	320	95	16	41	0.44	6.7	51
G51S	7/27/2021	Background	7.09	340	85	14	36	0.27	6.5	51
G51S	8/10/2021	Background	7.01	340	100	17	46	0.86	8.8	51
G51S	1/31/2022	Background	7	310	100	17	42	1.2	6.5	52
G51S	7/20/2022	Background	6.93	390	100	12	42	0.34	6.9	55
G51S	1/12/2023	Background	6.42	160	94	13	39	0.56	7.5	51
G02S	5/15/2023	Background	6.85	420	96	2.6	37	0.70	14	0.50
G50S	5/15/2023	Background	7.26	460	90	9.5	37	0.35	9.0	40
G51S	5/15/2023	Background	7.12	290	98	12	41	0.29	7.3	56
P60	3/24/2021	Other	6.6	380	150	32	75	3.0	22	53
P60	4/24/2017	Other	--	480	140	26	42	4.5	25	85
P60	5/11/2017	Other	--	440	130	21	40	2.9	17	70
P60	6/8/2017	Other	--	420	120	19	44	2.1	20	68
P60	7/3/2017	Other	--	400	130	18	36	2.0	15	63
P60	8/2/2017	Other	--	320	90	15	37	0.94	12	53
P60	9/14/2017	Other	--	340	90	16	36	0.75	11	49
R61L	8/3/2017	Other	--	340	130	29	45	2.2	12	82
R61L	9/14/2017	Other	--	360	95	24	46	1.2	9.7	80
R61L	11/9/2017	Other	--	380	110	23	51	0.91	8.2	77
R61L	7/17/2018	Other	--	360	78	21	46	0.61	12	110
R61L	4/10/2019	Other	--	260	100	22	47	0.55	7.7	90

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Appendix B-2. Supporting groundwater analytical data for Attachment 3

Well	Date	Well Type	pH (field) (SU)	Alkalinity as bicarbonate (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)
R61L	7/9/2019	Other	--	380	130	30	62	0.58	16	93
R61L	11/13/2019	Other	--	380	120	36	54	0.45	9.8	96
R61L	1/14/2020	Other	--	350	130	33	59	0.48	9.7	110
R61L	4/16/2020	Other	--	490	140	41	66	0.31	15	83
R61L	11/18/2020	Other	6.67	450	140	40	72	0.42	15	88
R61L	2/23/2021	Other	6.61	440	140	41	61	0.40	12	88
R61L	5/21/2021	Other	6.67	450	140	30	73	0.36	15	93
R61L	8/9/2021	Other	7.29	500	140	39	74	0.35	23	84
R61L	11/16/2021	Other	7.01	510	160	39	80	0.36	19	100
R61L	1/31/2022	Other	6.67	560	150	36	79	0.39	15	100
R61L	5/2/2022	Other	6.62	490	140	28	71	0.32	16	93
R61L	5/11/2023	Other	8.76	350	110	21	58	0.31	17	80
G61S	8/3/2017	Other	--	440	150	19	71	0.85	70	190
G61S	11/9/2017	Other	--	620	140	18	68	0.76	85	220
G61S	2/8/2018	Other	--	600	140	17	66	0.84	74	220
G61S	4/18/2018	Other	--	540	110	17	64	0.80	67	200
G61S	7/17/2018	Other	--	390	120	17	63	0.86	71	190
G61S	10/17/2018	Other	--	510	160	19	68	0.82	65	180
G61S	2/15/2019	Other	--	510	150	31	63	0.79	65	250
G61S	4/24/2019	Other	--	440	150	18	64	0.78	64	190
G61S	7/10/2019	Other	--	440	190	19	81	0.92	78	470
G61S	11/13/2019	Other	--	440	190	22	78	0.80	59	460
G61S	1/14/2020	Other	--	340	210	22	86	0.89	65	430
G61S	4/14/2020	Other	--	380	160	12	72	0.61	48	350
G61S	11/18/2020	Other	6.6	540	190	27	87	0.68	50	350
G61S	2/23/2021	Other	6.48	480	200	25	80	0.70	46	370
G61S	5/14/2021	Other	6.57	460	200	25	88	0.69	50	410
G61S	8/9/2021	Other	6.57	460	180	27	82	0.61	42	330
G61S	11/16/2021	Other	6.49	440	170	26	75	0.61	40	270
G61S	1/31/2022	Other	6.5	410	170	26	76	0.67	40	270
G61S	4/28/2022	Other	6.44	400	140	15	66	0.51	33	260

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Appendix B-2. Supporting groundwater analytical data for Attachment 3

Well	Date	Well Type	pH (field) (SU)	Alkalinity as bicarbonate (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)
G61S	5/9/2023	Other	6.64	380	160	14	65	0.63	33	300
G62L	5/11/2017	Other	--	220	160	16	76	0.55	22	120
G62L	6/8/2017	Other	--	310	180	17	79	0.54	28	120
G62L	7/3/2017	Other	--	300	170	17	86	0.57	31	130
G62L	8/3/2017	Other	--	380	170	17	89	0.48	35	120
G62L	9/14/2017	Other	--	440	160	15	87	0.53	36	120
G62L	11/9/2017	Other	--	500	170	18	86	0.64	38	120
G62L	2/12/2018	Other	--	600	160	17	83	0.84	43	120
G62L	4/19/2018	Other	--	220	88	13	49	0.31	18	140
G62L	7/18/2018	Other	--	440	150	14	77	0.62	32	140
G62L	10/19/2018	Other	--	450	180	17	89	0.51	35	150
G62L	2/15/2019	Other	--	250	110	20	51	0.39	19	190
G62L	4/10/2019	Other	--	150	130	8.2	63	0.39	14	310
G62L	7/9/2019	Other	--	140	180	3.2	76	0.40	9.1	520
G62L	11/13/2019	Other	--	420	190	5.6	79	0.36	15	510
G62L	1/14/2020	Other	--	110	210	3.7	76	0.31	9.7	650
G62L	4/16/2020	Other	--	120	210	4.1	82	0.26	9.5	590
G62L	11/18/2020	Other	6.81	290	190	6.2	88	0.37	14	520
G62L	2/24/2021	Other	6.71	380	190	9.2	83	0.43	15	460
G62L	5/14/2021	Other	7.52	190	150	3.0	65	0.44	10	370
G62L	8/12/2021	Other	7.26	220	140	4.5	55	0.33	8.3	300
G62L	11/18/2021	Other	7.35	350	160	3.6	68	0.49	14	290
G62L	1/31/2022	Other	6.82	360	150	7.8	67	0.40	12	220
G62L	5/2/2022	Other	6.69	260	130	5.1	55	0.34	8.8	300
G62L	5/11/2023	Other	6.82	310	170	6.7	75	0.43	10	400
G60L	4/14/2021	Exceedance	6.2	360	110	19	46	0.45	29	125
G60L	4/29/2021	Exceedance	6.1	320	120	19	49	0.39	31	160
G60L	5/13/2021	Exceedance	6.19	310	110	19	46	0.38	30	180
G60L	6/1/2021	Exceedance	6.26	300	110	20	46	0.41	30	170
G60L	6/15/2021	Exceedance	6.18	300	110	16	46	0.33	32	180
G60L	6/21/2021	Exceedance	6.16	300	110	18	45	0.29	29	180

Appendix B-2. Supporting groundwater analytical data for Attachment 3

Well	Date	Well Type	pH (field) (SU)	Alkalinity as bicarbonate (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)
G60L	7/12/2021	Exceedance	5.98	300	110	18	45	0.27	30	180
G60L	7/28/2021	Exceedance	6.22	280	110	15	43	0.39	29	160
G60L	1/12/2023	Exceedance	5.9	200	110	15	46	0.70	38	150
G60L	5/12/2023	Exceedance	5.97	300	100	11	40	0.33	33	160
XTPW02	6/23/2021	Porewater	6.6	180	750	3900	1700	56	570	4300
X301	6/9/2020	Leachate	6.7	490	420	1000	400	12	85	1600
X301	11/19/2020	Leachate	5.93	7.5	580	4300	1900	62	430	8100
X301	2/24/2021	Leachate	5.5	10	180	1200	470	18	110	2300
X301	4/14/2021	Leachate	6.7	12	580	3700	1800	65	390	7300
X301	4/29/2021	Leachate	6.6	22	560	3600	1700	55	400	7200
X301	5/12/2021	Leachate	6.48	8.0	560	4100	1600	56	410	7700
X301	6/1/2021	Leachate	6.64	180	550	3700	1700	57	400	7300
X301	7/26/2021	Leachate	6.22	3.5	600	3600	1800	53	370	6900
X301	8/12/2021	Leachate	6.07	3.0	630	3300	1700	61	420	6800
X301	11/19/2021	Leachate	6.87	12	590	3700	1700	48	330	7100
X301	2/21/2022	Leachate	6.2	14	88	130	39	2.7	11	330
X301	4/28/2022	Leachate	--	9.0	570	3400	1600	56	380	6900
X301	7/20/2022	Leachate	--	4.0	630	2300	1600	54	360	4900
X301	1/16/2023	Leachate	--	460	430	420	260	7.3	56	910
X301	5/10/2023	Leachate	6.76	30	580	320	1500	50	340	640

Notes:

mg/L = milligrams per liter

SU= standard units

< = less than analytical detection limit; data not included in Attachment 3.

-- = data not measured

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FIELD BORING LOG

HANSON

CLIENT: Ameren
Site: Gypsum Stack
Location: Duck Creek Generating Station
Project: 03S5010
DATES: Start: 4/1/407
Finish: 4/4/2007
WEATHER: Overcast, cool

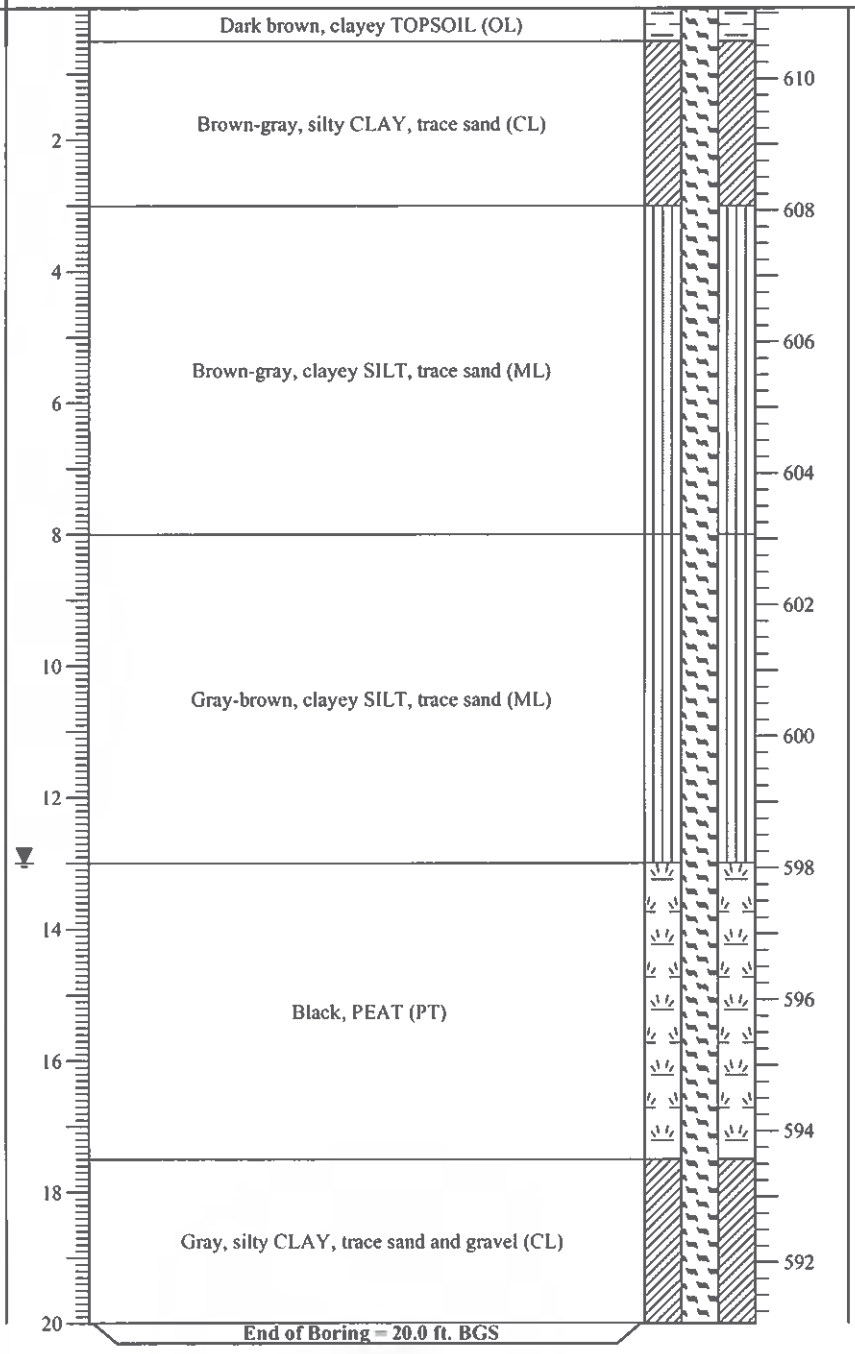
CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME-650 Track Rig
Drilling Method: 3¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: B-55
Well ID: hole abandoned
Surface Elev: 611.07 ft. MSL
Completion: 20.00 ft. BGS
Station: 15,438.7N
987.3E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type
1A	15/18 83%	SS	2-3 3 N=6	29		1.75 B
2A	16/18 89%	SS	3-4 5 N=9	22		0.78 BSh
3A	16/18 89%	SS	3-4 4 N=8	26		
4A	15/18 83%	SS	3-4 5 N=9	26		1.94 BSh
5A	18/18 100%	SS	2-3 4 N=7	33		1.32 B
6A	18/18 100%	SS	3-4 5 N=9	20		1.16 BSh



NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. CONTRACTOR: Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility Rig mfg/model: CME-650 Track Rig
Location: Canton, Fulton Co., Illinois Drilling Method: 4¼" hollow stem auger - blind drilled within 5 ft of BG60
Project: 03S5010
DATES: Start: 1/17/2008
Finish: 1/17/2008
WEATHER: Overcast, windy, cold
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: R. Hasenyager

BOREHOLE ID: ~~BG60~~
Well ID: G60L
Surface Elev: 612.5 ft. MSL
Completion: 25.3 ft. BGS
Station: 15,474.74N
1,049.75E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, Tier 6N; Range 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ = 21.02 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellow brown (10YR3/4), slightly moist, silty CLAY, trace sand		612	
							1	Light gray (10YR7/2) with 40% brown yellow (10YR6/8) mottles, moist, silty CLAY, trace sand			
							2	Brown yellow (10YR6/8) with 40% light gray (10YR7/2) mottles, moist, clayey SILT, trace sand		610	
							4	Yellow brown (10YR5/8), moist, clayey SILT, trace sand		608	
							6	Light yellow brown (10YR6/4) with 30% brown yellow (10YR6/8) mottles, moist, clayey SILT, trace sand		606	
							8	Yellow brown (10YR5/8) with 20% light yellow brown (10YR6/4) mottles, moist, clayey SILT, trace sand		604	
							10	Light brown gray (10YR6/2) with 10% brown yellow (10YR6/8) mottles, very moist, clayey SILT, trace sand		602	
							12	Gray brown (10YR5/2) with 30% very dark gray brown (10YR3/2) mottles, moist, clayey SILT, trace sand		600	
							14	Dark gray (10YR4/1), moist, clayey SILT, trace sand		598	
							16	Dark gray (10YR4/1) with 10% very dark gray (10YR3/1) mottles, moist, clayey SILT, trace sand		596	
							18	Black (10YR2/1), moist, very silty CLAY, trace sand		594	
								Dark gray (10YR4/1), moist, silty CLAY, trace sand			
								Dark green gray (10Y4/1) with 5% very dark gray (10YR3/1) mottles, moist, silty CLAY, trace sand, trace organics			
							20	Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel			

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co. **CONTRACTOR:** Testing Service Corporation
Site: Duck Creek Gypsum Managment Facility **Rig mfg/model:** CME-650 Track Rig
Location: Canton, Fulton Co., Illinois **Drilling Method:** 4¼" hollow stem auger - blind drilled within 5 ft of BG60
Project: 03S5010
DATES: Start: 1/17/2008 **FIELD STAFF: Driller:** B. Williamson
Finish: 1/17/2008 **Helper:** R. Keedy
WEATHER: Overcast, windy, cold **Eng/Geo:** R. Hasenyager

BOREHOLE ID: BG60b
Well ID: G60L
Surface Elev: 612.5 ft. MSL
Completion: 25.3 ft. BGS
Station: 15,474.74N
1,049.75E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 30.60 - during drilling
▼ = 21.02 - 1/30/2008
▽ =

SAMPLE Number	SAMPLE Recov / Total (in) % Recovery	SAMPLE Type	TESTING Blows / 6 in N - Value RQD	TESTING Moisture (%)	TESTING Dry Den. (lb/ft³)	TESTING Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							▼	Dark green gray (10Y4/1) moist, silty CLAY, trace sand and gravel *[Continued from previous page]*		592	
							22	Green gray (5GY5/1), very moist, silty CLAY, trace sand and gravel		590	
							24	Green gray (5GY5/1) with 5% yellow brown (10YR5/4) mottles, wet, very silty CLAY, trace sand and gravel		588	

End of Boring = 25.28 ft. BGS

NOTE(S):

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	14/24 58%	SS	2-3 3-4 N=6				0			620	
2A	18/24 75%	SS	3-6 8-11 N=14	17.5			2			618	
3A	15/24 63%	SS	3-4 6-7 N=10	19.6			4	FILL - Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		616	
4A	20/24 83%	SS	6-8 11-14 N=19	18.5			6			614	
5A	22/24 92%	SS	3-5 6-7 N=11	26.8			8			612	
6A	21/24 88%	SS	2-4 5-5 N=9	23.8			10	Yellowish brown (10YR5/6), moist, medium, SILT with few clay and trace sand.		610	
7A	20/24 83%	SS	4-4 6-7 N=10	22.8			12	Yellowish brown (10YR5/8) with 30% gray (10YR5/1) mottles, moist, medium, SILT with few clay and trace sand.		608	
8A	21/24 88%	SS	5-6 7-7 N=13	22.1			14	Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, moist, medium, SILT with few clay and trace sand.		606	
9A	21/24 88%	SS	5-5 6-6 N=11	21.0			16			604	
10A	24/24 100%	SS	2-3 4-7 N=7	28.1			18	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, wet, medium, SILT with few clay and trace sand.		602	
10B				61.7				Dark yellowish brown (10YR3/4), moist, medium, SILT with few clay and trace sand, trace organics.			
							20	Dark brown (10YR3/3), moist, medium, PEAT.			

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Ash Landfill
Location: 17751 N. CILCO Rd., Canton, IL 61520
Project: 17E0057
DATES: **Start:** 3/15/2017
Finish: 3/15/2017
WEATHER: Sunny, cold (lo-30s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4¼" Hollow Stem Auger, split spoon sampler
FIELD STAFF: **Driller:** B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: P60
Well ID: P60
Surface Elev: 620.12 ft. MSL
Completion: 34.62 ft. BGS
Station: 15,477.09N
992.24E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner, IL
Township: Banner
Section 18, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.80 - During drilling
▼ = Dry - At completion
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark brown (10YR3/3), moist, medium, PEAT. *[Continued from previous page]*		600	
11A	20/24 83%	SS	2-5 6-7 N=11	31.4			22	Very dark gray (10YR3/1), moist, medium, SILT with some clay and trace sand, trace organics.		598	
12A	24/24 100%	SS	9-8 7-6 N=15	33.7				Very dark gray (10YR3/1), wet, medium, SILT with some clay and trace sand, trace organics.			
							24	Dark brown (10YR3/3), moist, medium, PEAT.		596	
13A	20/24 83%	SS	4-3 4-4 N=7	23.0				Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand and gravel.			
14A	22/24 92%	SS	4-5 6-6 N=11	20.6			26			594	
15A	24/24 100%	SS	3-3 4-5 N=7	17.5			28	Greenish gray (5G6/1), moist, medium, CLAY with some silt and trace sand and gravel.		592	
16A	24/24 100%	SS	1-3 3-3 N=6	20.2			30			590	
17A	24/24 100%	SS	5-6 6-7 N=12	15.9			32	Greenish gray (5G6/1), wet, soft, SILT with few clay, little sand, and trace gravel.		588	
	0/7 0%	BD					34			586	

End of Boring = 34.62 ft bgs

NOTE(S): P60 installed in boring.
Coordinates are on Plant (Local) grid.

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Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Golder Associates USA*
Project Number/ LIMS No.	*18502-01/MI7010-MAY21*
Batch:	*MNA Duck Creek Power Station (21454831 Phase 0001)*
Sample Receipt:	*May 25, 2021*
Sample Analysis:	*June 8, 2021*
Reporting Date:	*July 9, 2021*

Instrument:	Panalytical X'pert Pro Diffractometer
Test Conditions:	Co radiation, 40 kV, 45 mA Regular Scanning: Step: 0.033°, Step time:0.15s, 2θ range: 6-70°
Interpretations :	PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

1) Method Summary
2) Quantitative XRD Results
3) XRD Pattern(s)

Ben Eaton, B.Sc.
Junior Mineralogist

Tassos Grammatikopoulos, Ph.D, P.Geo.
Senior Mineralogist

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Method Summary

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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07/09/2021

Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	B-AP-1 MAY7010-01 (wt %)	B-G52S MAY7010-02 (wt %)	B-G54L MAY7010-03 (wt %)	B-G57L MAY7010-04 (wt %)	B-G57S MAY7010-05 (wt %)	B-G62L MAY7010-06 (wt %)	B-G53S MAY7010-07 (wt %)	B-G02S MAY7010-08 (wt %)
Quartz	0.3	48.4	57.6	51.2	59.9	61.7	51.1	61.1
Hornblende	0.6	3.7	1.4	2.4	-	-	-	-
Gypsum	99.0	-	-	-	-	-	-	-
Dolomite	-	23.7	11.7	2.5	12.8	-	23.8	-
Calcite	-	6.7	0.8	0.1	0.3	-	4.1	-
Albite	-	6.7	8.1	17.4	8.2	8.6	5.5	9.9
Chlorite	-	0.8	0.3	0.3	0.2	0.4	2.4	5.4
Muscovite	-	3.3	13.8	8.8	11.7	18.7	6.7	15.4
Rhodochrosite	-	3.2	-	-	-	-	-	0.4
Microcline	-	2.9	5.5	9.4	5.9	10.7	5.7	7.5
Pyrite	-	0.4	-	0.3	-	-	-	-
Halite	-	-	0.7	-	-	-	-	-
Montmorillonite	-	-	-	5.1	-	-	-	-
Goethite	-	-	-	1.1	-	-	-	-
Diaspore	-	-	-	0.3	-	-	-	-
Magnetite	-	-	-	0.4	-	-	-	-
Diopside	-	-	-	1.0	0.5	-	-	0.2
Actinolite	-	-	-	-	0.5	-	0.6	0.2
TOTAL	100	100	100	100	100	100	100	100

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

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Mineral/Compound	B-G02L MAY7010-09 (wt %)
Quartz	49.2
Hornblende	-
Gypsum	-
Dolomite	9.2
Calcite	-
Albite	12.2
Chlorite	6.0
Muscovite	12.3
Rhodochrosite	-
Microcline	9.3
Pyrite	0.3
Halite	-
Montmorillonite	-
Goethite	-
Diaspore	-
Magnetite	0.4
Diopside	1.0
Actinolite	0.3
TOTAL	100

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

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07/09/2021

Mineral/Compound	Formula
Quartz	SiO_2
Hornblende	$(Ca,Na)_2^-3(Mg,Fe,Al)_5Si_6(Si,Al)_2O_{22}(OH)_2$
Gypsum	$CaSO_4{\cdot}2H_2O$
Dolomite	$CaMg(CO_3)_2$
Calcite	$CaCO_3$
Albite	$NaAlSi_3O_8$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Rhodochrosite	$MnCO_3$
Microcline	$KAlSi_3O_8$
Pyrite	FeS_2
Halite	NaCl
Montmorillonite	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2{\cdot}nH_2O$
Goethite	αFeO·OH
Diaspore	αAlO.OH
Magnetite	Fe_3O_4
Diopside	$CaMgSi_2O_6$
Actinolite	$Ca_2(Mg\ Fe)_5Si_8O_{22}(OH)_2$

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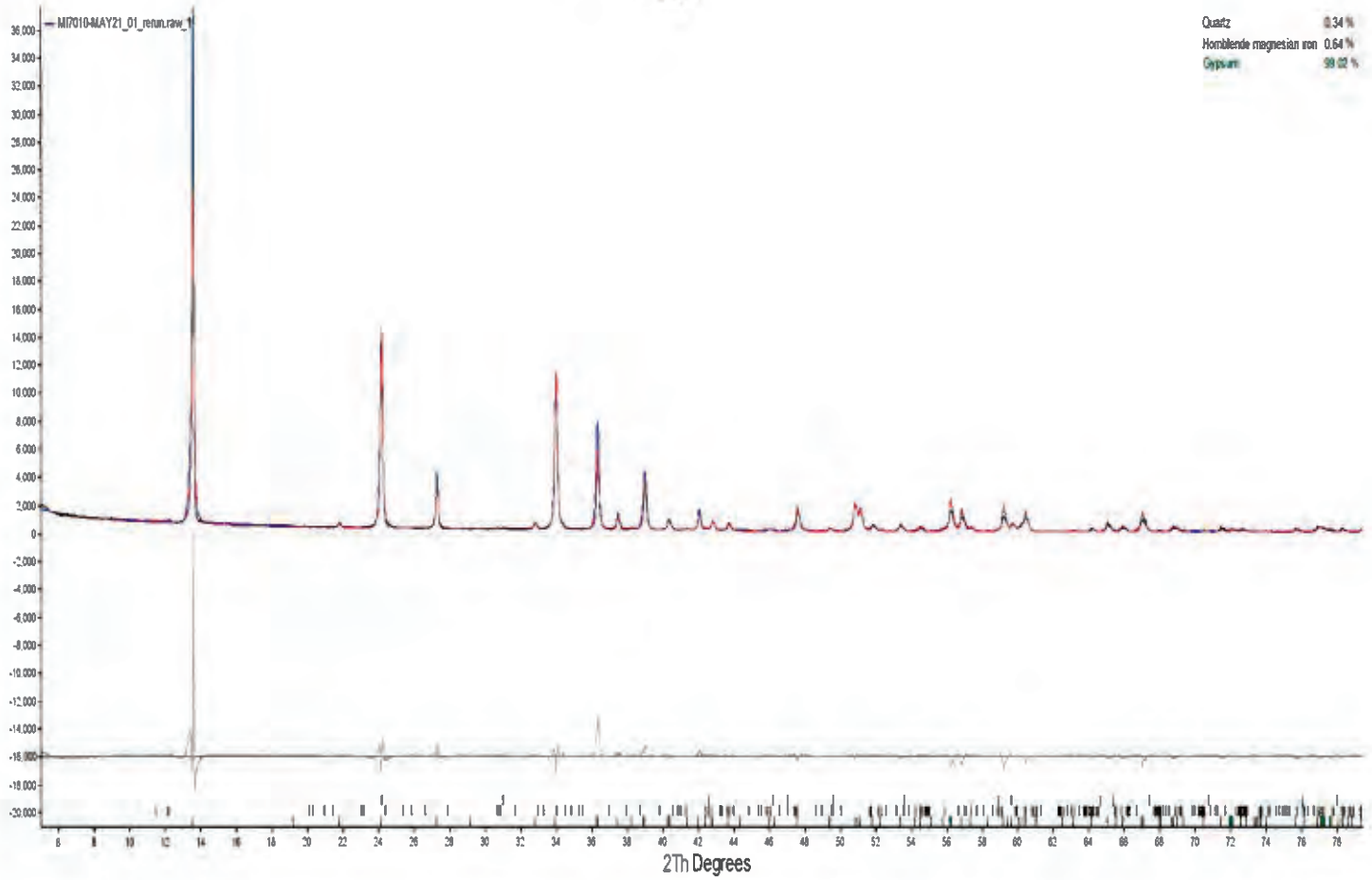
18502-01/MI7010-MAY21
07/09/2021

B-AP-1



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SGS

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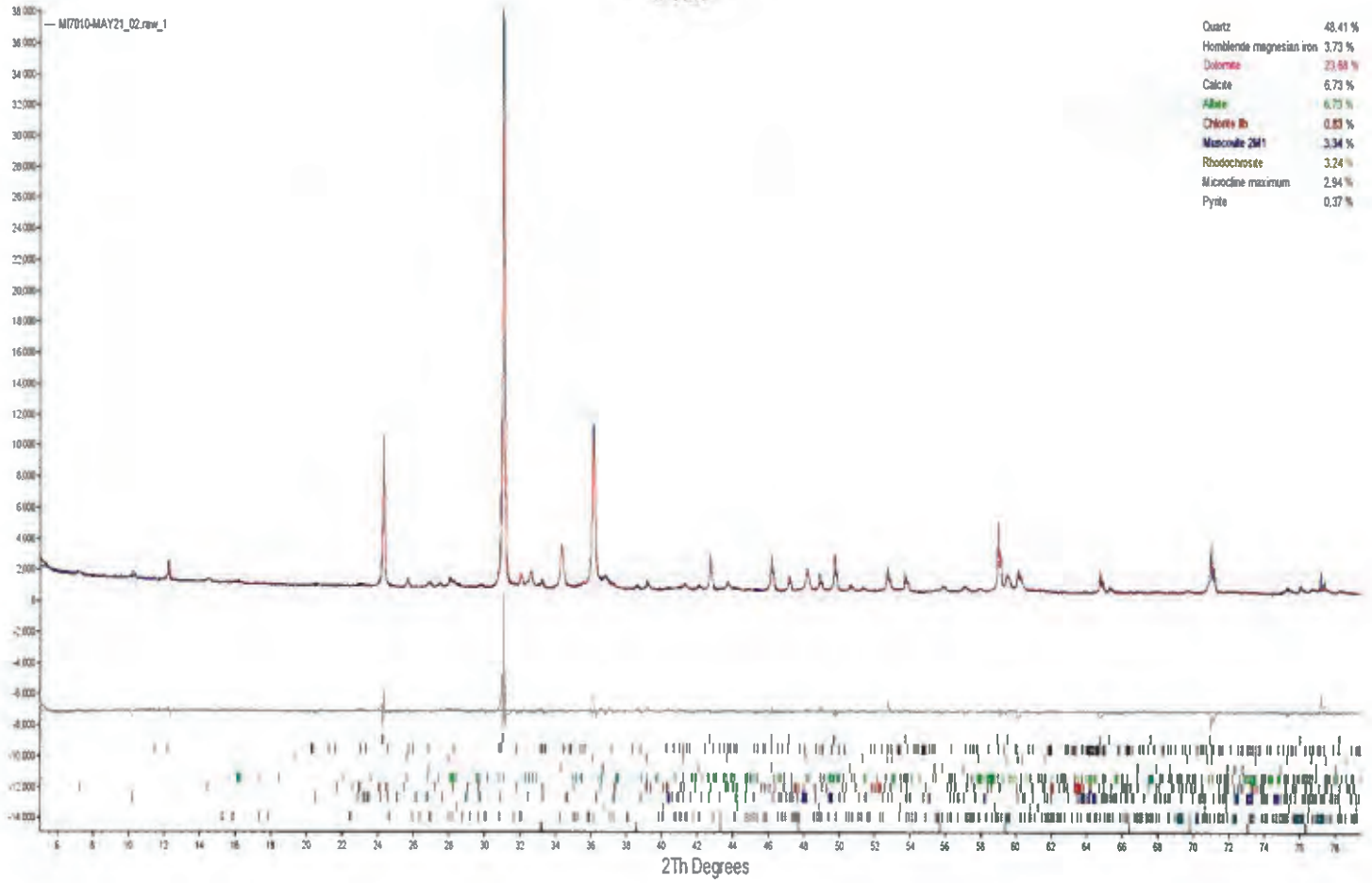
18502-01/MI7010-MAY21
07/09/2021

B-G52S



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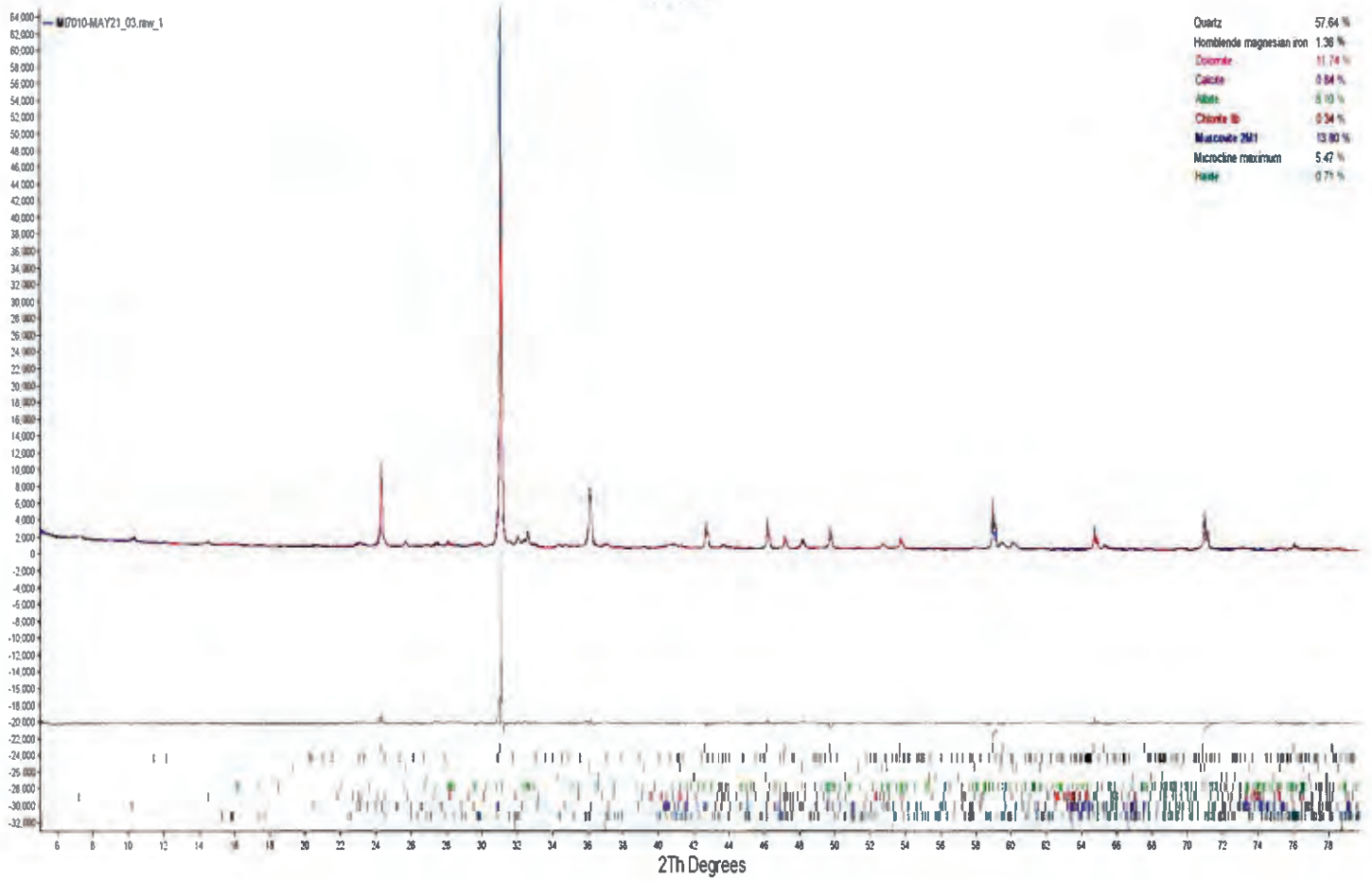
18502-01/MI7010-MAY21
07/09/2021

B-G54L



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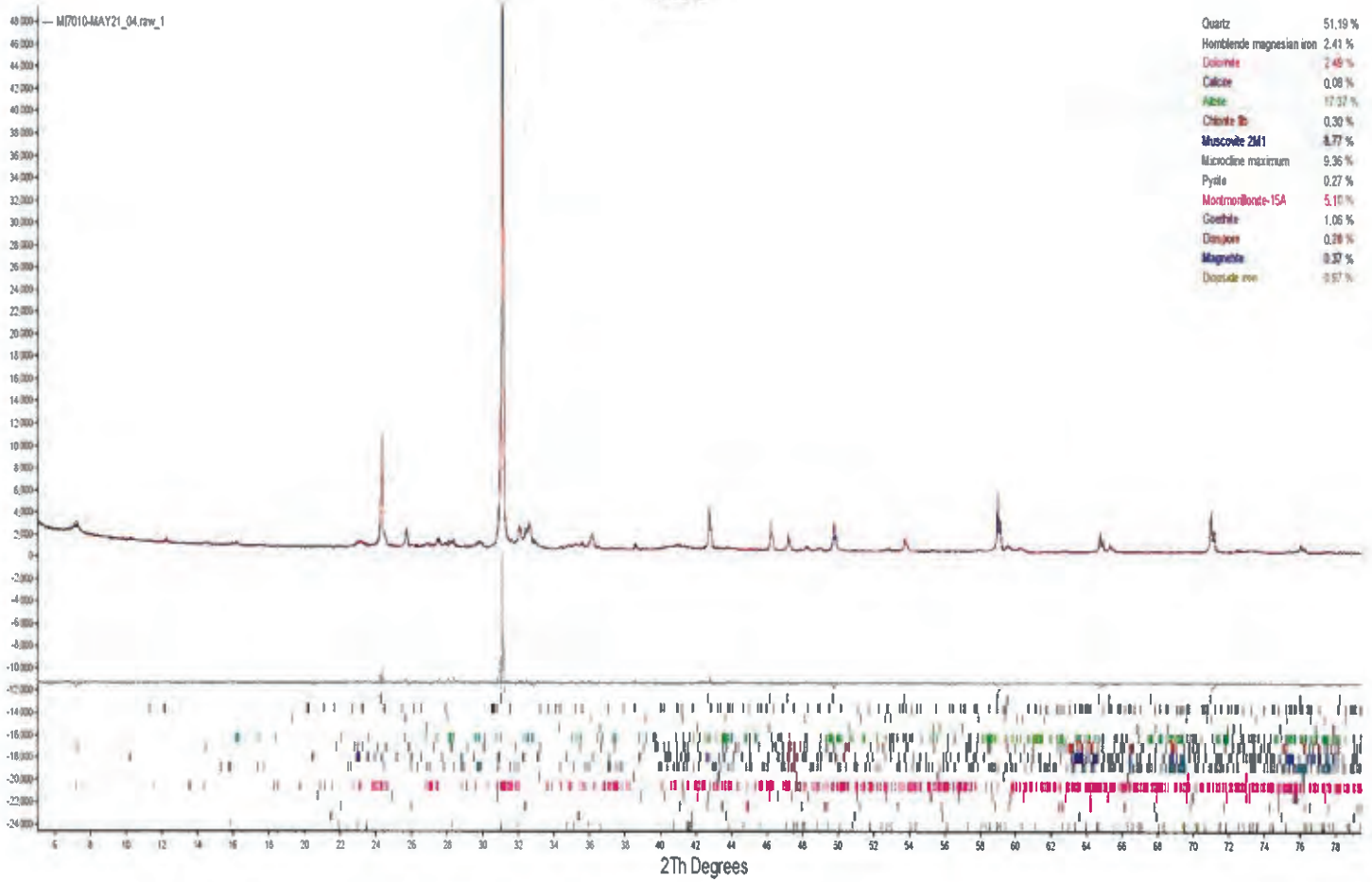
Golder Associates USA
18502-01/MI7010-MAY21
07/09/2021

B-G57L



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Golder Associates USA
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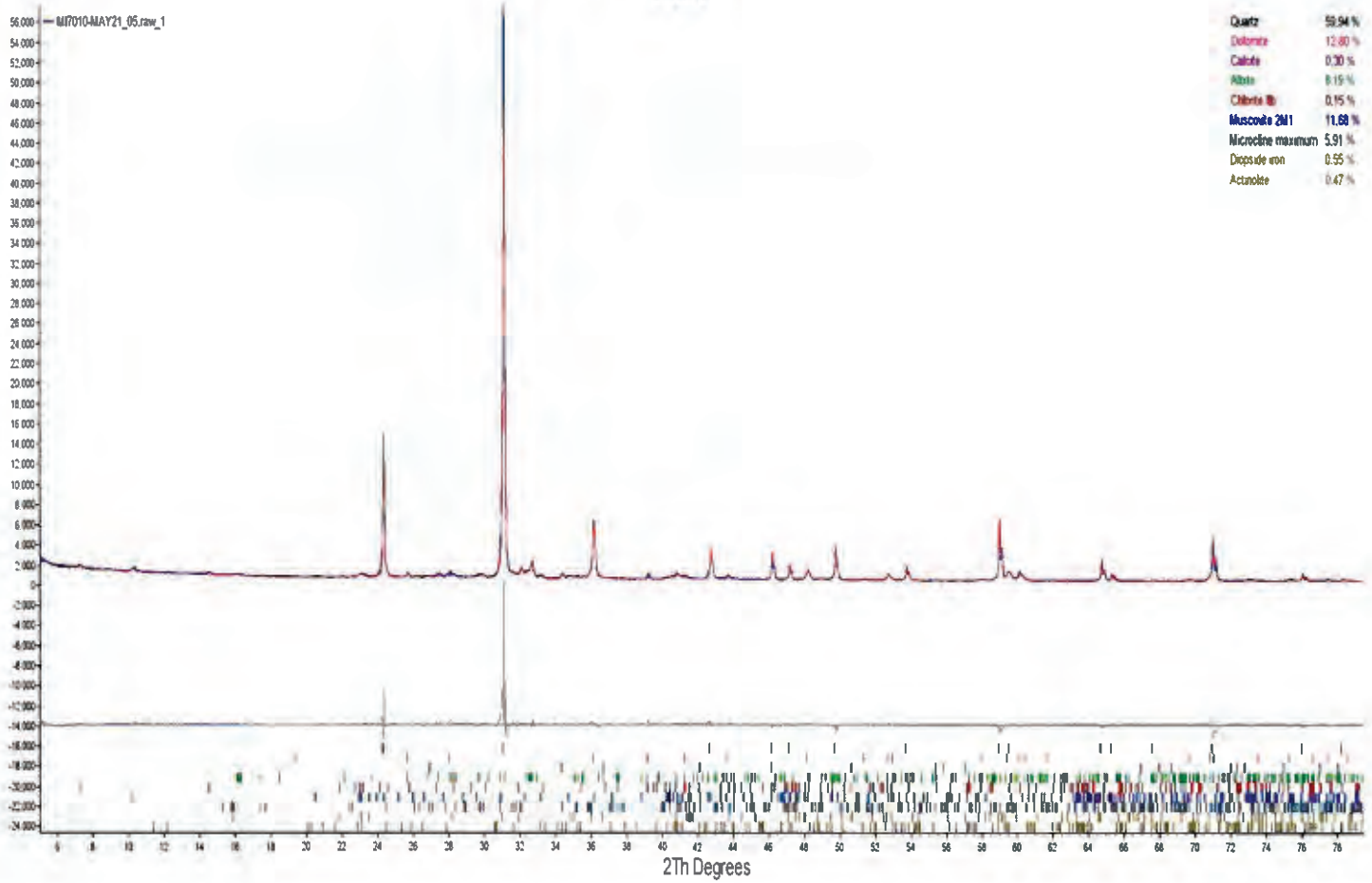
07/09/2021

B-G57S



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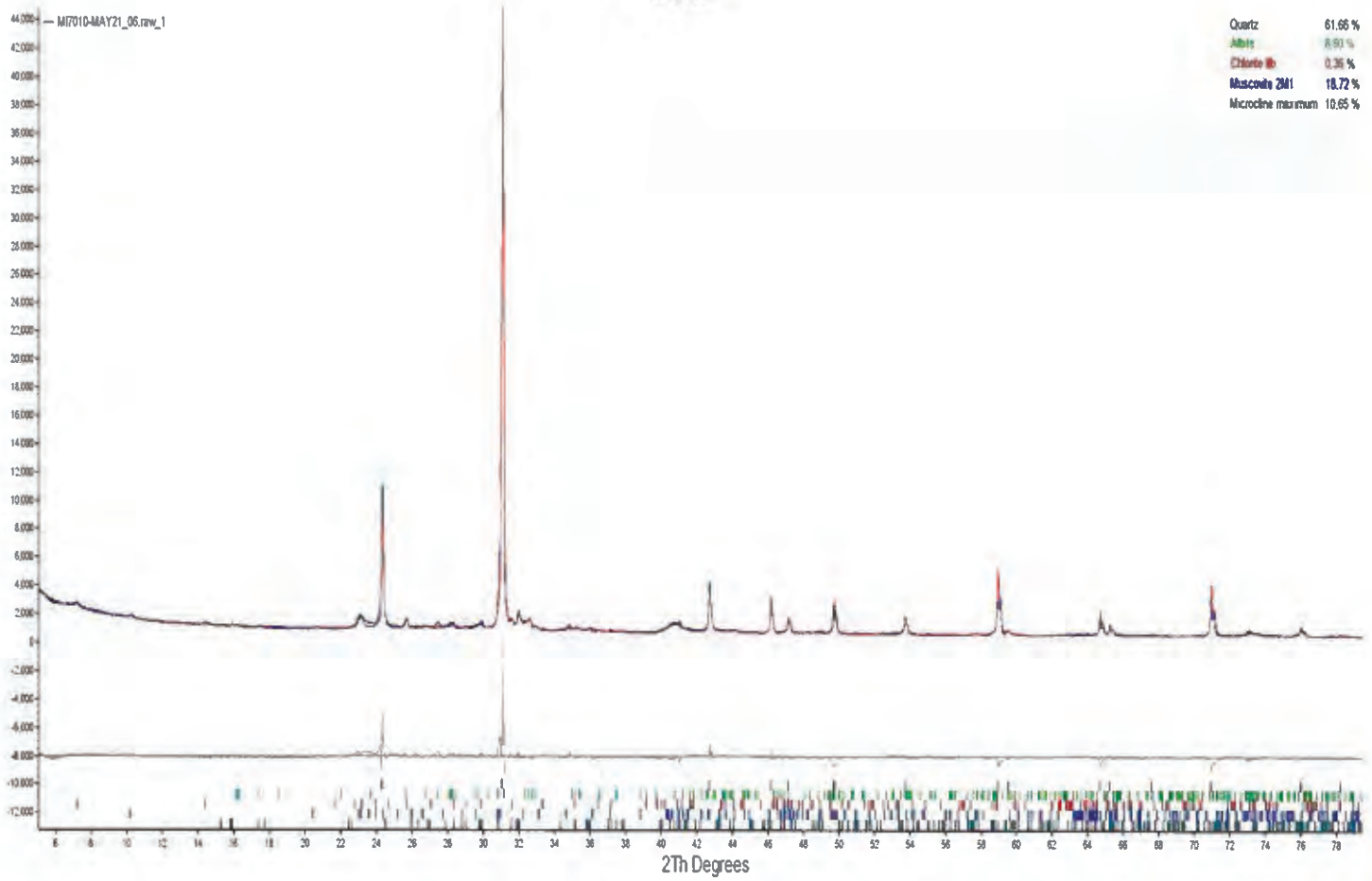
18502-01/MI7010-MAY21
07/09/2021

B-G62L



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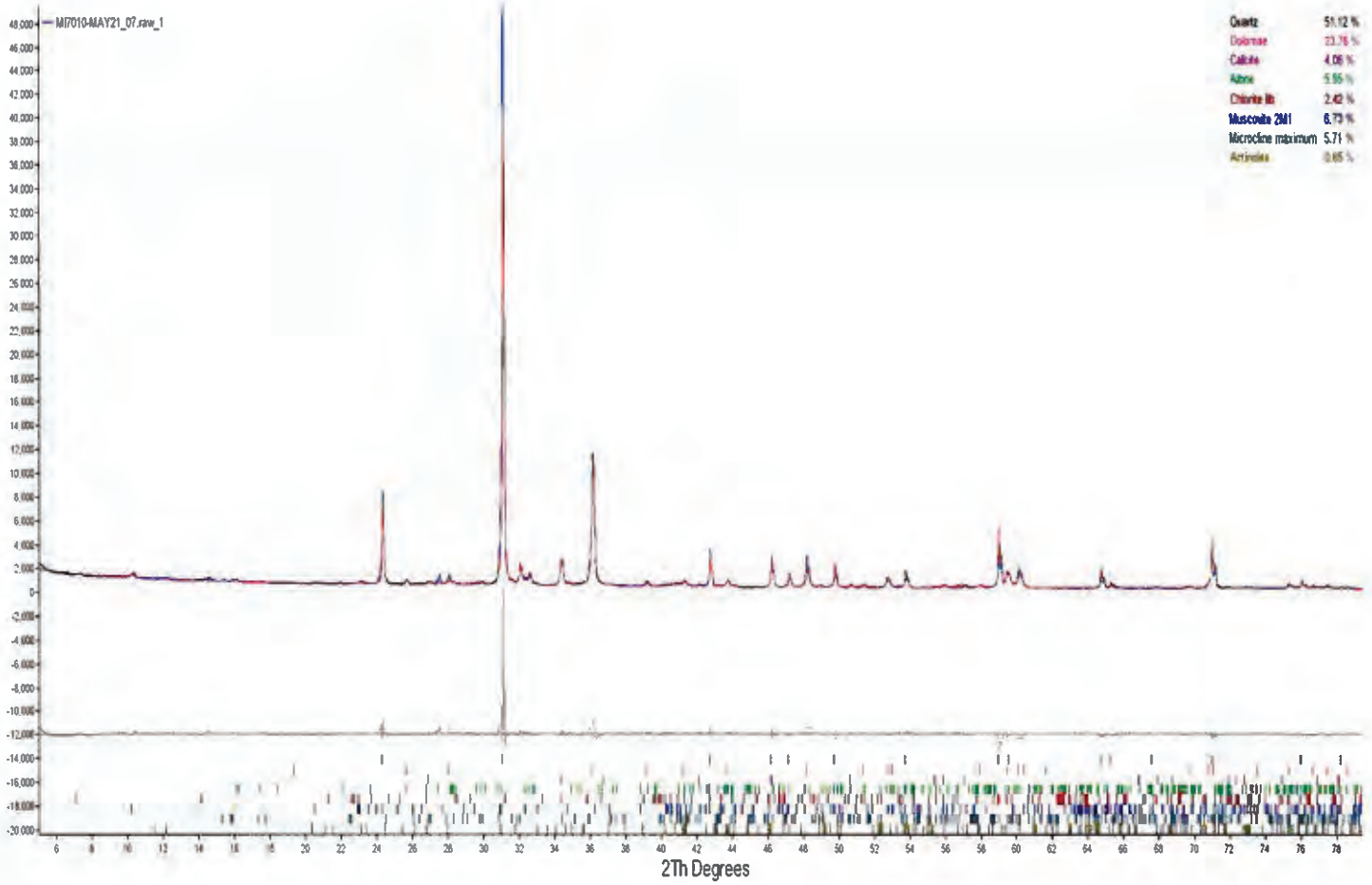
Golder Associates USA
18502-01/MI7010-MAY21
07/09/2021

B-G53S



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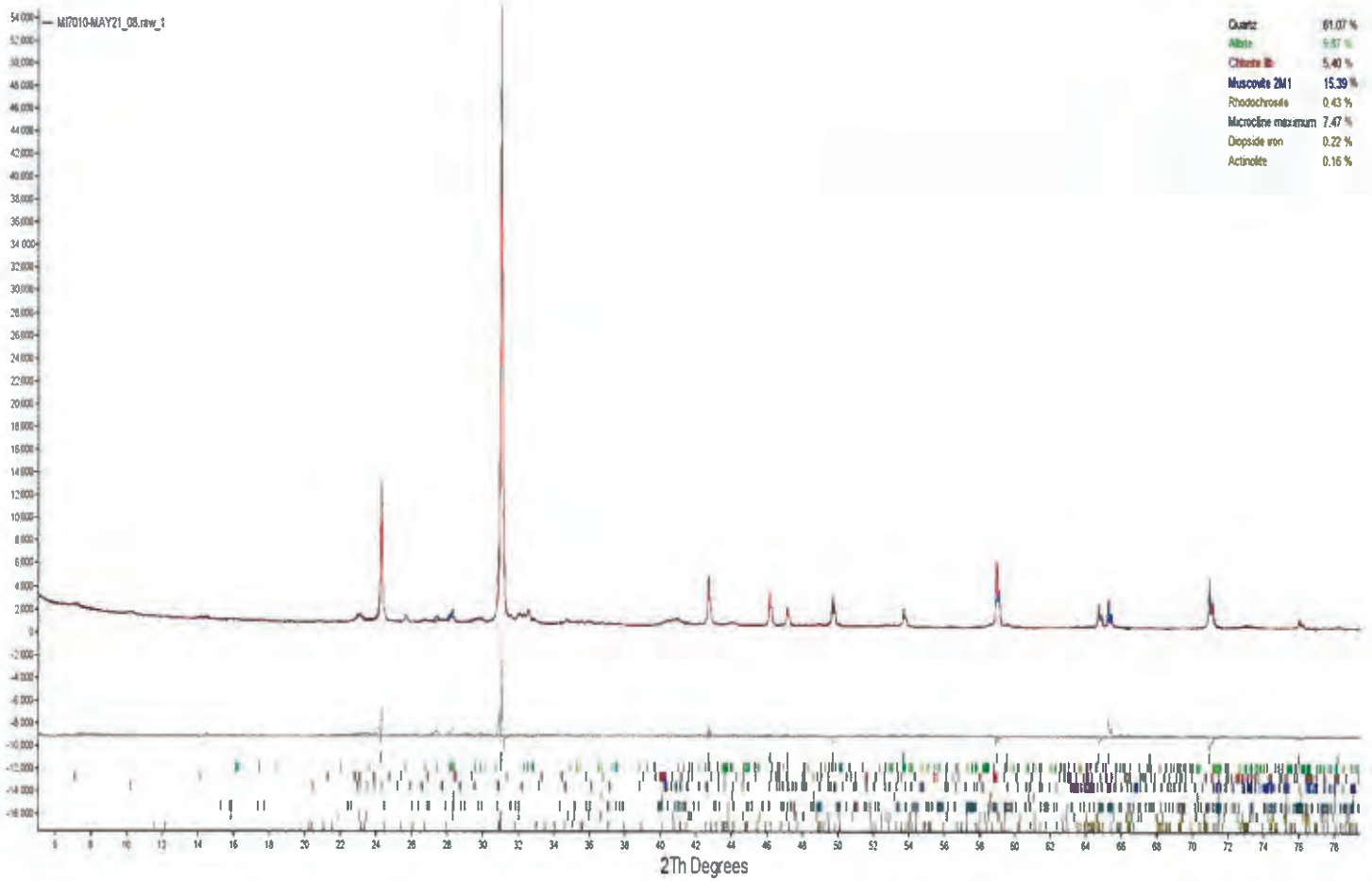
Golder Associates USA
18502-01/MI7010-MAY21
07/09/2021

B-G02S



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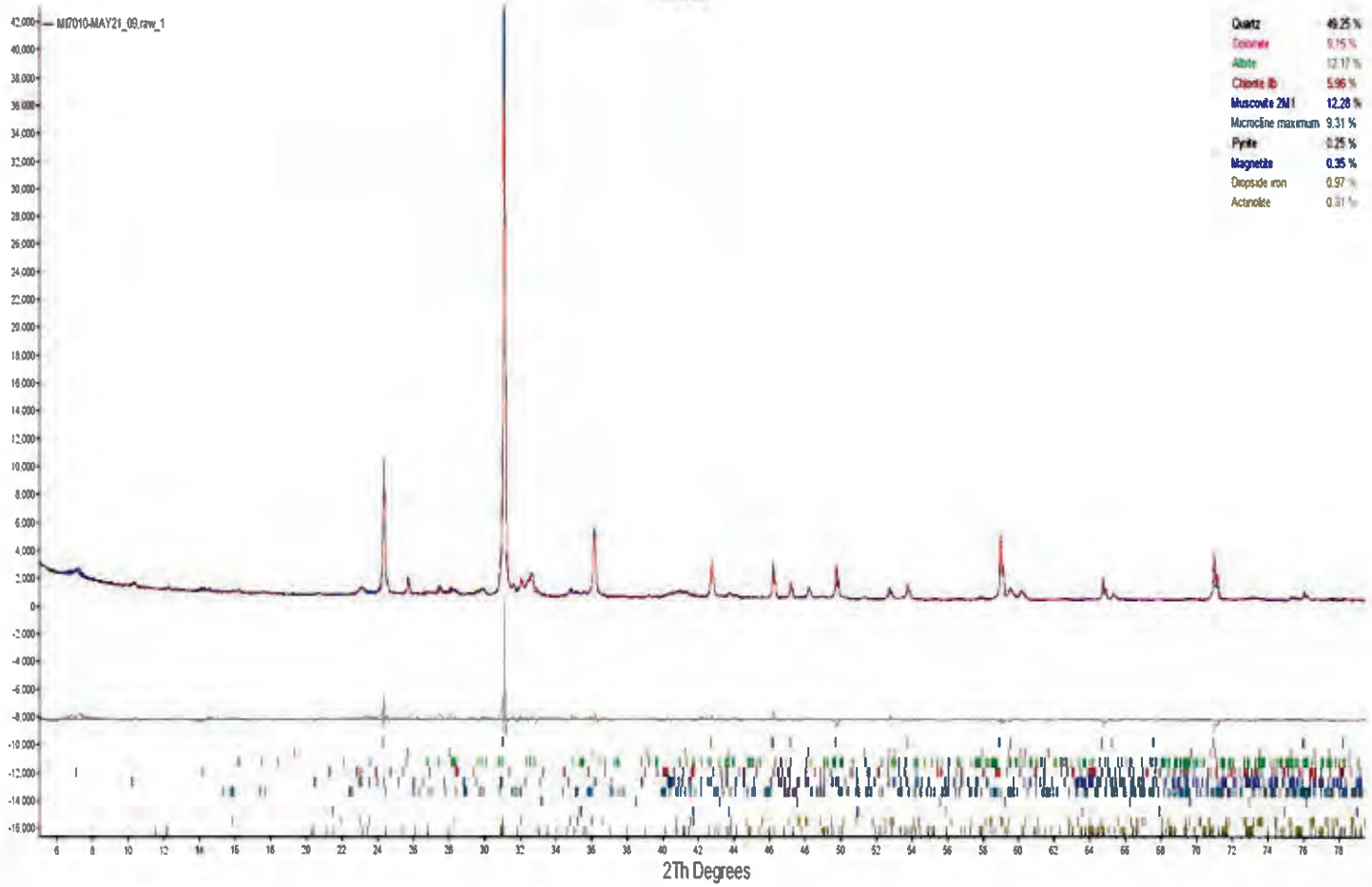
Golder Associates USA
18502-01/MI7010-MAY21
07/09/2021

B-G02L



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eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Tel: (865)291-3000

Laboratory Job ID: 140-23190-1
Client Project/Site: Duck Creek Power Station - Illinois

For:
Golder Associates Inc.
13515 Barrett Parkway Drive
Suite 260
Ballwin, Missouri 63021

Attn: Jeffrey Ingram

Ryan Henry

Authorized for release by:
7/20/2021 2:43:38 PM

Ryan Henry, Project Manager I
(865)291-3000
williamr.henry@eurofinset.com

LINKS

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This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature

Results relate only to the items tested and the sample(s) as received by the laboratory

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Definitions/Glossary

Client: Golder Associates Inc. Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Qualifiers

Metals

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

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Case Narrative

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Job ID: 140-23190-1

Laboratory: Eurofins TestAmerica, Knoxville

Narrative

Job Narrative
140-23190-1

Receipt
The samples were received on 5/21/2021 at 9:20am and arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 0.5° C.

Metals
7 Step Sequential Extraction Procedure

These soil samples were prepared and analyzed using Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0008, "7 Step Sequential Extraction Procedure". SW-846 Method 6010B as incorporated in Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0007 was used to perform the final instrument analyses.

An aliquot of each sample was sequentially extracted using the steps listed below:

- Step 1 - Exchangeable Fraction: A 5 gram aliquot of sample was extracted with 25 mL of 1M magnesium sulfate (MgSO4), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 2 - Carbonate Fraction: The sample residue from step 1 was extracted with 25 mL of 1M sodium acetate/acetic acid (NaOAc/HOAc) at pH 5, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 3 - Non-crystalline Materials Fraction: The sample residue from step 2 was extracted with 25 mL of 0.2M ammonium oxalate (pH 3), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 4 - Metal Hydroxide Fraction: The sample residue from step 3 was extracted with 25 mL of 1M hydroxylamine hydrochloride solution in 25% v/v acetic acid, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 5 - Organic-bound Fraction: The sample residue from step 4 was extracted three times with 25 mL of 5% sodium hypochlorite (NaClO) at pH 9.5, centrifuged and filtered. The resulting leachates were combined and 5 mL were digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 6 - Acid/Sulfide Fraction: The sample residue from step 5 was extracted with 25 mL of a 3:1:2 v/v solution of HCl-HNO3-H2O, centrifuged and filtered. 5 mL of the resulting leachate was diluted to 50 mL with reagent water and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 7 - Residual Fraction: A 1.0 g aliquot of the sample residue from step 6 was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Results are reported in mg/kg on a dry weight basis.

In addition, a 1.0 g aliquot of the original sample was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Total metal results are reported in mg/kg on a dry weight basis.

Results were calculated using the following equation:

Result, µg/g or mg/Kg, dry weight = (C × V × V1 × D) / (W × S × V2)

Where:
C = Concentration from instrument readout, µg/mL
V = Final volume of digestate, mL
D = Instrument dilution factor
V1 = Total volume of leachate, mL
V2 = Volume of leachate digested, mL
W = Wet weight of sample, g
S = Percent solids/100

A method blank, laboratory control sample and laboratory control sample duplicate were prepared and analyzed with each SEP step in

Case Narrative

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Job ID: 140-23190-1 (Continued)

Laboratory: Eurofins TestAmerica, Knoxville (Continued)

order to provide information about both the presence of elements of interest in the extraction solutions, and the recovery of elements of interest from the extraction solutions. Results outside of laboratory QC limits do not reflect out of control performance, but rather the effect of the extraction solution upon the analyte.

A laboratory sample duplicate was prepared and analyzed with each batch of samples in order to provide information regarding the reproducibility of the procedure.

SEP Report Notes:

The final report lists the results for each step, the result for the total digestion of the sample, and a sum of the results of steps 1 through 7 by element.

Magnesium was not reported for step 1 because the extraction solution for this step (magnesium sulfate) contains high levels of magnesium. Sodium was not reported for steps 2 and 5 since the extraction solutions for these steps contain high levels of sodium. The sum of steps 1 through 7 is much higher than the total result for sodium and magnesium due to the magnesium and sodium introduced by the extraction solutions.

The digestates for steps 1, 2 and 5 were analyzed at a dilution due to instrument problems caused by the high solids content of the digestates. The reporting limits were adjusted accordingly.

Method 6010B: The following sample was diluted to bring the concentration of target analyte, calcium, within the calibration range: B-AP-1 (140-23190-1). Elevated reporting limits (RLs) are provided.

Method 6010B: The following samples were diluted due to the nature of the sample matrix: B-AP-1 (140-23190-1), B-G52S (140-23190-2), B-G54L (140-23190-3), B-G57L (140-23190-4), B-G57S (140-23190-5), B-G62L (140-23190-6), B-G53S (140-23190-7), B-G02S (140-23190-8) and B-G02L (140-23190-9). Elevated reporting limits (RLs) are provided for aluminum and calcium.

Method 6010B: The following samples were diluted to bring the concentration of target analyte, potassium, within the calibration range: B-G52S (140-23190-2), B-G54L (140-23190-3), B-G57S (140-23190-5), B-G62L (140-23190-6), B-G53S (140-23190-7), B-G02S (140-23190-8) and B-G02L (140-23190-9). Elevated reporting limits (RLs) are provided.

Method 6010B: The following samples were diluted due to the presence of silicon which interferes with Arsenic, Lead and Selenium: B-G52S (140-23190-2) and B-G53S (140-23190-7). Elevated reporting limits (RLs) are provided.

Method 6010B: The following samples were diluted due to the presence of titanium which interferes with Cobalt and Lead: B-G54L (140-23190-3), B-G62L (140-23190-6) and B-G02L (140-23190-9). Elevated reporting limits (RLs) are provided.

Method 6010B: Due to sample matrix effect on the internal standard (ISTD), a dilution was required for the following sample: B-G57L (140-23190-4).

Method 6010B SEP: The method blank for preparation batch 140-51550 and 140-51581 contained Iron above the reporting limit (RL). The following samples, 23190-1, 23190-3, 23190-4, 23190-5, 23190-6, 23190-7, 23190-8 and 23190-9 associated with this method blank did not contain the target compound; therefore, re-extraction and/or re-analysis of samples were not performed.

Method 6010B SEP: The following sample was diluted to bring the concentration of target analyte, calcium, within the calibration range: B-AP-1 (140-23190-1). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted to bring the concentration of target analyte, sodium, within the calibration range: B-AP-1 (140-23190-1), B-G52S (140-23190-2), B-G54L (140-23190-3), B-G57L (140-23190-4), B-G57S (140-23190-5), B-G62L (140-23190-6), B-G53S (140-23190-7), B-G02S (140-23190-8) and B-G02L (140-23190-9). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The method blank for preparation batch 140-51449 and 140-51455 and analytical batch 140-51720 contained Iron above the reporting limit (RL). Associated sample 23190-2 was not re-extracted and/or re-analyzed because results were greater than

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Case Narrative

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Job ID: 140-23190-1 (Continued)

Laboratory: Eurofins TestAmerica, Knoxville (Continued)

10X the value found in the method blank.

Method 6010B SEP: The method blank for preparation batch 140-51449 and 140-51455 contained Iron above the reporting limit (RL). The following samples, 23190-1, 23190-4, 23190-6, 23190-9 associated with this method blank did not contain the target compound; therefore, re-extraction and/or re-analysis of samples were not performed.

Method 6010B SEP: The following samples were diluted to bring the concentration of target analyte, sodium, within the calibration range: B-G57L (140-23190-4) and B-G62L (140-23190-6). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted to bring the concentration of target analyte, potassium, within the calibration range: B-G52S (140-23190-2), B-G54L (140-23190-3), B-G57L (140-23190-4), B-G57S (140-23190-5), B-G62L (140-23190-6), B-G53S (140-23190-7), B-G02S (140-23190-8) and B-G02L (140-23190-9). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted due to the presence of titanium which interferes with Cobalt and Lead: B-G54L (140-23190-3), B-G57L (140-23190-4), B-G57S (140-23190-5), B-G62L (140-23190-6) and B-G02L (140-23190-9). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted due to the presence of silicon which interferes with Arsenic, Lead and Selenium: B-G54L (140-23190-3), B-G62L (140-23190-6), B-G53S (140-23190-7) and B-G02S (140-23190-8). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted due to the nature of the sample matrix: B-AP-1 (140-23190-1), B-G52S (140-23190-2), B-G54L (140-23190-3), B-G57L (140-23190-4), B-G57S (140-23190-5), B-G62L (140-23190-6), B-G53S (140-23190-7), B-G02S (140-23190-8) and B-G02L (140-23190-9). Elevated reporting limits (RLs) are provided for aluminum and calcium.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

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Sample Summary

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
140-23190-1	B-AP-1	Solid	05/17/21 11:45	05/21/21 09:20	
140-23190-2	B-G52S	Solid	05/18/21 11:30	05/21/21 09:20	
140-23190-3	B-G54L	Solid	05/18/21 15:30	05/21/21 09:20	
140-23190-4	B-G57L	Solid	05/19/21 10:40	05/21/21 09:20	
140-23190-5	B-G57S	Solid	05/19/21 10:48	05/21/21 09:20	
140-23190-6	B-G62L	Solid	05/19/21 14:00	05/21/21 09:20	
140-23190-7	B-G53S	Solid	05/19/21 16:15	05/21/21 09:20	
140-23190-8	B-G02S	Solid	05/20/21 09:40	05/21/21 09:20	
140-23190-9	B-G02L	Solid	05/20/21 10:30	05/21/21 09:20	

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-AP-1
Date Collected: 05/17/21 11:45
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-1
Matrix: Solid
Percent Solids: 58.9

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		68	11	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Arsenic	ND		3.4	0.88	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Calcium	**4600**	**B**	1700	13	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Cobalt	ND		17	0.31	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Iron	ND		34	20	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Lead	ND		3.4	0.75	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Lithium	ND		17	1.0	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Manganese	**0.40**	**J**	5.1	0.21	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Molybdenum	**0.64**	**J**	14	0.56	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Potassium	ND		1700	180	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Sodium	ND		1700	880	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4
Selenium	ND		3.4	1.2	mg/Kg	☼	07/02/21 08:00	07/13/21 11:26	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**10**	**J**	51	8.2	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Arsenic	ND		2.5	0.66	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Calcium	**12000**		1300	11	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Cobalt	ND		13	0.32	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Iron	ND		25	15	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Lead	ND		2.5	0.56	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Lithium	ND		13	0.76	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Manganese	**7.7**		3.8	1.4	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Molybdenum	ND		10	0.42	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Potassium	ND		1300	130	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3
Selenium	ND		2.5	0.87	mg/Kg	☼	07/02/21 14:02	07/13/21 13:23	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**28**		17	3.6	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Arsenic	ND		0.85	0.22	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Calcium	**4300**		420	2.5	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Cobalt	ND		4.2	0.076	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Iron	**240**		8.5	4.9	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Lead	ND		0.85	0.19	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Lithium	ND		4.2	0.25	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Manganese	**28**	**B**	1.3	0.046	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Molybdenum	**0.27**	**J**	3.4	0.14	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Potassium	ND		420	44	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Sodium	**9700**		420	220	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1
Selenium	**1.6**		0.85	0.29	mg/Kg	☼	07/07/21 08:00	07/14/21 12:01	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**26**		17	2.7	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Arsenic	ND		0.85	0.37	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Calcium	**9200**		420	3.7	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Cobalt	ND		4.2	0.090	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Iron	**110**		8.5	4.9	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Lead	ND		0.85	0.19	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-AP-1
Date Collected: 05/17/21 11:45
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-1
Matrix: Solid
Percent Solids: 58.9

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	ND		4.2	0.25	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Manganese	**22**		1.3	0.22	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Molybdenum	**0.22**	**J**	3.4	0.14	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Potassium	ND		420	44	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Sodium	**1300**		420	220	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1
Selenium	ND		0.85	0.80	mg/Kg	☼	07/08/21 08:00	07/14/21 13:59	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**64**	**J**	250	40	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Arsenic	ND		13	3.2	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Calcium	**58000**	**B**	6400	19	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Cobalt	ND		64	1.0	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Iron	ND		130	75	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Lead	ND		13	2.8	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Lithium	**5.3**	**J**	64	3.7	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Manganese	**10**	**J**	19	3.1	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Molybdenum	ND		51	2.1	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Potassium	**4300**	**J B**	6400	720	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5
Selenium	ND		13	4.4	mg/Kg	☼	07/08/21 15:21	07/15/21 13:50	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**61**		17	2.7	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Arsenic	**0.28**	**J**	0.85	0.25	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Calcium	**89000**		2100	18	mg/Kg	☼	07/09/21 08:00	07/15/21 18:07	5
Cobalt	ND		4.2	0.078	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Iron	**280**		8.5	4.9	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Lead	**0.72**	**J**	0.85	0.19	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Lithium	**0.99**	**J**	4.2	0.25	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Manganese	**21**		1.3	0.42	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Molybdenum	**0.24**	**J**	3.4	0.17	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Potassium	**140**	**J**	420	44	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1
Sodium	**39000**		2100	1100	mg/Kg	☼	07/09/21 08:00	07/15/21 18:07	5
Selenium	**3.0**		0.85	0.29	mg/Kg	☼	07/09/21 08:00	07/15/21 15:49	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**37**		17	2.7	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Arsenic	**0.34**	**J B**	0.85	0.22	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Calcium	**26000**		4200	44	mg/Kg	☼	07/12/21 08:00	07/17/21 13:02	10
Cobalt	ND		4.2	0.044	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Iron	**43**		8.5	7.0	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Lead	ND		0.85	0.19	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Lithium	ND		4.2	0.25	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Manganese	**3.0**		1.3	0.19	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Molybdenum	ND		3.4	0.14	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Potassium	**150**	**J**	420	17	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Sodium	**5700**		420	73	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1
Selenium	ND		0.85	0.29	mg/Kg	☼	07/12/21 08:00	07/17/21 14:56	1

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-AP-1
Date Collected: 05/17/21 11:45
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-1
Matrix: Solid
Percent Solids: 58.9

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	230		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	0.61		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	200000		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	ND		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	680		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	0.72		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	6.3		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	93		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	1.4	J	2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	4500		250	26	mg/Kg			07/19/21 15:03	1
Sodium	56000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	4.6		0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	300		66	8.3	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Arsenic	ND		3.3	0.48	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Calcium	290000		1700	290	mg/Kg	☼	06/28/21 08:00	07/07/21 16:53	2
Cobalt	0.17	J	8.3	0.079	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Iron	710		33	13	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Lead	1.7	J	2.5	0.36	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Lithium	2.9	J	8.3	0.50	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Manganese	90		2.5	1.0	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Molybdenum	1.4	J	6.6	0.18	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Potassium	160	J	830	40	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Sodium	280	J	830	59	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1
Selenium	8.0		2.5	0.73	mg/Kg	☼	06/28/21 08:00	07/07/21 14:44	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	9.0	J	17	2.7	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Arsenic	0.66	J B	0.85	0.22	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Calcium	37000		4200	44	mg/Kg	☼	07/02/21 08:00	07/18/21 11:05	10
Cobalt	0.11	J	4.2	0.044	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Iron	590		8.5	7.0	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Lead	0.81	J	0.85	0.19	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Lithium	0.46	J	4.2	0.25	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Manganese	82		1.3	0.19	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Molybdenum	1.5	J	3.4	0.14	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Potassium	190	J	420	17	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Sodium	140	J	420	73	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1
Selenium	8.6		0.85	0.29	mg/Kg	☼	07/02/21 08:00	07/18/21 12:53	1

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G52S
Date Collected: 05/18/21 11:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-2
Matrix: Solid
Percent Solids: 85.9

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**28**	**J**	47	7.5	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Arsenic	ND		2.3	0.61	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Calcium	**780**	**J B**	1200	8.9	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Cobalt	ND		12	0.21	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Iron	ND		23	14	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Lead	ND		2.3	0.51	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Lithium	ND		12	0.70	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Manganese	**7.3**		3.5	0.14	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Molybdenum	ND		9.3	0.38	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Potassium	ND		1200	120	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Sodium	ND		1200	610	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4
Selenium	ND		2.3	0.79	mg/Kg	☼	07/02/21 08:00	07/13/21 11:31	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**6.3**	**J**	35	5.6	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Arsenic	ND		1.7	0.45	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Calcium	**18000**		870	7.7	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Cobalt	**0.55**	**J**	8.7	0.22	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Iron	**500**	**B**	17	10	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Lead	**11**		1.7	0.38	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Lithium	ND		8.7	0.52	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Manganese	**100**		2.6	0.98	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Molybdenum	ND		7.0	0.29	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Potassium	ND		870	91	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3
Selenium	ND		1.7	0.59	mg/Kg	☼	07/02/21 14:02	07/13/21 13:28	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**55**		12	2.4	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Arsenic	**2.1**		0.58	0.15	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Calcium	**6.7**	**J**	290	1.7	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Cobalt	**1.1**	**J**	2.9	0.052	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Iron	**11000**		5.8	3.4	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Lead	ND		0.58	0.13	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Lithium	**0.20**	**J**	2.9	0.17	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Manganese	**98**	**B**	0.87	0.031	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Molybdenum	ND		2.3	0.096	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Potassium	ND		290	30	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Sodium	**6500**		290	150	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1
Selenium	**0.41**	**J**	0.58	0.20	mg/Kg	☼	07/07/21 08:00	07/14/21 12:06	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**120**		12	1.9	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Arsenic	**0.56**	**J**	0.58	0.26	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Calcium	**37000**		290	2.6	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Cobalt	**1.4**	**J**	2.9	0.062	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Iron	**7400**		5.8	3.4	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Lead	**14**		0.58	0.13	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G52S
Date Collected: 05/18/21 11:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-2
Matrix: Solid
Percent Solids: 85.9

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.92**	**J**	2.9	0.17	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Manganese	**340**		0.87	0.15	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Molybdenum	ND		2.3	0.096	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Potassium	ND		290	30	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Sodium	**580**		290	150	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1
Selenium	ND		0.58	0.55	mg/Kg	☼	07/08/21 08:00	07/14/21 14:04	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**140**	**J**	170	27	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Arsenic	**7.5**	**J**	8.7	2.2	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Calcium	**11000**	**B**	4400	13	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Cobalt	ND		44	0.70	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Iron	**270**		87	51	mg/Kg	☼	07/08/21 15:21	07/17/21 12:08	5
Lead	ND		8.7	1.9	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Lithium	**2.7**	**J**	44	2.6	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Manganese	**40**		13	2.2	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Molybdenum	ND		35	1.5	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Potassium	**3000**	**J B**	4400	500	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5
Selenium	ND		8.7	3.0	mg/Kg	☼	07/08/21 15:21	07/15/21 13:55	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1300**		12	1.9	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Arsenic	**4.4**		0.58	0.17	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Calcium	**18000**		290	2.4	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Cobalt	**2.0**	**J**	2.9	0.054	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Iron	**4900**		5.8	3.4	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Lead	**3.9**		0.58	0.13	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Lithium	**3.0**		2.9	0.17	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Manganese	**58**		0.87	0.29	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Molybdenum	ND		2.3	0.12	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Potassium	**250**	**J**	290	30	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1
Sodium	**21000**		1500	760	mg/Kg	☼	07/09/21 08:00	07/15/21 18:12	5
Selenium	ND		0.58	0.20	mg/Kg	☼	07/09/21 08:00	07/15/21 15:55	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**23000**		120	19	mg/Kg	☼	07/12/21 08:00	07/17/21 13:07	10
Arsenic	**1.7**	**B**	0.58	0.15	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Calcium	**5800**		2900	30	mg/Kg	☼	07/12/21 08:00	07/17/21 13:07	10
Cobalt	**2.2**	**J**	2.9	0.030	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Iron	**5500**		5.8	4.8	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Lead	**2.6**		0.58	0.13	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Lithium	**8.0**		2.9	0.17	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Manganese	**100**		0.87	0.13	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Molybdenum	ND		2.3	0.096	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Potassium	**8900**		580	23	mg/Kg	☼	07/12/21 08:00	07/17/21 16:45	2
Sodium	**7900**		290	50	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1
Selenium	ND		0.58	0.20	mg/Kg	☼	07/12/21 08:00	07/17/21 15:01	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G52S
Date Collected: 05/18/21 11:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-2
Matrix: Solid
Percent Solids: 85.9

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	25000		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	16		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	90000		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	7.3		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	29000		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	31		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	15		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	750		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	ND		2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	12000		250	26	mg/Kg			07/19/21 15:03	1
Sodium	36000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	0.41	J	0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	2500		43	5.4	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Arsenic	14		2.2	0.31	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Calcium	40000		540	95	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Cobalt	5.0	J	5.4	0.052	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Iron	20000		22	8.5	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Lead	28		1.6	0.24	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Lithium	4.7	J	5.4	0.32	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Manganese	460		1.6	0.67	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Molybdenum	0.45	J	4.3	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Potassium	620		540	26	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Sodium	72	J	540	39	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1
Selenium	ND		1.6	0.47	mg/Kg	☼	06/28/21 08:00	07/07/21 14:49	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	11000		120	19	mg/Kg	☼	07/02/21 08:00	07/18/21 11:10	10
Arsenic	20	B	1.2	0.30	mg/Kg	☼	07/02/21 08:00	07/18/21 15:06	2
Calcium	83000		2900	30	mg/Kg	☼	07/02/21 08:00	07/18/21 11:10	10
Cobalt	5.3		2.9	0.030	mg/Kg	☼	07/02/21 08:00	07/18/21 12:58	1
Iron	24000		5.8	4.8	mg/Kg	☼	07/02/21 08:00	07/18/21 12:58	1
Lead	27		1.2	0.26	mg/Kg	☼	07/02/21 08:00	07/18/21 15:06	2
Lithium	11		2.9	0.17	mg/Kg	☼	07/02/21 08:00	07/18/21 12:58	1
Manganese	530		0.87	0.13	mg/Kg	☼	07/02/21 08:00	07/18/21 12:58	1
Molybdenum	0.54	J	2.3	0.096	mg/Kg	☼	07/02/21 08:00	07/18/21 12:58	1
Potassium	7600		580	23	mg/Kg	☼	07/02/21 08:00	07/18/21 15:06	2
Sodium	4000		290	50	mg/Kg	☼	07/02/21 08:00	07/18/21 12:58	1
Selenium	ND		1.2	0.40	mg/Kg	☼	07/02/21 08:00	07/18/21 15:06	2

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G54L
Date Collected: 05/18/21 15:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-3
Matrix: Solid
Percent Solids: 83.3

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		48	7.7	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Arsenic	ND		2.4	0.62	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Calcium	**1400**	**B**	1200	9.1	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Cobalt	ND		12	0.22	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Iron	ND		24	14	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Lead	ND		2.4	0.53	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Lithium	ND		12	0.72	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Manganese	**16**		3.6	0.15	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Molybdenum	ND		9.6	0.39	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Potassium	ND		1200	120	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Sodium	ND		1200	620	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4
Selenium	ND		2.4	0.82	mg/Kg	☼	07/02/21 08:00	07/13/21 11:36	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**10**	**J**	36	5.8	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Arsenic	ND		1.8	0.47	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Calcium	**2300**		900	7.9	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Cobalt	**0.72**	**J**	9.0	0.23	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Iron	**170**		18	10	mg/Kg	☼	07/02/21 14:02	07/17/21 11:04	3
Lead	**2.6**		1.8	0.40	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Lithium	ND		9.0	0.54	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Manganese	**63**		2.7	1.0	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Molybdenum	ND		7.2	0.30	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Potassium	ND		900	94	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3
Selenium	ND		1.8	0.61	mg/Kg	☼	07/02/21 14:02	07/13/21 13:33	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**190**		12	2.5	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Arsenic	**0.85**		0.60	0.16	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Calcium	**9.1**	**J**	300	1.8	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Cobalt	**0.51**	**J**	3.0	0.054	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Iron	**4000**		6.0	3.5	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Lead	ND		0.60	0.13	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Lithium	**0.25**	**J**	3.0	0.18	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Manganese	**68**	**B**	0.90	0.032	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Molybdenum	**0.13**	**J**	2.4	0.098	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Potassium	ND		300	31	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Sodium	**10000**		300	160	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1
Selenium	**0.22**	**J**	0.60	0.20	mg/Kg	☼	07/07/21 08:00	07/14/21 12:10	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1700**		12	1.9	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Arsenic	**0.85**		0.60	0.26	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Calcium	**5700**		300	2.6	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Cobalt	**2.4**	**J**	3.0	0.064	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Iron	**5500**		6.0	3.5	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Lead	**7.8**		0.60	0.13	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G54L **Lab Sample ID: 140-23190-3**
Date Collected: 05/18/21 15:30 **Matrix: Solid**
Date Received: 05/21/21 09:20 **Percent Solids: 83.3**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**2.9**	**J**	3.0	0.18	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Manganese	**140**		0.90	0.16	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Molybdenum	**0.19**	**J**	2.4	0.098	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Potassium	ND		300	31	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Sodium	**1600**		300	160	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1
Selenium	ND		0.60	0.56	mg/Kg	☼	07/08/21 08:00	07/14/21 14:09	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**160**	**J**	180	28	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Arsenic	ND		9.0	2.3	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Calcium	**8000**	**B**	4500	13	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Cobalt	ND		45	0.72	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Iron	ND		90	53	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Lead	ND		9.0	2.0	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Lithium	**3.1**	**J**	45	2.6	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Manganese	**12**	**J**	13	2.2	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Molybdenum	ND		36	1.5	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Potassium	**2800**	**J B**	4500	510	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5
Selenium	ND		9.0	3.1	mg/Kg	☼	07/08/21 15:21	07/15/21 14:01	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**5300**		12	1.9	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Arsenic	**1.4**		0.60	0.18	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Calcium	**3900**		300	2.5	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Cobalt	**2.2**	**J**	3.0	0.055	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Iron	**6700**		6.0	3.5	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Lead	**3.8**		0.60	0.13	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Lithium	**5.0**		3.0	0.18	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Manganese	**66**		0.90	0.30	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Molybdenum	ND		2.4	0.12	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Potassium	**750**		300	31	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1
Sodium	**38000**		1500	780	mg/Kg	☼	07/09/21 08:00	07/15/21 18:17	5
Selenium	ND		0.60	0.20	mg/Kg	☼	07/09/21 08:00	07/15/21 16:00	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**30000**		120	19	mg/Kg	☼	07/12/21 08:00	07/17/21 13:12	10
Arsenic	**2.2**	**B**	1.2	0.31	mg/Kg	☼	07/12/21 08:00	07/17/21 16:50	2
Calcium	**1500**		300	3.1	mg/Kg	☼	07/12/21 08:00	07/17/21 15:06	1
Cobalt	**1.2**	**J**	6.0	0.062	mg/Kg	☼	07/12/21 08:00	07/17/21 16:50	2
Iron	**4900**		6.0	4.9	mg/Kg	☼	07/12/21 08:00	07/17/21 15:06	1
Lead	**3.0**		1.2	0.26	mg/Kg	☼	07/12/21 08:00	07/17/21 16:50	2
Lithium	**15**		3.0	0.18	mg/Kg	☼	07/12/21 08:00	07/17/21 15:06	1
Manganese	**41**		0.90	0.13	mg/Kg	☼	07/12/21 08:00	07/17/21 15:06	1
Molybdenum	ND		2.4	0.098	mg/Kg	☼	07/12/21 08:00	07/17/21 15:06	1
Potassium	**15000**		1500	60	mg/Kg	☼	07/12/21 08:00	07/17/21 16:55	5
Sodium	**7600**		300	52	mg/Kg	☼	07/12/21 08:00	07/17/21 15:06	1
Selenium	ND		1.2	0.41	mg/Kg	☼	07/12/21 08:00	07/17/21 16:50	2

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G54L
Date Collected: 05/18/21 15:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-3
Matrix: Solid
Percent Solids: 83.3

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	38000		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	5.4		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	23000		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	7.0		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	21000		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	17		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	26		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	400		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	0.31	J	2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	19000		250	26	mg/Kg			07/19/21 15:03	1
Sodium	57000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	0.22	J	0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	8500		44	5.5	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Arsenic	3.4		2.2	0.32	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Calcium	45000		550	96	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Cobalt	5.9		5.5	0.052	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Iron	16000		22	8.6	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Lead	13		1.6	0.24	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Lithium	11		5.5	0.33	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Manganese	550		1.6	0.68	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Molybdenum	0.23	J	4.4	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Potassium	1500		550	26	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Sodium	77	J	550	39	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1
Selenium	ND		1.6	0.48	mg/Kg	☼	06/28/21 08:00	07/07/21 14:54	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	35000		120	19	mg/Kg	☼	07/02/21 08:00	07/18/21 11:15	10
Arsenic	5.3	B	0.60	0.16	mg/Kg	☼	07/02/21 08:00	07/18/21 13:03	1
Calcium	21000		3000	31	mg/Kg	☼	07/02/21 08:00	07/18/21 11:15	10
Cobalt	8.0		6.0	0.062	mg/Kg	☼	07/02/21 08:00	07/18/21 15:12	2
Iron	20000		6.0	4.9	mg/Kg	☼	07/02/21 08:00	07/18/21 13:03	1
Lead	23		1.2	0.26	mg/Kg	☼	07/02/21 08:00	07/18/21 15:12	2
Lithium	25		3.0	0.18	mg/Kg	☼	07/02/21 08:00	07/18/21 13:03	1
Manganese	320		0.90	0.13	mg/Kg	☼	07/02/21 08:00	07/18/21 13:03	1
Molybdenum	0.46	J	2.4	0.098	mg/Kg	☼	07/02/21 08:00	07/18/21 13:03	1
Potassium	20000		1500	60	mg/Kg	☼	07/02/21 08:00	07/18/21 15:17	5
Sodium	4900		300	52	mg/Kg	☼	07/02/21 08:00	07/18/21 13:03	1
Selenium	ND		0.60	0.20	mg/Kg	☼	07/02/21 08:00	07/18/21 13:03	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G57L

Date Collected: 05/19/21 10:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-4

Matrix: Solid
Percent Solids: 79.9

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		50	8.0	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Arsenic	ND		2.5	0.65	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Calcium	**1600**	**B**	1300	9.5	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Cobalt	ND		13	0.23	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Iron	ND		25	15	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Lead	ND		2.5	0.55	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Lithium	ND		13	0.75	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Manganese	**0.25**	**J**	3.8	0.16	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Molybdenum	ND		10	0.41	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Potassium	ND		1300	130	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Sodium	ND		1300	650	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4
Selenium	ND		2.5	0.85	mg/Kg	☼	07/02/21 08:00	07/13/21 11:41	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**12**	**J**	38	6.0	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Arsenic	ND		1.9	0.49	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Calcium	**730**	**J**	940	8.3	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Cobalt	ND		9.4	0.24	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Iron	ND		19	11	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Lead	ND		1.9	0.41	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Lithium	ND		9.4	0.56	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Manganese	**3.8**		2.8	1.1	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Molybdenum	ND		7.5	0.31	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Potassium	ND		940	98	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3
Selenium	ND		1.9	0.64	mg/Kg	☼	07/02/21 14:02	07/13/21 13:38	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**340**		13	2.6	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Arsenic	**1.0**		0.63	0.16	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Calcium	**8.8**	**J**	310	1.9	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Cobalt	**2.3**	**J**	3.1	0.056	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Iron	**750**		6.3	3.6	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Lead	**0.15**	**J**	0.63	0.14	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Lithium	**0.23**	**J**	3.1	0.19	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Manganese	**67**	**B**	0.94	0.034	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Molybdenum	ND		2.5	0.10	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Potassium	ND		310	33	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1
Sodium	**13000**		630	330	mg/Kg	☼	07/07/21 08:00	07/14/21 15:47	2
Selenium	ND		0.63	0.21	mg/Kg	☼	07/07/21 08:00	07/14/21 12:15	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**2600**		13	2.0	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Arsenic	**2.2**		0.63	0.28	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Calcium	**2900**		310	2.8	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Cobalt	**1.5**	**J**	3.1	0.066	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Iron	**4600**		6.3	3.6	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Lead	**4.5**		0.63	0.14	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G57L
Date Collected: 05/19/21 10:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-4
Matrix: Solid
Percent Solids: 79.9

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	2.4	J	3.1	0.19	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Manganese	50		0.94	0.16	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Molybdenum	0.16	J	2.5	0.10	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Potassium	ND		310	33	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Sodium	1800		310	160	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1
Selenium	ND		0.63	0.59	mg/Kg	☼	07/08/21 08:00	07/14/21 14:14	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	120	J	190	29	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Arsenic	ND		9.4	2.4	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Calcium	1900	J B	4700	14	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Cobalt	ND		47	0.75	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Iron	ND		94	55	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Lead	ND		9.4	2.1	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Lithium	3.7	J	47	2.8	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Manganese	4.6	J	14	2.3	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Molybdenum	ND		38	1.6	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Potassium	2900	J B	4700	530	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5
Selenium	ND		9.4	3.3	mg/Kg	☼	07/08/21 15:21	07/15/21 14:06	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	7400		13	2.0	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Arsenic	2.1		0.63	0.19	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Calcium	580		310	2.6	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Cobalt	1.9	J	3.1	0.058	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Iron	6900		6.3	3.6	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Lead	2.7		0.63	0.14	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Lithium	6.4		3.1	0.19	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Manganese	46		0.94	0.31	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Molybdenum	ND		2.5	0.12	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Potassium	630		310	33	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1
Sodium	44000		1600	810	mg/Kg	☼	07/09/21 08:00	07/15/21 18:22	5
Selenium	ND		0.63	0.21	mg/Kg	☼	07/09/21 08:00	07/15/21 16:04	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	33000		130	20	mg/Kg	☼	07/12/21 08:00	07/17/21 13:17	10
Arsenic	2.1	B	0.63	0.16	mg/Kg	☼	07/12/21 08:00	07/17/21 15:11	1
Calcium	3800		3100	33	mg/Kg	☼	07/12/21 08:00	07/17/21 13:17	10
Cobalt	1.3	J	6.3	0.065	mg/Kg	☼	07/12/21 08:00	07/17/21 17:00	2
Iron	4800		6.3	5.1	mg/Kg	☼	07/12/21 08:00	07/17/21 15:11	1
Lead	3.7		1.3	0.28	mg/Kg	☼	07/12/21 08:00	07/17/21 17:00	2
Lithium	10		3.1	0.19	mg/Kg	☼	07/12/21 08:00	07/17/21 15:11	1
Manganese	76		0.94	0.14	mg/Kg	☼	07/12/21 08:00	07/17/21 15:11	1
Molybdenum	ND		2.5	0.10	mg/Kg	☼	07/12/21 08:00	07/17/21 15:11	1
Potassium	14000		1600	63	mg/Kg	☼	07/12/21 08:00	07/17/21 17:05	5
Sodium	12000		310	54	mg/Kg	☼	07/12/21 08:00	07/17/21 15:11	1
Selenium	ND		0.63	0.21	mg/Kg	☼	07/12/21 08:00	07/17/21 15:11	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G57L
Date Collected: 05/19/21 10:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-4
Matrix: Solid
Percent Solids: 79.9

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	43000		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	7.4		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	11000		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	6.9		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	17000		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	11		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	23		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	250		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	0.16	J	2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	17000		250	26	mg/Kg			07/19/21 15:03	1
Sodium	70000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	ND		0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	18000		49	6.1	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Arsenic	5.7		2.4	0.35	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Calcium	4700		610	110	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Cobalt	5.6	J	6.1	0.058	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Iron	14000		24	9.6	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Lead	8.9		1.8	0.27	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Lithium	13		6.1	0.36	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Manganese	140		1.8	0.75	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Molybdenum	0.20	J	4.9	0.13	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Potassium	910		610	29	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Sodium	80	J	610	44	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1
Selenium	ND		1.8	0.53	mg/Kg	☼	06/28/21 08:00	07/07/21 14:59	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	71000		130	20	mg/Kg	☼	07/02/21 08:00	07/18/21 11:20	10
Arsenic	9.5	B	1.3	0.33	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Calcium	18000		3100	33	mg/Kg	☼	07/02/21 08:00	07/18/21 11:20	10
Cobalt	8.5		6.3	0.065	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Iron	22000		13	10	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Lead	17		1.3	0.28	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Lithium	26		6.3	0.38	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Manganese	290		1.9	0.28	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Molybdenum	0.41	J	5.0	0.21	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Potassium	24000		1600	63	mg/Kg	☼	07/02/21 08:00	07/18/21 15:22	5
Sodium	12000		630	110	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2
Selenium	ND		1.3	0.43	mg/Kg	☼	07/02/21 08:00	07/18/21 16:22	2

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G57S
Date Collected: 05/19/21 10:48
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-5
Matrix: Solid
Percent Solids: 84.2

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		48	7.6	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Arsenic	ND		2.4	0.62	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Calcium	**800**	**J B**	1200	9.0	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Cobalt	ND		12	0.21	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Iron	ND		24	14	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Lead	ND		2.4	0.52	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Lithium	ND		12	0.71	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Manganese	**16**		3.6	0.15	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Molybdenum	ND		9.5	0.39	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Potassium	ND		1200	120	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Sodium	ND		1200	620	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4
Selenium	ND		2.4	0.81	mg/Kg	☼	07/02/21 08:00	07/13/21 11:45	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**7.4**	**J**	36	5.7	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Arsenic	ND		1.8	0.46	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Calcium	**3600**		890	7.8	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Cobalt	ND		8.9	0.22	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Iron	**26**		18	10	mg/Kg	☼	07/02/21 14:02	07/17/21 11:09	3
Lead	**0.95**	**J**	1.8	0.39	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Lithium	**0.57**	**J**	8.9	0.53	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Manganese	**88**		2.7	1.0	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Molybdenum	ND		7.1	0.29	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Potassium	ND		890	93	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3
Selenium	ND		1.8	0.61	mg/Kg	☼	07/02/21 14:02	07/13/21 14:21	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**76**		12	2.5	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Arsenic	ND		0.59	0.15	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Calcium	**10**	**J**	300	1.8	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Cobalt	**1.7**	**J**	3.0	0.053	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Iron	**1000**		5.9	3.4	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Lead	ND		0.59	0.13	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Lithium	**0.18**	**J**	3.0	0.18	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Manganese	**200**	**B**	0.89	0.032	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Molybdenum	ND		2.4	0.097	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Potassium	ND		300	31	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Sodium	**9400**		300	150	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1
Selenium	**0.21**	**J**	0.59	0.20	mg/Kg	☼	07/07/21 08:00	07/14/21 12:20	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**440**		12	1.9	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Arsenic	**0.63**		0.59	0.26	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Calcium	**14000**		300	2.6	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Cobalt	**1.2**	**J**	3.0	0.063	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Iron	**6300**		5.9	3.4	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Lead	**6.0**		0.59	0.13	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G57S
Date Collected: 05/19/21 10:48
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-5
Matrix: Solid
Percent Solids: 84.2

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.89**	**J**	3.0	0.18	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Manganese	**240**		0.89	0.15	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Molybdenum	ND		2.4	0.097	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Potassium	ND		300	31	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Sodium	**1200**		300	150	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1
Selenium	ND		0.59	0.56	mg/Kg	☼	07/08/21 08:00	07/14/21 14:18	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**330**		180	28	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Arsenic	ND		8.9	2.3	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Calcium	**13000**	**B**	4500	13	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Cobalt	ND		45	0.71	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Iron	ND		89	52	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Lead	ND		8.9	2.0	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Lithium	ND		45	2.6	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Manganese	**17**		13	2.2	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Molybdenum	ND		36	1.5	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Potassium	**3000**	**J B**	4500	500	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5
Selenium	ND		8.9	3.1	mg/Kg	☼	07/08/21 15:21	07/15/21 14:11	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**3500**		12	1.9	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Arsenic	**2.4**		0.59	0.18	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Calcium	**5500**		300	2.5	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Cobalt	**2.2**	**J**	3.0	0.055	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Iron	**8000**		5.9	3.4	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Lead	**3.5**		0.59	0.13	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Lithium	**5.3**		3.0	0.18	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Manganese	**100**		0.89	0.30	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Molybdenum	ND		2.4	0.12	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Potassium	**540**		300	31	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1
Sodium	**28000**		1500	770	mg/Kg	☼	07/09/21 08:00	07/15/21 18:27	5
Selenium	ND		0.59	0.20	mg/Kg	☼	07/09/21 08:00	07/15/21 16:09	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**33000**		120	19	mg/Kg	☼	07/12/21 08:00	07/17/21 13:22	10
Arsenic	**2.2**	**B**	0.59	0.15	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1
Calcium	**2100**		300	3.1	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1
Cobalt	**0.93**	**J**	5.9	0.062	mg/Kg	☼	07/12/21 08:00	07/17/21 17:09	2
Iron	**4500**		5.9	4.9	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1
Lead	**3.2**		1.2	0.26	mg/Kg	☼	07/12/21 08:00	07/17/21 17:09	2
Lithium	**13**		3.0	0.18	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1
Manganese	**46**		0.89	0.13	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1
Molybdenum	ND		2.4	0.097	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1
Potassium	**18000**		1500	59	mg/Kg	☼	07/12/21 08:00	07/17/21 17:14	5
Sodium	**7400**		300	51	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1
Selenium	ND		0.59	0.20	mg/Kg	☼	07/12/21 08:00	07/17/21 15:16	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G57S
Date Collected: 05/19/21 10:48
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-5
Matrix: Solid
Percent Solids: 84.2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	37000		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	5.2		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	39000		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	6.0		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	20000		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	14		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	20		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	700		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	ND		2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	21000		250	26	mg/Kg			07/19/21 15:03	1
Sodium	46000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	0.21	J	0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	7700		45	5.6	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Arsenic	3.2		2.2	0.33	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Calcium	28000		560	99	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Cobalt	5.8		5.6	0.054	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Iron	25000		22	8.9	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Lead	12		1.7	0.25	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Lithium	11		5.6	0.34	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Manganese	570		1.7	0.70	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Molybdenum	ND		4.5	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Potassium	1800		560	27	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Sodium	77	J	560	40	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1
Selenium	ND		1.7	0.49	mg/Kg	☼	06/28/21 08:00	07/07/21 15:04	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	25000		120	19	mg/Kg	☼	07/02/21 08:00	07/18/21 11:24	10
Arsenic	5.7	B	0.59	0.15	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Calcium	41000		3000	31	mg/Kg	☼	07/02/21 08:00	07/18/21 11:24	10
Cobalt	5.8		3.0	0.031	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Iron	17000		5.9	4.9	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Lead	14		0.59	0.13	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Lithium	17		3.0	0.18	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Manganese	520		0.89	0.13	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Molybdenum	0.29	J	2.4	0.097	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Potassium	20000		1500	59	mg/Kg	☼	07/02/21 08:00	07/18/21 15:26	5
Sodium	5700		300	51	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1
Selenium	ND		0.59	0.20	mg/Kg	☼	07/02/21 08:00	07/18/21 13:14	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G62L
Date Collected: 05/19/21 14:00
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-6
Matrix: Solid
Percent Solids: 76.4

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		52	8.4	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Arsenic	ND		2.6	0.68	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Calcium	**1800**	**B**	1300	10	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Cobalt	ND		13	0.24	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Iron	ND		26	15	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Lead	ND		2.6	0.58	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Lithium	ND		13	0.79	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Manganese	ND		3.9	0.16	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Molybdenum	ND		10	0.43	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Potassium	ND		1300	140	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Sodium	ND		1300	680	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4
Selenium	ND		2.6	0.89	mg/Kg	☼	07/02/21 08:00	07/13/21 11:50	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**14**	**J**	39	6.3	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Arsenic	ND		2.0	0.51	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Calcium	**600**	**J**	980	8.6	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Cobalt	ND		9.8	0.25	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Iron	ND		20	11	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Lead	**1.6**	**J**	2.0	0.43	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Lithium	ND		9.8	0.59	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Manganese	ND		2.9	1.1	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Molybdenum	ND		7.9	0.32	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Potassium	ND		980	100	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3
Selenium	ND		2.0	0.67	mg/Kg	☼	07/02/21 14:02	07/13/21 14:26	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**400**		13	2.8	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Arsenic	**0.79**		0.65	0.17	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Calcium	**8.8**	**J**	330	2.0	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Cobalt	**1.4**	**J**	3.3	0.059	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Iron	**1000**		6.5	3.8	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Lead	**5.0**		0.65	0.14	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Lithium	**0.20**	**J**	3.3	0.20	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Manganese	**4.7**	**B**	0.98	0.035	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Molybdenum	ND		2.6	0.11	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Potassium	**34**	**J**	330	34	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1
Sodium	**14000**		650	340	mg/Kg	☼	07/07/21 08:00	07/14/21 15:52	2
Selenium	ND		0.65	0.22	mg/Kg	☼	07/07/21 08:00	07/14/21 12:25	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**3100**		13	2.1	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Arsenic	**1.0**		0.65	0.29	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Calcium	**140**	**J**	330	2.9	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Cobalt	**3.9**		3.3	0.069	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Iron	**4900**		6.5	3.8	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Lead	**8.5**		0.65	0.14	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G62L
Date Collected: 05/19/21 14:00
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-6
Matrix: Solid
Percent Solids: 76.4

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**3.4**		3.3	0.20	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Manganese	**21**		0.98	0.17	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Molybdenum	**0.20**	**J**	2.6	0.11	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Potassium	**68**	**J**	330	34	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Sodium	**2300**		330	170	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1
Selenium	ND		0.65	0.62	mg/Kg	☼	07/08/21 08:00	07/14/21 14:23	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**84**	**J**	200	31	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Arsenic	ND		9.8	2.5	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Calcium	**55**	**J B**	4900	14	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Cobalt	ND		49	0.79	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Iron	**67**	**J B**	98	58	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Lead	ND		9.8	2.2	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Lithium	**3.5**	**J**	49	2.9	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Manganese	**3.5**	**J**	15	2.4	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Molybdenum	ND		39	1.6	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Potassium	**2800**	**J B**	4900	560	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5
Selenium	ND		9.8	3.4	mg/Kg	☼	07/08/21 15:21	07/15/21 14:16	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**10000**		13	2.1	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Arsenic	**1.2**		0.65	0.20	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Calcium	**73**	**J**	330	2.8	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Cobalt	**2.3**	**J**	3.3	0.060	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Iron	**7300**		6.5	3.8	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Lead	**2.6**		0.65	0.14	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Lithium	**6.7**		3.3	0.20	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Manganese	**26**		0.98	0.33	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Molybdenum	ND		2.6	0.13	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Potassium	**1300**		330	34	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1
Sodium	**49000**		1600	850	mg/Kg	☼	07/09/21 08:00	07/15/21 18:31	5
Selenium	ND		0.65	0.22	mg/Kg	☼	07/09/21 08:00	07/15/21 16:14	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**30000**		130	21	mg/Kg	☼	07/12/21 08:00	07/17/21 13:26	10
Arsenic	**2.0**	**B**	1.3	0.34	mg/Kg	☼	07/12/21 08:00	07/17/21 17:19	2
Calcium	**580**		330	3.4	mg/Kg	☼	07/12/21 08:00	07/17/21 15:21	1
Cobalt	**0.95**	**J**	6.5	0.068	mg/Kg	☼	07/12/21 08:00	07/17/21 17:19	2
Iron	**5200**		6.5	5.4	mg/Kg	☼	07/12/21 08:00	07/17/21 15:21	1
Lead	**2.1**		1.3	0.29	mg/Kg	☼	07/12/21 08:00	07/17/21 17:19	2
Lithium	**20**		3.3	0.20	mg/Kg	☼	07/12/21 08:00	07/17/21 15:21	1
Manganese	**35**		0.98	0.14	mg/Kg	☼	07/12/21 08:00	07/17/21 15:21	1
Molybdenum	ND		2.6	0.11	mg/Kg	☼	07/12/21 08:00	07/17/21 15:21	1
Potassium	**12000**		650	26	mg/Kg	☼	07/12/21 08:00	07/17/21 17:19	2
Sodium	**8200**		330	56	mg/Kg	☼	07/12/21 08:00	07/17/21 15:21	1
Selenium	ND		1.3	0.45	mg/Kg	☼	07/12/21 08:00	07/17/21 17:19	2

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G62L

Date Collected: 05/19/21 14:00
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-6

Matrix: Solid
Percent Solids: 76.4

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**44000**		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	**5.0**		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	**3200**		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	**8.5**		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	**19000**		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	**20**		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	**34**		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	**91**		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	**0.20**	**J**	2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	**16000**		250	26	mg/Kg			07/19/21 15:03	1
Sodium	**74000**		250	130	mg/Kg			07/19/21 15:03	1
Selenium	ND		0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**16000**		51	6.4	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Arsenic	**3.3**		2.6	0.37	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Calcium	**1800**		640	110	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Cobalt	**7.9**		6.4	0.062	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Iron	**14000**		26	10	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Lead	**14**		1.9	0.28	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Lithium	**14**		6.4	0.39	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Manganese	**59**		1.9	0.80	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Molybdenum	**0.32**	**J**	5.1	0.14	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Potassium	**1800**		640	31	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Sodium	**56**	**J**	640	46	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1
Selenium	ND		1.9	0.56	mg/Kg	☼	06/28/21 08:00	07/07/21 15:09	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**48000**		130	21	mg/Kg	☼	07/02/21 08:00	07/18/21 11:29	10
Arsenic	**4.9**	**B**	0.65	0.17	mg/Kg	☼	07/02/21 08:00	07/18/21 13:19	1
Calcium	**3400**		3300	34	mg/Kg	☼	07/02/21 08:00	07/18/21 11:29	10
Cobalt	**9.2**		6.5	0.068	mg/Kg	☼	07/02/21 08:00	07/18/21 15:31	2
Iron	**16000**		6.5	5.4	mg/Kg	☼	07/02/21 08:00	07/18/21 13:19	1
Lead	**22**		1.3	0.29	mg/Kg	☼	07/02/21 08:00	07/18/21 15:31	2
Lithium	**34**		3.3	0.20	mg/Kg	☼	07/02/21 08:00	07/18/21 13:19	1
Manganese	**87**		0.98	0.14	mg/Kg	☼	07/02/21 08:00	07/18/21 13:19	1
Molybdenum	**0.39**	**J**	2.6	0.11	mg/Kg	☼	07/02/21 08:00	07/18/21 13:19	1
Potassium	**19000**		1600	65	mg/Kg	☼	07/02/21 08:00	07/18/21 15:36	5
Sodium	**3700**		330	56	mg/Kg	☼	07/02/21 08:00	07/18/21 13:19	1
Selenium	ND		0.65	0.22	mg/Kg	☼	07/02/21 08:00	07/18/21 13:19	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G53S
Date Collected: 05/19/21 16:15
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-7
Matrix: Solid
Percent Solids: 88.0

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		45	7.3	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Arsenic	ND		2.3	0.59	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Calcium	**620**	**J B**	1100	8.6	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Cobalt	ND		11	0.20	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Iron	ND		23	13	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Lead	ND		2.3	0.50	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Lithium	ND		11	0.68	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Manganese	**11**		3.4	0.14	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Molybdenum	ND		9.1	0.37	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Potassium	ND		1100	120	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Sodium	ND		1100	590	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4
Selenium	ND		2.3	0.77	mg/Kg	☼	07/02/21 08:00	07/13/21 11:55	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**10**	**J**	34	5.5	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Arsenic	ND		1.7	0.44	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Calcium	**13000**		850	7.5	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Cobalt	ND		8.5	0.21	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Iron	**310**		17	9.9	mg/Kg	☼	07/02/21 14:02	07/17/21 11:14	3
Lead	**1.9**		1.7	0.37	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Lithium	ND		8.5	0.51	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Manganese	**150**		2.6	0.95	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Molybdenum	ND		6.8	0.28	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Potassium	ND		850	89	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3
Selenium	ND		1.7	0.58	mg/Kg	☼	07/02/21 14:02	07/13/21 14:31	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**48**		11	2.4	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Arsenic	**0.26**	**J**	0.57	0.15	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Calcium	**7.2**	**J**	280	1.7	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Cobalt	**0.25**	**J**	2.8	0.051	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Iron	**2200**		5.7	3.3	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Lead	ND		0.57	0.12	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Lithium	ND		2.8	0.17	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Manganese	**40**	**B**	0.85	0.031	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Molybdenum	ND		2.3	0.093	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Potassium	ND		280	30	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Sodium	**6200**		280	150	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1
Selenium	ND		0.57	0.19	mg/Kg	☼	07/07/21 08:00	07/14/21 12:30	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**190**		11	1.8	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Arsenic	**0.25**	**J**	0.57	0.25	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Calcium	**44000**		280	2.5	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Cobalt	**1.2**	**J**	2.8	0.060	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Iron	**2200**		5.7	3.3	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Lead	**5.3**		0.57	0.12	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G53S
Date Collected: 05/19/21 16:15
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-7
Matrix: Solid
Percent Solids: 88.0

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**1.2**	**J**	2.8	0.17	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Manganese	**200**		0.85	0.15	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Molybdenum	**0.11**	**J**	2.3	0.093	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Potassium	ND		280	30	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Sodium	**770**		280	150	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1
Selenium	ND		0.57	0.53	mg/Kg	☼	07/08/21 08:00	07/14/21 14:28	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**92**	**J**	170	27	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Arsenic	ND		8.5	2.2	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Calcium	**12000**	**B**	4300	12	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Cobalt	ND		43	0.68	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Iron	ND		85	50	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Lead	ND		8.5	1.9	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Lithium	ND		43	2.5	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Manganese	**12**	**J**	13	2.1	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Molybdenum	ND		34	1.4	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Potassium	**2800**	**J B**	4300	480	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5
Selenium	ND		8.5	3.0	mg/Kg	☼	07/08/21 15:21	07/15/21 14:21	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1700**		11	1.8	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Arsenic	**2.6**		0.57	0.17	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Calcium	**8900**		280	2.4	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Cobalt	**1.6**	**J**	2.8	0.052	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Iron	**5700**		5.7	3.3	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Lead	**2.0**		0.57	0.12	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Lithium	**3.6**		2.8	0.17	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Manganese	**63**		0.85	0.28	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Molybdenum	**0.37**	**J**	2.3	0.11	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Potassium	**380**		280	30	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1
Sodium	**19000**		1400	740	mg/Kg	☼	07/09/21 08:00	07/15/21 18:47	5
Selenium	ND		0.57	0.19	mg/Kg	☼	07/09/21 08:00	07/15/21 16:19	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**26000**		110	18	mg/Kg	☼	07/12/21 08:00	07/17/21 13:53	10
Arsenic	**2.1**	**B**	1.1	0.30	mg/Kg	☼	07/12/21 08:00	07/17/21 17:29	2
Calcium	**2000**		280	3.0	mg/Kg	☼	07/12/21 08:00	07/17/21 15:26	1
Cobalt	**0.28**	**J**	2.8	0.030	mg/Kg	☼	07/12/21 08:00	07/17/21 15:26	1
Iron	**3200**		5.7	4.7	mg/Kg	☼	07/12/21 08:00	07/17/21 15:26	1
Lead	**2.6**		1.1	0.25	mg/Kg	☼	07/12/21 08:00	07/17/21 17:29	2
Lithium	**10**		2.8	0.17	mg/Kg	☼	07/12/21 08:00	07/17/21 15:26	1
Manganese	**27**		0.85	0.12	mg/Kg	☼	07/12/21 08:00	07/17/21 15:26	1
Molybdenum	ND		2.3	0.093	mg/Kg	☼	07/12/21 08:00	07/17/21 15:26	1
Potassium	**16000**		1400	57	mg/Kg	☼	07/12/21 08:00	07/17/21 17:43	5
Sodium	**5200**		280	49	mg/Kg	☼	07/12/21 08:00	07/17/21 15:26	1
Selenium	ND		1.1	0.39	mg/Kg	☼	07/12/21 08:00	07/17/21 17:29	2

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G53S
Date Collected: 05/19/21 16:15
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-7
Matrix: Solid
Percent Solids: 88.0

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	28000		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	5.2		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	80000		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	3.2		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	14000		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	12		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	15		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	500		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	0.48	J	2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	19000		250	26	mg/Kg			07/19/21 15:03	1
Sodium	31000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	ND		0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	3800		44	5.5	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Arsenic	3.5		2.2	0.32	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Calcium	63000		550	97	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Cobalt	3.6	J	5.5	0.053	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Iron	11000		22	8.7	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Lead	7.8		1.7	0.24	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Lithium	6.6		5.5	0.33	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Manganese	420		1.7	0.68	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Molybdenum	0.46	J	4.4	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Potassium	1100		550	26	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Sodium	79	J	550	40	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1
Selenium	ND		1.7	0.49	mg/Kg	☼	06/28/21 08:00	07/07/21 15:14	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	7500		110	18	mg/Kg	☼	07/02/21 08:00	07/18/21 11:43	10
Arsenic	4.1	B	1.1	0.30	mg/Kg	☼	07/02/21 08:00	07/18/21 15:57	2
Calcium	64000		2800	30	mg/Kg	☼	07/02/21 08:00	07/18/21 11:43	10
Cobalt	3.0		2.8	0.030	mg/Kg	☼	07/02/21 08:00	07/18/21 13:24	1
Iron	11000		5.7	4.7	mg/Kg	☼	07/02/21 08:00	07/18/21 13:24	1
Lead	11		1.1	0.25	mg/Kg	☼	07/02/21 08:00	07/18/21 15:57	2
Lithium	10		2.8	0.17	mg/Kg	☼	07/02/21 08:00	07/18/21 13:24	1
Manganese	400		0.85	0.12	mg/Kg	☼	07/02/21 08:00	07/18/21 13:24	1
Molybdenum	0.55	J	2.3	0.093	mg/Kg	☼	07/02/21 08:00	07/18/21 13:24	1
Potassium	13000		1400	57	mg/Kg	☼	07/02/21 08:00	07/18/21 16:02	5
Sodium	3400		280	49	mg/Kg	☼	07/02/21 08:00	07/18/21 13:24	1
Selenium	ND		1.1	0.39	mg/Kg	☼	07/02/21 08:00	07/18/21 15:57	2

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G02S
Date Collected: 05/20/21 09:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-8
Matrix: Solid
Percent Solids: 83.3

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		48	7.7	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Arsenic	ND		2.4	0.62	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Calcium	**960**	**J B**	1200	9.1	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Cobalt	ND		12	0.22	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Iron	ND		24	14	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Lead	ND		2.4	0.53	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Lithium	ND		12	0.72	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Manganese	**3.5**	**J**	3.6	0.15	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Molybdenum	ND		9.6	0.39	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Potassium	ND		1200	120	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Sodium	ND		1200	620	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4
Selenium	ND		2.4	0.82	mg/Kg	☼	07/02/21 08:00	07/13/21 12:10	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**23**	**J**	36	5.8	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Arsenic	ND		1.8	0.47	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Calcium	**210**	**J**	900	7.9	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Cobalt	ND		9.0	0.23	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Iron	**210**		18	10	mg/Kg	☼	07/02/21 14:02	07/17/21 11:19	3
Lead	**5.6**		1.8	0.40	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Lithium	ND		9.0	0.54	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Manganese	**3.2**		2.7	1.0	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Molybdenum	ND		7.2	0.30	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Potassium	ND		900	94	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3
Selenium	ND		1.8	0.61	mg/Kg	☼	07/02/21 14:02	07/13/21 14:46	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**300**		12	2.5	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Arsenic	**0.63**		0.60	0.16	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Calcium	**6.5**	**J**	300	1.8	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Cobalt	**0.37**	**J**	3.0	0.054	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Iron	**1700**		6.0	3.5	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Lead	**0.20**	**J**	0.60	0.13	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Lithium	**0.19**	**J**	3.0	0.18	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Manganese	**15**	**B**	0.90	0.032	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Molybdenum	ND		2.4	0.098	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Potassium	ND		300	31	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Sodium	**9600**		300	160	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1
Selenium	ND		0.60	0.20	mg/Kg	☼	07/07/21 08:00	07/14/21 12:45	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**2700**		12	1.9	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Arsenic	**0.83**		0.60	0.26	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Calcium	**2000**		300	2.6	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Cobalt	**2.9**	**J**	3.0	0.064	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Iron	**4200**		6.0	3.5	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Lead	**9.8**		0.60	0.13	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G02S
Date Collected: 05/20/21 09:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-8
Matrix: Solid
Percent Solids: 83.3

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**3.9**		3.0	0.18	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Manganese	**36**		0.90	0.16	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Molybdenum	ND		2.4	0.098	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Potassium	**63**	**J**	300	31	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Sodium	**1100**		300	160	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1
Selenium	ND		0.60	0.56	mg/Kg	☼	07/08/21 08:00	07/14/21 14:43	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**100**	**J**	180	28	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Arsenic	ND		9.0	2.3	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Calcium	**370**	**J B**	4500	13	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Cobalt	ND		45	0.72	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Iron	ND		90	53	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Lead	ND		9.0	2.0	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Lithium	**2.8**	**J**	45	2.6	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Manganese	ND		14	2.2	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Molybdenum	ND		36	1.5	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Potassium	**2600**	**J B**	4500	510	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5
Selenium	ND		9.0	3.1	mg/Kg	☼	07/08/21 15:21	07/15/21 14:35	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**4100**		12	1.9	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Arsenic	**0.94**		0.60	0.18	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Calcium	**140**	**J**	300	2.5	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Cobalt	**1.4**	**J**	3.0	0.055	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Iron	**4100**		6.0	3.5	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Lead	**1.8**		0.60	0.13	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Lithium	**3.4**		3.0	0.18	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Manganese	**20**		0.90	0.30	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Molybdenum	ND		2.4	0.12	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Potassium	**680**		300	31	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1
Sodium	**30000**		1500	780	mg/Kg	☼	07/09/21 08:00	07/15/21 18:52	5
Selenium	ND		0.60	0.20	mg/Kg	☼	07/09/21 08:00	07/15/21 16:34	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**30000**		120	19	mg/Kg	☼	07/12/21 08:00	07/17/21 13:58	10
Arsenic	**2.0**	**B**	1.2	0.31	mg/Kg	☼	07/12/21 08:00	07/17/21 17:48	2
Calcium	**1300**		300	3.1	mg/Kg	☼	07/12/21 08:00	07/17/21 15:31	1
Cobalt	**0.98**	**J**	3.0	0.031	mg/Kg	☼	07/12/21 08:00	07/17/21 15:31	1
Iron	**3800**		6.0	4.9	mg/Kg	☼	07/12/21 08:00	07/17/21 15:31	1
Lead	**3.1**		1.2	0.26	mg/Kg	☼	07/12/21 08:00	07/17/21 17:48	2
Lithium	**14**		3.0	0.18	mg/Kg	☼	07/12/21 08:00	07/17/21 15:31	1
Manganese	**30**		0.90	0.13	mg/Kg	☼	07/12/21 08:00	07/17/21 15:31	1
Molybdenum	ND		2.4	0.098	mg/Kg	☼	07/12/21 08:00	07/17/21 15:31	1
Potassium	**16000**		1500	60	mg/Kg	☼	07/12/21 08:00	07/17/21 17:53	5
Sodium	**6600**		300	52	mg/Kg	☼	07/12/21 08:00	07/17/21 15:31	1
Selenium	ND		1.2	0.41	mg/Kg	☼	07/12/21 08:00	07/17/21 17:48	2

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Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G02S
Date Collected: 05/20/21 09:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-8
Matrix: Solid
Percent Solids: 83.3

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	38000		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	4.4		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	4900		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	5.6		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	14000		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	21		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	24		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	110		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	ND		2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	20000		250	26	mg/Kg			07/19/21 15:03	1
Sodium	47000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	ND		0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	9700		45	5.6	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Arsenic	2.3		2.2	0.33	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Calcium	3200		560	99	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Cobalt	4.5	J	5.6	0.054	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Iron	10000		22	8.9	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Lead	15		1.7	0.25	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Lithium	9.9		5.6	0.34	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Manganese	67		1.7	0.70	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Molybdenum	0.18	J	4.5	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Potassium	1300		560	27	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Sodium	51	J	560	40	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1
Selenium	ND		1.7	0.49	mg/Kg	☼	06/28/21 08:00	07/07/21 15:19	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	39000		120	19	mg/Kg	☼	07/02/21 08:00	07/18/21 11:48	10
Arsenic	3.8	B	0.60	0.16	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Calcium	5500		3000	31	mg/Kg	☼	07/02/21 08:00	07/18/21 11:48	10
Cobalt	5.1		3.0	0.031	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Iron	12000		6.0	4.9	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Lead	19		0.60	0.13	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Lithium	19		3.0	0.18	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Manganese	100		0.90	0.13	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Molybdenum	0.27	J	2.4	0.098	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Potassium	17000		1500	60	mg/Kg	☼	07/02/21 08:00	07/18/21 16:07	5
Sodium	4600		300	52	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1
Selenium	ND		0.60	0.20	mg/Kg	☼	07/02/21 08:00	07/18/21 13:30	1

Client Sample Results

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G02L
Date Collected: 05/20/21 10:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-9
Matrix: Solid
Percent Solids: 78.1

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		51	8.2	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Arsenic	ND		2.6	0.67	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Calcium	**1400**	**B**	1300	9.7	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Cobalt	ND		13	0.23	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Iron	ND		26	15	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Lead	ND		2.6	0.56	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Lithium	ND		13	0.77	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Manganese	ND		3.8	0.16	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Molybdenum	ND		10	0.42	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Potassium	ND		1300	130	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Sodium	ND		1300	670	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4
Selenium	ND		2.6	0.87	mg/Kg	☼	07/02/21 08:00	07/13/21 12:15	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**12**	**J**	38	6.1	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Arsenic	ND		1.9	0.50	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Calcium	**2400**		960	8.5	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Cobalt	ND		9.6	0.24	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Iron	ND		19	11	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Lead	ND		1.9	0.42	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Lithium	ND		9.6	0.58	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Manganese	**4.0**		2.9	1.1	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Molybdenum	ND		7.7	0.32	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Potassium	ND		960	100	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3
Selenium	ND		1.9	0.65	mg/Kg	☼	07/02/21 14:02	07/13/21 14:51	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**210**		13	2.7	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Arsenic	**0.46**	**J**	0.64	0.17	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Calcium	**10**	**J**	320	1.9	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Cobalt	**3.4**		3.2	0.058	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Iron	**530**		6.4	3.7	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Lead	ND		0.64	0.14	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Lithium	**0.24**	**J**	3.2	0.19	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Manganese	**360**	**B**	0.96	0.035	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Molybdenum	**0.22**	**J**	2.6	0.11	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Potassium	ND		320	33	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Sodium	**12000**		320	170	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1
Selenium	ND		0.64	0.22	mg/Kg	☼	07/07/21 08:00	07/14/21 12:50	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1800**		13	2.0	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Arsenic	**2.7**		0.64	0.28	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Calcium	**5700**		320	2.8	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Cobalt	**1.7**	**J**	3.2	0.068	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Iron	**8400**		6.4	3.7	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Lead	**5.8**		0.64	0.14	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G02L
Date Collected: 05/20/21 10:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-9
Matrix: Solid
Percent Solids: 78.1

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**2.1**	**J**	3.2	0.19	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Manganese	**140**		0.96	0.17	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Molybdenum	**0.53**	**J**	2.6	0.11	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Potassium	ND		320	33	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Sodium	**1900**		320	170	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1
Selenium	ND		0.64	0.60	mg/Kg	☼	07/08/21 08:00	07/14/21 14:48	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**140**	**J**	190	30	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Arsenic	ND		9.6	2.4	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Calcium	**7500**	**B**	4800	14	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Cobalt	ND		48	0.77	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Iron	ND		96	56	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Lead	ND		9.6	2.1	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Lithium	ND		48	2.8	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Manganese	**22**		14	2.4	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Molybdenum	ND		38	1.6	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Potassium	**2800**	**J B**	4800	540	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5
Selenium	ND		9.6	3.3	mg/Kg	☼	07/08/21 15:21	07/15/21 14:40	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**5000**		13	2.0	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Arsenic	**1.9**		0.64	0.19	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Calcium	**3400**		320	2.7	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Cobalt	**1.7**	**J**	3.2	0.059	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Iron	**7400**		6.4	3.7	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Lead	**2.7**		0.64	0.14	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Lithium	**4.6**		3.2	0.19	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Manganese	**78**		0.96	0.32	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Molybdenum	ND		2.6	0.13	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Potassium	**730**		320	33	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1
Sodium	**35000**		1600	830	mg/Kg	☼	07/09/21 08:00	07/15/21 18:57	5
Selenium	ND		0.64	0.22	mg/Kg	☼	07/09/21 08:00	07/15/21 16:39	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**38000**		130	20	mg/Kg	☼	07/12/21 08:00	07/17/21 14:03	10
Arsenic	**2.2**	**B**	0.64	0.17	mg/Kg	☼	07/12/21 08:00	07/17/21 15:36	1
Calcium	**3700**		3200	33	mg/Kg	☼	07/12/21 08:00	07/17/21 14:03	10
Cobalt	**1.1**	**J**	6.4	0.067	mg/Kg	☼	07/12/21 08:00	07/17/21 17:58	2
Iron	**5900**		6.4	5.3	mg/Kg	☼	07/12/21 08:00	07/17/21 15:36	1
Lead	**3.9**		1.3	0.28	mg/Kg	☼	07/12/21 08:00	07/17/21 17:58	2
Lithium	**11**		3.2	0.19	mg/Kg	☼	07/12/21 08:00	07/17/21 15:36	1
Manganese	**71**		0.96	0.14	mg/Kg	☼	07/12/21 08:00	07/17/21 15:36	1
Molybdenum	**0.15**	**J**	2.6	0.11	mg/Kg	☼	07/12/21 08:00	07/17/21 15:36	1
Potassium	**17000**		1600	64	mg/Kg	☼	07/12/21 08:00	07/17/21 18:02	5
Sodium	**10000**		320	55	mg/Kg	☼	07/12/21 08:00	07/17/21 15:36	1
Selenium	ND		0.64	0.22	mg/Kg	☼	07/12/21 08:00	07/17/21 15:36	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G02L
Date Collected: 05/20/21 10:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-9
Matrix: Solid
Percent Solids: 78.1

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	45000		10	1.6	mg/Kg			07/19/21 15:03	1
Arsenic	7.2		0.50	0.13	mg/Kg			07/19/21 15:03	1
Calcium	24000		250	0.74	mg/Kg			07/19/21 15:03	1
Cobalt	7.9		2.5	0.023	mg/Kg			07/19/21 15:03	1
Iron	22000		5.0	4.1	mg/Kg			07/19/21 15:03	1
Lead	12		0.50	0.11	mg/Kg			07/19/21 15:03	1
Lithium	18		2.5	0.15	mg/Kg			07/19/21 15:03	1
Manganese	670		0.75	0.052	mg/Kg			07/19/21 15:03	1
Molybdenum	0.90	J	2.0	0.082	mg/Kg			07/19/21 15:03	1
Potassium	20000		250	26	mg/Kg			07/19/21 15:03	1
Sodium	59000		250	130	mg/Kg			07/19/21 15:03	1
Selenium	ND		0.50	0.17	mg/Kg			07/19/21 15:03	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	12000		49	6.2	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Arsenic	5.6		2.5	0.36	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Calcium	21000		620	110	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Cobalt	6.3		6.2	0.059	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Iron	16000		25	9.7	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Lead	11		1.9	0.27	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Lithium	10		6.2	0.37	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Manganese	600		1.9	0.77	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Molybdenum	0.60	J	4.9	0.14	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Potassium	1300		620	30	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Sodium	92	J	620	44	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1
Selenium	ND		1.9	0.54	mg/Kg	☼	06/28/21 08:00	07/07/21 15:24	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	56000		130	20	mg/Kg	☼	07/02/21 08:00	07/18/21 11:53	10
Arsenic	8.4	B	0.64	0.17	mg/Kg	☼	07/02/21 08:00	07/18/21 13:35	1
Calcium	38000		3200	33	mg/Kg	☼	07/02/21 08:00	07/18/21 11:53	10
Cobalt	9.9		6.4	0.067	mg/Kg	☼	07/02/21 08:00	07/18/21 16:11	2
Iron	22000		6.4	5.3	mg/Kg	☼	07/02/21 08:00	07/18/21 13:35	1
Lead	18		1.3	0.28	mg/Kg	☼	07/02/21 08:00	07/18/21 16:11	2
Lithium	19		3.2	0.19	mg/Kg	☼	07/02/21 08:00	07/18/21 13:35	1
Manganese	700		0.96	0.14	mg/Kg	☼	07/02/21 08:00	07/18/21 13:35	1
Molybdenum	1.0	J	2.6	0.11	mg/Kg	☼	07/02/21 08:00	07/18/21 13:35	1
Potassium	24000		1600	64	mg/Kg	☼	07/02/21 08:00	07/18/21 16:17	5
Sodium	8200		320	55	mg/Kg	☼	07/02/21 08:00	07/18/21 13:35	1
Selenium	ND		0.64	0.22	mg/Kg	☼	07/02/21 08:00	07/18/21 13:35	1

Electronic Filing: Received, Clerk's Office 06/20/2024

Default Detection Limits

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Prep: 3010A
SEP: Exchangeable

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	1.9	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Lead	0.50	0.11	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.031	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Prep: 3010A
SEP: Carbonate

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	2.2	mg/Kg
Cobalt	2.5	0.063	mg/Kg
Iron	5.0	2.9	mg/Kg
Lead	0.50	0.11	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.28	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Prep: 3010A
SEP: Non-Crystalline

Analyte	RL	MDL	Units
Aluminum	10	2.1	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	1.5	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Lead	0.50	0.11	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.027	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A
SEP: Metal Hydroxide

Electronic Filing: Received, Clerk's Office 06/20/2024

Default Detection Limits

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A
SEP: Metal Hydroxide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Arsenic	0.50	0.22	mg/Kg
Calcium	250	2.2	mg/Kg
Cobalt	2.5	0.053	mg/Kg
Iron	5.0	2.9	mg/Kg
Lead	0.50	0.11	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.13	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.47	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Prep: 3010A
SEP: Organic-Bound

Analyte	RL	MDL	Units
Aluminum	30	4.7	mg/Kg
Arsenic	1.5	0.38	mg/Kg
Calcium	750	2.2	mg/Kg
Cobalt	7.5	0.12	mg/Kg
Iron	15	8.8	mg/Kg
Lead	1.5	0.33	mg/Kg
Lithium	7.5	0.44	mg/Kg
Manganese	2.3	0.37	mg/Kg
Molybdenum	6.0	0.25	mg/Kg
Potassium	750	85	mg/Kg
Selenium	1.5	0.52	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 6

SEP: Acid/Sulfide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Arsenic	0.50	0.15	mg/Kg
Calcium	250	2.1	mg/Kg
Cobalt	2.5	0.046	mg/Kg
Iron	5.0	2.9	mg/Kg
Lead	0.50	0.11	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.25	mg/Kg
Molybdenum	2.0	0.099	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Prep: Residual

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Arsenic	0.50	0.13	mg/Kg

Default Detection Limits

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Prep: Residual

Analyte	RL	MDL	Units
Calcium	250	2.6	mg/Kg
Cobalt	2.5	0.026	mg/Kg
Iron	5.0	4.1	mg/Kg
Lead	0.50	0.11	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.11	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	10	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	43	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	0.74	mg/Kg
Cobalt	2.5	0.023	mg/Kg
Iron	5.0	4.1	mg/Kg
Lead	0.50	0.11	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B - Metals (ICP)

Prep: 3050B

Analyte	RL	MDL	Units
Aluminum	40	5.0	mg/Kg
Arsenic	2.0	0.29	mg/Kg
Calcium	500	88	mg/Kg
Cobalt	5.0	0.048	mg/Kg
Iron	20	7.9	mg/Kg
Lead	1.5	0.22	mg/Kg
Lithium	5.0	0.30	mg/Kg
Manganese	1.5	0.62	mg/Kg
Molybdenum	4.0	0.11	mg/Kg
Potassium	500	24	mg/Kg
Selenium	1.5	0.44	mg/Kg
Sodium	500	36	mg/Kg

Method: 6010B - SEP Metals (ICP) - Total

Prep: Total

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	2.6	mg/Kg
Cobalt	2.5	0.026	mg/Kg
Iron	5.0	4.1	mg/Kg
Lead	0.50	0.11	mg/Kg

Electronic Filing: Received, Clerk's Office 06/20/2024

Default Detection Limits

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B - SEP Metals (ICP) - Total (Continued)

Prep: Total

Analyte	RL	MDL	Units
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.11	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	10	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	43	mg/Kg

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 140-51236/21-A
Matrix: Solid
Analysis Batch: 51553

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 51236

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		40	5.0	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Arsenic	ND		2.0	0.29	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Calcium	ND		500	88	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Cobalt	ND		5.0	0.048	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Iron	ND		20	7.9	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Lead	ND		1.5	0.22	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Lithium	ND		5.0	0.30	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Manganese	ND		1.5	0.62	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Molybdenum	ND		4.0	0.11	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Potassium	ND		500	24	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Sodium	ND		500	36	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Selenium	ND		1.5	0.44	mg/Kg		06/28/21 08:00	07/07/21 11:36	1

Lab Sample ID: LCS 140-51236/22-A
Matrix: Solid
Analysis Batch: 51553

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 51236

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	200	200		mg/Kg		100	90 - 110
Arsenic	10.0	9.56		mg/Kg		96	90 - 110
Calcium	5000	5040		mg/Kg		101	90 - 110
Cobalt	10.0	10.2		mg/Kg		102	90 - 110
Iron	100	103		mg/Kg		103	90 - 113
Lead	10.0	10.2		mg/Kg		102	90 - 110
Lithium	10.0	9.79		mg/Kg		98	80 - 120
Manganese	10.0	10.3		mg/Kg		103	90 - 110
Molybdenum	50.0	51.8		mg/Kg		104	90 - 110
Potassium	5000	4970		mg/Kg		99	90 - 110
Sodium	5000	5050		mg/Kg		101	87 - 116
Selenium	15.0	14.8		mg/Kg		99	90 - 110

Method: 6010B - SEP Metals (ICP) - Total

Lab Sample ID: MB 140-51423/17-A
Matrix: Solid
Analysis Batch: 51841

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 51423

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Arsenic	0.155	J	0.50	0.13	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Calcium	ND		250	2.6	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Cobalt	ND		2.5	0.026	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Iron	ND		5.0	4.1	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Lead	ND		0.50	0.11	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Lithium	ND		2.5	0.15	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Manganese	ND		0.75	0.11	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Potassium	ND		250	10	mg/Kg		07/02/21 08:00	07/18/21 10:46	1
Sodium	ND		250	43	mg/Kg		07/02/21 08:00	07/18/21 10:46	1

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B - SEP Metals (ICP) - Total (Continued)

Lab Sample ID: MB 140-51423/17-A
Matrix: Solid
Analysis Batch: 51841

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 51423

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		0.50	0.17	mg/Kg		07/02/21 08:00	07/18/21 10:46	1

Lab Sample ID: LCS 140-51423/18-A
Matrix: Solid
Analysis Batch: 51841

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 51423

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	101		mg/Kg		101	80 - 120
Arsenic	5.00	5.14		mg/Kg		103	80 - 120
Calcium	2500	2520		mg/Kg		101	80 - 120
Cobalt	5.00	5.18		mg/Kg		104	80 - 125
Iron	50.0	52.2		mg/Kg		104	80 - 120
Lead	5.00	5.33		mg/Kg		107	80 - 120
Lithium	5.00	5.00		mg/Kg		100	80 - 120
Manganese	5.00	5.36		mg/Kg		107	80 - 120
Molybdenum	25.0	26.2		mg/Kg		105	80 - 125
Potassium	2500	2530		mg/Kg		101	80 - 120
Sodium	2500	2570		mg/Kg		103	80 - 120
Selenium	7.50	7.44		mg/Kg		99	80 - 120

Lab Sample ID: LCSD 140-51423/19-A
Matrix: Solid
Analysis Batch: 51841

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 51423

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	101		mg/Kg		101	80 - 120	0	30
Arsenic	5.00	5.15		mg/Kg		103	80 - 120	0	30
Calcium	2500	2540		mg/Kg		101	80 - 120	1	30
Cobalt	5.00	5.22		mg/Kg		104	80 - 125	1	30
Iron	50.0	51.9		mg/Kg		104	80 - 120	1	30
Lead	5.00	5.37		mg/Kg		107	80 - 120	1	30
Lithium	5.00	4.98		mg/Kg		100	80 - 120	0	30
Manganese	5.00	5.31		mg/Kg		106	80 - 120	1	30
Molybdenum	25.0	26.5		mg/Kg		106	80 - 125	1	30
Potassium	2500	2550		mg/Kg		102	80 - 120	0	30
Sodium	2500	2570		mg/Kg		103	80 - 120	0	30
Selenium	7.50	7.45		mg/Kg		99	80 - 120	0	30

Method: 6010B SEP - SEP Metals (ICP)

Lab Sample ID: MB 140-51421/17-B ^4
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Method Blank
Prep Type: Step 1
Prep Batch: 51438

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		40	6.4	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Arsenic	ND		2.0	0.52	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Calcium	22.6	J	1000	7.6	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Cobalt	ND		10	0.18	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Iron	ND		20	12	mg/Kg		07/02/21 08:00	07/13/21 11:12	4

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51421/17-B ^4
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Method Blank
Prep Type: Step 1
Prep Batch: 51438

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		2.0	0.44	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Lithium	ND		10	0.60	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Manganese	ND		3.0	0.12	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Molybdenum	ND		8.0	0.33	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Potassium	ND		1000	100	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Sodium	ND		1000	520	mg/Kg		07/02/21 08:00	07/13/21 11:12	4
Selenium	ND		2.0	0.68	mg/Kg		07/02/21 08:00	07/13/21 11:12	4

Lab Sample ID: LCS 140-51421/18-B ^5
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Lab Control Sample
Prep Type: Step 1
Prep Batch: 51438

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	97.7		mg/Kg		98	80 - 120
Arsenic	5.00	4.83		mg/Kg		97	80 - 120
Calcium	2500	2550		mg/Kg		102	80 - 120
Cobalt	5.00	5.14	J	mg/Kg		103	80 - 120
Iron	50.0	52.3		mg/Kg		105	80 - 120
Lead	5.00	5.20		mg/Kg		104	80 - 120
Lithium	5.00	5.59	J	mg/Kg		112	80 - 120
Manganese	5.00	5.48		mg/Kg		110	80 - 120
Molybdenum	25.0	25.8		mg/Kg		103	80 - 120
Potassium	2500	2670		mg/Kg		107	80 - 120
Sodium	2500	2640		mg/Kg		106	80 - 120
Selenium	7.50	7.37		mg/Kg		98	80 - 120

Lab Sample ID: LCSD 140-51421/19-B ^5
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 1
Prep Batch: 51438

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	102		mg/Kg		102	80 - 120	5	30
Arsenic	5.00	4.88		mg/Kg		98	80 - 120	1	30
Calcium	2500	2510		mg/Kg		101	80 - 120	1	30
Cobalt	5.00	5.06	J	mg/Kg		101	80 - 120	1	30
Iron	50.0	51.1		mg/Kg		102	80 - 120	2	30
Lead	5.00	5.25		mg/Kg		105	80 - 120	1	30
Lithium	5.00	5.31	J	mg/Kg		106	80 - 120	5	30
Manganese	5.00	5.34		mg/Kg		107	80 - 120	3	30
Molybdenum	25.0	25.4		mg/Kg		102	80 - 120	1	30
Potassium	2500	2620		mg/Kg		105	80 - 120	2	30
Sodium	2500	2600		mg/Kg		104	80 - 120	2	30
Selenium	7.50	7.27		mg/Kg		97	80 - 120	1	30

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51449/17-B ^3
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Method Blank
Prep Type: Step 2
Prep Batch: 51455

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		30	4.8	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Arsenic	ND		1.5	0.39	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Calcium	ND		750	6.6	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Cobalt	ND		7.5	0.19	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Iron	28.7		15	8.7	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Lead	ND		1.5	0.33	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Lithium	ND		7.5	0.45	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Manganese	ND		2.3	0.84	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Molybdenum	ND		6.0	0.25	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Potassium	ND		750	78	mg/Kg		07/02/21 14:02	07/13/21 13:08	3
Selenium	ND		1.5	0.51	mg/Kg		07/02/21 14:02	07/13/21 13:08	3

Lab Sample ID: MB 140-51449/17-B ^3
Matrix: Solid
Analysis Batch: 51840

Client Sample ID: Method Blank
Prep Type: Step 2
Prep Batch: 51455

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		15	8.7	mg/Kg		07/02/21 14:02	07/17/21 10:54	3

Lab Sample ID: LCS 140-51449/18-B ^5
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Lab Control Sample
Prep Type: Step 2
Prep Batch: 51455

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	ND		mg/Kg		2	
Arsenic	5.00	3.60		mg/Kg		72	60 - 120
Calcium	2500	672	J	mg/Kg		27	10 - 40
Cobalt	5.00	4.76	J	mg/Kg		95	80 - 120
Iron	50.0	ND		mg/Kg		3	
Lead	5.00	4.53		mg/Kg		91	70 - 120
Lithium	5.00	4.93	J	mg/Kg		99	80 - 120
Manganese	5.00	4.88		mg/Kg		98	80 - 120
Molybdenum	25.0	21.1		mg/Kg		85	70 - 120
Potassium	2500	2440		mg/Kg		98	80 - 120
Selenium	7.50	6.26		mg/Kg		84	70 - 120

Lab Sample ID: LCSD 140-51449/19-B ^5
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 2
Prep Batch: 51455

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	ND		mg/Kg		-0.6		374	
Arsenic	5.00	3.80		mg/Kg		76	60 - 120	5	30
Calcium	2500	654	J	mg/Kg		26	10 - 40	3	30
Cobalt	5.00	4.64	J	mg/Kg		93	80 - 120	3	30
Iron	50.0	ND		mg/Kg		15		139	
Lead	5.00	4.11		mg/Kg		82	70 - 120	10	30
Lithium	5.00	4.67	J	mg/Kg		93	80 - 120	5	30
Manganese	5.00	4.89		mg/Kg		98	80 - 120	0	30

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCSD 140-51449/19-B ^5
Matrix: Solid
Analysis Batch: 51720

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 2
Prep Batch: 51455

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Molybdenum	25.0	20.5		mg/Kg		82	70 - 120	3	30
Potassium	2500	2400		mg/Kg		96	80 - 120	2	30
Selenium	7.50	6.03		mg/Kg		80	70 - 120	4	30

Lab Sample ID: MB 140-51456/17-B
Matrix: Solid
Analysis Batch: 51768

Client Sample ID: Method Blank
Prep Type: Step 3
Prep Batch: 51501

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	2.1	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Arsenic	ND		0.50	0.13	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Calcium	ND		250	1.5	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Cobalt	ND		2.5	0.045	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Iron	ND		5.0	2.9	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Lead	ND		0.50	0.11	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Lithium	ND		2.5	0.15	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Manganese	0.0870	J	0.75	0.027	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Potassium	ND		250	26	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Sodium	ND		250	130	mg/Kg		07/07/21 08:00	07/14/21 11:46	1
Selenium	ND		0.50	0.17	mg/Kg		07/07/21 08:00	07/14/21 11:46	1

Lab Sample ID: LCS 140-51456/18-B
Matrix: Solid
Analysis Batch: 51768

Client Sample ID: Lab Control Sample
Prep Type: Step 3
Prep Batch: 51501

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	96.1		mg/Kg		96	80 - 120
Arsenic	5.00	4.64		mg/Kg		93	80 - 120
Calcium	2500	49.8	J	mg/Kg		2	
Cobalt	5.00	5.02		mg/Kg		100	80 - 120
Iron	50.0	49.7		mg/Kg		99	80 - 120
Lead	5.00	0.113	J	mg/Kg		2	
Lithium	5.00	4.81		mg/Kg		96	80 - 120
Manganese	5.00	5.04		mg/Kg		101	80 - 120
Molybdenum	25.0	24.3		mg/Kg		97	80 - 120
Potassium	2500	2380		mg/Kg		95	80 - 120
Sodium	2500	2370		mg/Kg		95	80 - 120
Selenium	7.50	7.27		mg/Kg		97	80 - 120

Lab Sample ID: LCSD 140-51456/19-B
Matrix: Solid
Analysis Batch: 51768

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 3
Prep Batch: 51501

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	95.9		mg/Kg		96	80 - 120	0	30
Arsenic	5.00	4.68		mg/Kg		94	80 - 120	1	30
Calcium	2500	51.1	J	mg/Kg		2		3	
Cobalt	5.00	5.01		mg/Kg		100	80 - 120	0	30

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCSD 140-51456/19-B
Matrix: Solid
Analysis Batch: 51768

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 3
Prep Batch: 51501

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Iron	50.0	50.2		mg/Kg		100	80 - 120	1	30
Lead	5.00	ND		mg/Kg		2		25	
Lithium	5.00	4.86		mg/Kg		97	80 - 120	1	30
Manganese	5.00	5.02		mg/Kg		100	80 - 120	0	30
Molybdenum	25.0	24.2		mg/Kg		97	80 - 120	0	30
Potassium	2500	2390		mg/Kg		95	80 - 120	0	30
Sodium	2500	2370		mg/Kg		95	80 - 120	0	30
Selenium	7.50	7.20		mg/Kg		96	80 - 120	1	30

Lab Sample ID: MB 140-51499/17-B
Matrix: Solid
Analysis Batch: 51768

Client Sample ID: Method Blank
Prep Type: Step 4
Prep Batch: 51551

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Arsenic	ND		0.50	0.22	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Calcium	ND		250	2.2	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Cobalt	ND		2.5	0.053	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Iron	ND		5.0	2.9	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Lead	ND		0.50	0.11	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Lithium	ND		2.5	0.15	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Manganese	ND		0.75	0.13	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Potassium	ND		250	26	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Sodium	ND		250	130	mg/Kg		07/08/21 08:00	07/14/21 13:44	1
Selenium	ND		0.50	0.47	mg/Kg		07/08/21 08:00	07/14/21 13:44	1

Lab Sample ID: LCS 140-51499/18-B
Matrix: Solid
Analysis Batch: 51768

Client Sample ID: Lab Control Sample
Prep Type: Step 4
Prep Batch: 51551

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	98.3		mg/Kg		98	80 - 120
Arsenic	5.00	5.06		mg/Kg		101	80 - 130
Calcium	2500	2470		mg/Kg		99	80 - 120
Cobalt	5.00	5.18		mg/Kg		104	80 - 120
Iron	50.0	51.1		mg/Kg		102	80 - 120
Lead	5.00	4.99		mg/Kg		100	80 - 120
Lithium	5.00	4.98		mg/Kg		100	80 - 120
Manganese	5.00	5.09		mg/Kg		102	80 - 120
Molybdenum	25.0	25.9		mg/Kg		104	80 - 120
Potassium	2500	2480		mg/Kg		99	80 - 120
Sodium	2500	2490		mg/Kg		100	80 - 120
Selenium	7.50	ND		mg/Kg		5	

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCSD 140-51499/19-B
Matrix: Solid
Analysis Batch: 51768

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 4
Prep Batch: 51551

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	103		mg/Kg		103	80 - 120	4	30
Arsenic	5.00	5.38		mg/Kg		108	80 - 130	6	30
Calcium	2500	2590		mg/Kg		103	80 - 120	5	30
Cobalt	5.00	5.44		mg/Kg		109	80 - 120	5	30
Iron	50.0	55.3		mg/Kg		111	80 - 120	8	30
Lead	5.00	5.25		mg/Kg		105	80 - 120	5	30
Lithium	5.00	5.16		mg/Kg		103	80 - 120	4	30
Manganese	5.00	5.35		mg/Kg		107	80 - 120	5	30
Molybdenum	25.0	27.2		mg/Kg		109	80 - 120	5	30
Potassium	2500	2580		mg/Kg		103	80 - 120	4	30
Sodium	2500	2600		mg/Kg		104	80 - 120	4	30
Selenium	7.50	ND		mg/Kg		5		13	

Lab Sample ID: MB 140-51550/17-B ^5
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Method Blank
Prep Type: Step 5
Prep Batch: 51581

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		150	24	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Arsenic	ND		7.5	1.9	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Calcium	12.5	J	3800	11	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Cobalt	ND		38	0.60	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Iron	178		75	44	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Lead	ND		7.5	1.7	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Lithium	ND		38	2.2	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Manganese	ND		11	1.9	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Molybdenum	ND		30	1.3	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Potassium	2390	J	3800	430	mg/Kg		07/08/21 15:21	07/15/21 13:36	5
Selenium	ND		7.5	2.6	mg/Kg		07/08/21 15:21	07/15/21 13:36	5

Lab Sample ID: MB 140-51550/17-B ^5
Matrix: Solid
Analysis Batch: 51840

Client Sample ID: Method Blank
Prep Type: Step 5
Prep Batch: 51581

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		75	44	mg/Kg		07/08/21 15:21	07/17/21 11:58	5

Lab Sample ID: LCS 140-51550/18-B ^5
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Lab Control Sample
Prep Type: Step 5
Prep Batch: 51581

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	300	ND		mg/Kg		4	
Arsenic	15.0	12.2		mg/Kg		81	60 - 100
Calcium	7500	2070	J	mg/Kg		28	20 - 50
Cobalt	15.0	0.630	J	mg/Kg		4	1 - 60
Iron	150	ND		mg/Kg		11	
Lead	15.0	9.67		mg/Kg		64	40 - 80
Lithium	15.0	17.5	J	mg/Kg		116	80 - 150

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-51550/18-B ^5
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Lab Control Sample
Prep Type: Step 5
Prep Batch: 51581

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Manganese	15.0	3.95	J	mg/Kg		26	1 - 60
Molybdenum	75.0	57.4		mg/Kg		77	60 - 100
Potassium	7500	10300		mg/Kg		137	80 - 180
Selenium	22.5	25.3		mg/Kg		113	80 - 140

Lab Sample ID: LCSD 140-51550/19-B ^5
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 5
Prep Batch: 51581

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	300	ND		mg/Kg		-0.5		261	
Arsenic	15.0	11.1		mg/Kg		74	60 - 100	10	30
Calcium	7500	2040	J	mg/Kg		27	20 - 50	1	30
Cobalt	15.0	0.630	J	mg/Kg		4	1 - 60	0	30
Iron	150	ND		mg/Kg		3		112	
Lead	15.0	9.67		mg/Kg		64	40 - 80	0	30
Lithium	15.0	16.9	J	mg/Kg		113	80 - 150	3	30
Manganese	15.0	4.01	J	mg/Kg		27	1 - 60	2	30
Molybdenum	75.0	57.5		mg/Kg		77	60 - 100	0	30
Potassium	7500	10200		mg/Kg		136	80 - 180	0	30
Selenium	22.5	23.5		mg/Kg		104	80 - 140	8	30

Lab Sample ID: MB 140-51583/17-A
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Method Blank
Prep Type: Step 6
Prep Batch: 51583

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Arsenic	ND		0.50	0.15	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Calcium	ND		250	2.1	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Cobalt	ND		2.5	0.046	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Iron	ND		5.0	2.9	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Lead	ND		0.50	0.11	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Lithium	ND		2.5	0.15	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Manganese	ND		0.75	0.25	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Molybdenum	ND		2.0	0.099	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Potassium	ND		250	26	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Sodium	ND		250	130	mg/Kg		07/09/21 08:00	07/15/21 15:35	1
Selenium	ND		0.50	0.17	mg/Kg		07/09/21 08:00	07/15/21 15:35	1

Lab Sample ID: LCS 140-51583/18-A
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Lab Control Sample
Prep Type: Step 6
Prep Batch: 51583

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	102		mg/Kg		102	80 - 120
Arsenic	5.00	4.95		mg/Kg		99	80 - 120
Calcium	2500	2500		mg/Kg		100	80 - 120
Cobalt	5.00	5.23		mg/Kg		105	80 - 120

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QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-51583/18-A
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Lab Control Sample
Prep Type: Step 6
Prep Batch: 51583

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Iron	50.0	51.9		mg/Kg		104	80 - 120
Lead	5.00	5.07		mg/Kg		101	80 - 120
Lithium	5.00	4.92		mg/Kg		98	80 - 120
Manganese	5.00	5.12		mg/Kg		102	80 - 120
Molybdenum	25.0	25.4		mg/Kg		102	80 - 120
Potassium	2500	2520		mg/Kg		101	80 - 120
Sodium	2500	2550		mg/Kg		102	80 - 120
Selenium	7.50	7.68		mg/Kg		102	80 - 120

Lab Sample ID: LCSD 140-51583/19-A
Matrix: Solid
Analysis Batch: 51806

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 6
Prep Batch: 51583

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	94.4		mg/Kg		94	80 - 120	7	30
Arsenic	5.00	4.72		mg/Kg		94	80 - 120	5	30
Calcium	2500	2350		mg/Kg		94	80 - 120	6	30
Cobalt	5.00	5.01		mg/Kg		100	80 - 120	4	30
Iron	50.0	48.3		mg/Kg		97	80 - 120	7	30
Lead	5.00	4.88		mg/Kg		98	80 - 120	4	30
Lithium	5.00	4.58		mg/Kg		92	80 - 120	7	30
Manganese	5.00	4.89		mg/Kg		98	80 - 120	5	30
Molybdenum	25.0	24.4		mg/Kg		98	80 - 120	4	30
Potassium	2500	2370		mg/Kg		95	80 - 120	6	30
Sodium	2500	2390		mg/Kg		96	80 - 120	7	30
Selenium	7.50	7.34		mg/Kg		98	80 - 120	5	30

Lab Sample ID: MB 140-51609/17-A
Matrix: Solid
Analysis Batch: 51840

Client Sample ID: Method Blank
Prep Type: Step 7
Prep Batch: 51609

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Arsenic	0.198	J	0.50	0.13	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Calcium	ND		250	2.6	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Cobalt	ND		2.5	0.026	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Iron	ND		5.0	4.1	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Lead	ND		0.50	0.11	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Lithium	ND		2.5	0.15	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Manganese	ND		0.75	0.11	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Potassium	ND		250	10	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Sodium	ND		250	43	mg/Kg		07/12/21 08:00	07/17/21 12:43	1
Selenium	ND		0.50	0.17	mg/Kg		07/12/21 08:00	07/17/21 12:43	1

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QC Sample Results

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-51609/18-A
Matrix: Solid
Analysis Batch: 51840

Client Sample ID: Lab Control Sample
Prep Type: Step 7
Prep Batch: 51609

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	99.8		mg/Kg		100	80 - 120
Arsenic	5.00	5.15		mg/Kg		103	80 - 120
Calcium	2500	2570		mg/Kg		103	80 - 120
Cobalt	5.00	5.16		mg/Kg		103	80 - 125
Iron	50.0	52.7		mg/Kg		105	80 - 120
Lead	5.00	5.26		mg/Kg		105	80 - 120
Lithium	5.00	5.04		mg/Kg		101	80 - 120
Manganese	5.00	5.28		mg/Kg		106	80 - 120
Molybdenum	25.0	26.1		mg/Kg		104	80 - 125
Potassium	2500	2580		mg/Kg		103	80 - 120
Sodium	2500	2630		mg/Kg		105	80 - 120
Selenium	7.50	7.27		mg/Kg		97	80 - 120

Lab Sample ID: LCSD 140-51609/19-A
Matrix: Solid
Analysis Batch: 51840

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 7
Prep Batch: 51609

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	102		mg/Kg		102	80 - 120	2	30
Arsenic	5.00	5.21		mg/Kg		104	80 - 120	1	30
Calcium	2500	2570		mg/Kg		103	80 - 120	0	30
Cobalt	5.00	5.22		mg/Kg		104	80 - 125	1	30
Iron	50.0	53.4		mg/Kg		107	80 - 120	1	30
Lead	5.00	5.29		mg/Kg		106	80 - 120	1	30
Lithium	5.00	5.09		mg/Kg		102	80 - 120	1	30
Manganese	5.00	5.60		mg/Kg		112	80 - 120	6	30
Molybdenum	25.0	26.5		mg/Kg		106	80 - 125	2	30
Potassium	2500	2590		mg/Kg		103	80 - 120	0	30
Sodium	2500	2640		mg/Kg		106	80 - 120	0	30
Selenium	7.50	7.38		mg/Kg		98	80 - 120	1	30

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QC Association Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Metals

Prep Batch: 51236

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Total/NA	Solid	3050B	
140-23190-2	B-G52S	Total/NA	Solid	3050B	
140-23190-3	B-G54L	Total/NA	Solid	3050B	
140-23190-4	B-G57L	Total/NA	Solid	3050B	
140-23190-5	B-G57S	Total/NA	Solid	3050B	
140-23190-6	B-G62L	Total/NA	Solid	3050B	
140-23190-7	B-G53S	Total/NA	Solid	3050B	
140-23190-8	B-G02S	Total/NA	Solid	3050B	
140-23190-9	B-G02L	Total/NA	Solid	3050B	
MB 140-51236/21-A	Method Blank	Total/NA	Solid	3050B	
LCS 140-51236/22-A	Lab Control Sample	Total/NA	Solid	3050B	

SEP Batch: 51421

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 1	Solid	Exchangeable	
140-23190-2	B-G52S	Step 1	Solid	Exchangeable	
140-23190-3	B-G54L	Step 1	Solid	Exchangeable	
140-23190-4	B-G57L	Step 1	Solid	Exchangeable	
140-23190-5	B-G57S	Step 1	Solid	Exchangeable	
140-23190-6	B-G62L	Step 1	Solid	Exchangeable	
140-23190-7	B-G53S	Step 1	Solid	Exchangeable	
140-23190-8	B-G02S	Step 1	Solid	Exchangeable	
140-23190-9	B-G02L	Step 1	Solid	Exchangeable	
MB 140-51421/17-B ^4	Method Blank	Step 1	Solid	Exchangeable	
LCS 140-51421/18-B ^5	Lab Control Sample	Step 1	Solid	Exchangeable	
LCSD 140-51421/19-B ^5	Lab Control Sample Dup	Step 1	Solid	Exchangeable	

Prep Batch: 51423

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Total/NA	Solid	Total	
140-23190-2	B-G52S	Total/NA	Solid	Total	
140-23190-3	B-G54L	Total/NA	Solid	Total	
140-23190-4	B-G57L	Total/NA	Solid	Total	
140-23190-5	B-G57S	Total/NA	Solid	Total	
140-23190-6	B-G62L	Total/NA	Solid	Total	
140-23190-7	B-G53S	Total/NA	Solid	Total	
140-23190-8	B-G02S	Total/NA	Solid	Total	
140-23190-9	B-G02L	Total/NA	Solid	Total	
MB 140-51423/17-A	Method Blank	Total/NA	Solid	Total	
LCS 140-51423/18-A	Lab Control Sample	Total/NA	Solid	Total	
LCSD 140-51423/19-A	Lab Control Sample Dup	Total/NA	Solid	Total	

Prep Batch: 51438

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 1	Solid	3010A	51421
140-23190-2	B-G52S	Step 1	Solid	3010A	51421
140-23190-3	B-G54L	Step 1	Solid	3010A	51421
140-23190-4	B-G57L	Step 1	Solid	3010A	51421
140-23190-5	B-G57S	Step 1	Solid	3010A	51421
140-23190-6	B-G62L	Step 1	Solid	3010A	51421
140-23190-7	B-G53S	Step 1	Solid	3010A	51421

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QC Association Summary

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Metals (Continued)

Prep Batch: 51438 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-8	B-G02S	Step 1	Solid	3010A	51421
140-23190-9	B-G02L	Step 1	Solid	3010A	51421
MB 140-51421/17-B ^4	Method Blank	Step 1	Solid	3010A	51421
LCS 140-51421/18-B ^5	Lab Control Sample	Step 1	Solid	3010A	51421
LCSD 140-51421/19-B ^5	Lab Control Sample Dup	Step 1	Solid	3010A	51421

SEP Batch: 51449

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 2	Solid	Carbonate	
140-23190-2	B-G52S	Step 2	Solid	Carbonate	
140-23190-3	B-G54L	Step 2	Solid	Carbonate	
140-23190-4	B-G57L	Step 2	Solid	Carbonate	
140-23190-5	B-G57S	Step 2	Solid	Carbonate	
140-23190-6	B-G62L	Step 2	Solid	Carbonate	
140-23190-7	B-G53S	Step 2	Solid	Carbonate	
140-23190-8	B-G02S	Step 2	Solid	Carbonate	
140-23190-9	B-G02L	Step 2	Solid	Carbonate	
MB 140-51449/17-B ^3	Method Blank	Step 2	Solid	Carbonate	
LCS 140-51449/18-B ^5	Lab Control Sample	Step 2	Solid	Carbonate	
LCSD 140-51449/19-B ^5	Lab Control Sample Dup	Step 2	Solid	Carbonate	

Prep Batch: 51455

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 2	Solid	3010A	51449
140-23190-2	B-G52S	Step 2	Solid	3010A	51449
140-23190-3	B-G54L	Step 2	Solid	3010A	51449
140-23190-4	B-G57L	Step 2	Solid	3010A	51449
140-23190-5	B-G57S	Step 2	Solid	3010A	51449
140-23190-6	B-G62L	Step 2	Solid	3010A	51449
140-23190-7	B-G53S	Step 2	Solid	3010A	51449
140-23190-8	B-G02S	Step 2	Solid	3010A	51449
140-23190-9	B-G02L	Step 2	Solid	3010A	51449
MB 140-51449/17-B ^3	Method Blank	Step 2	Solid	3010A	51449
LCS 140-51449/18-B ^5	Lab Control Sample	Step 2	Solid	3010A	51449
LCSD 140-51449/19-B ^5	Lab Control Sample Dup	Step 2	Solid	3010A	51449

SEP Batch: 51456

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 3	Solid	Non-Crystalline	
140-23190-2	B-G52S	Step 3	Solid	Non-Crystalline	
140-23190-3	B-G54L	Step 3	Solid	Non-Crystalline	
140-23190-4	B-G57L	Step 3	Solid	Non-Crystalline	
140-23190-5	B-G57S	Step 3	Solid	Non-Crystalline	
140-23190-6	B-G62L	Step 3	Solid	Non-Crystalline	
140-23190-7	B-G53S	Step 3	Solid	Non-Crystalline	
140-23190-8	B-G02S	Step 3	Solid	Non-Crystalline	
140-23190-9	B-G02L	Step 3	Solid	Non-Crystalline	
MB 140-51456/17-B	Method Blank	Step 3	Solid	Non-Crystalline	
LCS 140-51456/18-B	Lab Control Sample	Step 3	Solid	Non-Crystalline	
LCSD 140-51456/19-B	Lab Control Sample Dup	Step 3	Solid	Non-Crystalline	

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QC Association Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Metals

SEP Batch: 51499

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 4	Solid	Metal Hydroxide	
140-23190-2	B-G52S	Step 4	Solid	Metal Hydroxide	
140-23190-3	B-G54L	Step 4	Solid	Metal Hydroxide	
140-23190-4	B-G57L	Step 4	Solid	Metal Hydroxide	
140-23190-5	B-G57S	Step 4	Solid	Metal Hydroxide	
140-23190-6	B-G62L	Step 4	Solid	Metal Hydroxide	
140-23190-7	B-G53S	Step 4	Solid	Metal Hydroxide	
140-23190-8	B-G02S	Step 4	Solid	Metal Hydroxide	
140-23190-9	B-G02L	Step 4	Solid	Metal Hydroxide	
MB 140-51499/17-B	Method Blank	Step 4	Solid	Metal Hydroxide	
LCS 140-51499/18-B	Lab Control Sample	Step 4	Solid	Metal Hydroxide	
LCSD 140-51499/19-B	Lab Control Sample Dup	Step 4	Solid	Metal Hydroxide	

Prep Batch: 51501

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 3	Solid	3010A	51456
140-23190-2	B-G52S	Step 3	Solid	3010A	51456
140-23190-3	B-G54L	Step 3	Solid	3010A	51456
140-23190-4	B-G57L	Step 3	Solid	3010A	51456
140-23190-5	B-G57S	Step 3	Solid	3010A	51456
140-23190-6	B-G62L	Step 3	Solid	3010A	51456
140-23190-7	B-G53S	Step 3	Solid	3010A	51456
140-23190-8	B-G02S	Step 3	Solid	3010A	51456
140-23190-9	B-G02L	Step 3	Solid	3010A	51456
MB 140-51456/17-B	Method Blank	Step 3	Solid	3010A	51456
LCS 140-51456/18-B	Lab Control Sample	Step 3	Solid	3010A	51456
LCSD 140-51456/19-B	Lab Control Sample Dup	Step 3	Solid	3010A	51456

SEP Batch: 51550

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 5	Solid	Organic-Bound	
140-23190-2	B-G52S	Step 5	Solid	Organic-Bound	
140-23190-3	B-G54L	Step 5	Solid	Organic-Bound	
140-23190-4	B-G57L	Step 5	Solid	Organic-Bound	
140-23190-5	B-G57S	Step 5	Solid	Organic-Bound	
140-23190-6	B-G62L	Step 5	Solid	Organic-Bound	
140-23190-7	B-G53S	Step 5	Solid	Organic-Bound	
140-23190-8	B-G02S	Step 5	Solid	Organic-Bound	
140-23190-9	B-G02L	Step 5	Solid	Organic-Bound	
MB 140-51550/17-B ^5	Method Blank	Step 5	Solid	Organic-Bound	
LCS 140-51550/18-B ^5	Lab Control Sample	Step 5	Solid	Organic-Bound	
LCSD 140-51550/19-B ^5	Lab Control Sample Dup	Step 5	Solid	Organic-Bound	

Prep Batch: 51551

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 4	Solid	3010A	51499
140-23190-2	B-G52S	Step 4	Solid	3010A	51499
140-23190-3	B-G54L	Step 4	Solid	3010A	51499
140-23190-4	B-G57L	Step 4	Solid	3010A	51499
140-23190-5	B-G57S	Step 4	Solid	3010A	51499
140-23190-6	B-G62L	Step 4	Solid	3010A	51499

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QC Association Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Metals (Continued)

Prep Batch: 51551 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-7	B-G53S	Step 4	Solid	3010A	51499
140-23190-8	B-G02S	Step 4	Solid	3010A	51499
140-23190-9	B-G02L	Step 4	Solid	3010A	51499
MB 140-51499/17-B	Method Blank	Step 4	Solid	3010A	51499
LCS 140-51499/18-B	Lab Control Sample	Step 4	Solid	3010A	51499
LCSD 140-51499/19-B	Lab Control Sample Dup	Step 4	Solid	3010A	51499

Analysis Batch: 51553

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Total/NA	Solid	6010B	51236
140-23190-1	B-AP-1	Total/NA	Solid	6010B	51236
140-23190-2	B-G52S	Total/NA	Solid	6010B	51236
140-23190-3	B-G54L	Total/NA	Solid	6010B	51236
140-23190-4	B-G57L	Total/NA	Solid	6010B	51236
140-23190-5	B-G57S	Total/NA	Solid	6010B	51236
140-23190-6	B-G62L	Total/NA	Solid	6010B	51236
140-23190-7	B-G53S	Total/NA	Solid	6010B	51236
140-23190-8	B-G02S	Total/NA	Solid	6010B	51236
140-23190-9	B-G02L	Total/NA	Solid	6010B	51236
MB 140-51236/21-A	Method Blank	Total/NA	Solid	6010B	51236
LCS 140-51236/22-A	Lab Control Sample	Total/NA	Solid	6010B	51236

Prep Batch: 51581

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 5	Solid	3010A	51550
140-23190-2	B-G52S	Step 5	Solid	3010A	51550
140-23190-3	B-G54L	Step 5	Solid	3010A	51550
140-23190-4	B-G57L	Step 5	Solid	3010A	51550
140-23190-5	B-G57S	Step 5	Solid	3010A	51550
140-23190-6	B-G62L	Step 5	Solid	3010A	51550
140-23190-7	B-G53S	Step 5	Solid	3010A	51550
140-23190-8	B-G02S	Step 5	Solid	3010A	51550
140-23190-9	B-G02L	Step 5	Solid	3010A	51550
MB 140-51550/17-B ^5	Method Blank	Step 5	Solid	3010A	51550
LCS 140-51550/18-B ^5	Lab Control Sample	Step 5	Solid	3010A	51550
LCSD 140-51550/19-B ^5	Lab Control Sample Dup	Step 5	Solid	3010A	51550

SEP Batch: 51583

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 6	Solid	Acid/Sulfide	
140-23190-2	B-G52S	Step 6	Solid	Acid/Sulfide	
140-23190-3	B-G54L	Step 6	Solid	Acid/Sulfide	
140-23190-4	B-G57L	Step 6	Solid	Acid/Sulfide	
140-23190-5	B-G57S	Step 6	Solid	Acid/Sulfide	
140-23190-6	B-G62L	Step 6	Solid	Acid/Sulfide	
140-23190-7	B-G53S	Step 6	Solid	Acid/Sulfide	
140-23190-8	B-G02S	Step 6	Solid	Acid/Sulfide	
140-23190-9	B-G02L	Step 6	Solid	Acid/Sulfide	
MB 140-51583/17-A	Method Blank	Step 6	Solid	Acid/Sulfide	
LCS 140-51583/18-A	Lab Control Sample	Step 6	Solid	Acid/Sulfide	
LCSD 140-51583/19-A	Lab Control Sample Dup	Step 6	Solid	Acid/Sulfide	

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QC Association Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Metals

Prep Batch: 51609

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 7	Solid	Residual	
140-23190-2	B-G52S	Step 7	Solid	Residual	
140-23190-3	B-G54L	Step 7	Solid	Residual	
140-23190-4	B-G57L	Step 7	Solid	Residual	
140-23190-5	B-G57S	Step 7	Solid	Residual	
140-23190-6	B-G62L	Step 7	Solid	Residual	
140-23190-7	B-G53S	Step 7	Solid	Residual	
140-23190-8	B-G02S	Step 7	Solid	Residual	
140-23190-9	B-G02L	Step 7	Solid	Residual	
MB 140-51609/17-A	Method Blank	Step 7	Solid	Residual	
LCS 140-51609/18-A	Lab Control Sample	Step 7	Solid	Residual	
LCSD 140-51609/19-A	Lab Control Sample Dup	Step 7	Solid	Residual	

Analysis Batch: 51720

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 1	Solid	6010B SEP	51438
140-23190-1	B-AP-1	Step 2	Solid	6010B SEP	51455
140-23190-2	B-G52S	Step 1	Solid	6010B SEP	51438
140-23190-2	B-G52S	Step 2	Solid	6010B SEP	51455
140-23190-3	B-G54L	Step 1	Solid	6010B SEP	51438
140-23190-3	B-G54L	Step 2	Solid	6010B SEP	51455
140-23190-4	B-G57L	Step 1	Solid	6010B SEP	51438
140-23190-4	B-G57L	Step 2	Solid	6010B SEP	51455
140-23190-5	B-G57S	Step 1	Solid	6010B SEP	51438
140-23190-5	B-G57S	Step 2	Solid	6010B SEP	51455
140-23190-6	B-G62L	Step 1	Solid	6010B SEP	51438
140-23190-6	B-G62L	Step 2	Solid	6010B SEP	51455
140-23190-7	B-G53S	Step 1	Solid	6010B SEP	51438
140-23190-7	B-G53S	Step 2	Solid	6010B SEP	51455
140-23190-8	B-G02S	Step 1	Solid	6010B SEP	51438
140-23190-8	B-G02S	Step 2	Solid	6010B SEP	51455
140-23190-9	B-G02L	Step 1	Solid	6010B SEP	51438
140-23190-9	B-G02L	Step 2	Solid	6010B SEP	51455
MB 140-51421/17-B ^4	Method Blank	Step 1	Solid	6010B SEP	51438
MB 140-51449/17-B ^3	Method Blank	Step 2	Solid	6010B SEP	51455
LCS 140-51421/18-B ^5	Lab Control Sample	Step 1	Solid	6010B SEP	51438
LCS 140-51449/18-B ^5	Lab Control Sample	Step 2	Solid	6010B SEP	51455
LCSD 140-51421/19-B ^5	Lab Control Sample Dup	Step 1	Solid	6010B SEP	51438
LCSD 140-51449/19-B ^5	Lab Control Sample Dup	Step 2	Solid	6010B SEP	51455

Analysis Batch: 51768

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 3	Solid	6010B SEP	51501
140-23190-1	B-AP-1	Step 4	Solid	6010B SEP	51551
140-23190-2	B-G52S	Step 3	Solid	6010B SEP	51501
140-23190-2	B-G52S	Step 4	Solid	6010B SEP	51551
140-23190-3	B-G54L	Step 3	Solid	6010B SEP	51501
140-23190-3	B-G54L	Step 4	Solid	6010B SEP	51551
140-23190-4	B-G57L	Step 3	Solid	6010B SEP	51501
140-23190-4	B-G57L	Step 3	Solid	6010B SEP	51501
140-23190-4	B-G57L	Step 4	Solid	6010B SEP	51551

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QC Association Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Metals (Continued)

Analysis Batch: 51768 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-5	B-G57S	Step 3	Solid	6010B SEP	51501
140-23190-5	B-G57S	Step 4	Solid	6010B SEP	51551
140-23190-6	B-G62L	Step 3	Solid	6010B SEP	51501
140-23190-6	B-G62L	Step 3	Solid	6010B SEP	51501
140-23190-6	B-G62L	Step 4	Solid	6010B SEP	51551
140-23190-7	B-G53S	Step 3	Solid	6010B SEP	51501
140-23190-7	B-G53S	Step 4	Solid	6010B SEP	51551
140-23190-8	B-G02S	Step 3	Solid	6010B SEP	51501
140-23190-8	B-G02S	Step 4	Solid	6010B SEP	51551
140-23190-9	B-G02L	Step 3	Solid	6010B SEP	51501
140-23190-9	B-G02L	Step 4	Solid	6010B SEP	51551
MB 140-51456/17-B	Method Blank	Step 3	Solid	6010B SEP	51501
MB 140-51499/17-B	Method Blank	Step 4	Solid	6010B SEP	51551
LCS 140-51456/18-B	Lab Control Sample	Step 3	Solid	6010B SEP	51501
LCS 140-51499/18-B	Lab Control Sample	Step 4	Solid	6010B SEP	51551
LCSD 140-51456/19-B	Lab Control Sample Dup	Step 3	Solid	6010B SEP	51501
LCSD 140-51499/19-B	Lab Control Sample Dup	Step 4	Solid	6010B SEP	51551

Analysis Batch: 51806

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 5	Solid	6010B SEP	51581
140-23190-1	B-AP-1	Step 6	Solid	6010B SEP	51583
140-23190-1	B-AP-1	Step 6	Solid	6010B SEP	51583
140-23190-2	B-G52S	Step 5	Solid	6010B SEP	51581
140-23190-2	B-G52S	Step 6	Solid	6010B SEP	51583
140-23190-2	B-G52S	Step 6	Solid	6010B SEP	51583
140-23190-3	B-G54L	Step 5	Solid	6010B SEP	51581
140-23190-3	B-G54L	Step 6	Solid	6010B SEP	51583
140-23190-3	B-G54L	Step 6	Solid	6010B SEP	51583
140-23190-4	B-G57L	Step 5	Solid	6010B SEP	51581
140-23190-4	B-G57L	Step 6	Solid	6010B SEP	51583
140-23190-4	B-G57L	Step 6	Solid	6010B SEP	51583
140-23190-5	B-G57S	Step 5	Solid	6010B SEP	51581
140-23190-5	B-G57S	Step 6	Solid	6010B SEP	51583
140-23190-5	B-G57S	Step 6	Solid	6010B SEP	51583
140-23190-6	B-G62L	Step 5	Solid	6010B SEP	51581
140-23190-6	B-G62L	Step 6	Solid	6010B SEP	51583
140-23190-6	B-G62L	Step 6	Solid	6010B SEP	51583
140-23190-7	B-G53S	Step 5	Solid	6010B SEP	51581
140-23190-7	B-G53S	Step 6	Solid	6010B SEP	51583
140-23190-7	B-G53S	Step 6	Solid	6010B SEP	51583
140-23190-8	B-G02S	Step 5	Solid	6010B SEP	51581
140-23190-8	B-G02S	Step 6	Solid	6010B SEP	51583
140-23190-8	B-G02S	Step 6	Solid	6010B SEP	51583
140-23190-9	B-G02L	Step 5	Solid	6010B SEP	51581
140-23190-9	B-G02L	Step 6	Solid	6010B SEP	51583
140-23190-9	B-G02L	Step 6	Solid	6010B SEP	51583
MB 140-51550/17-B ^5	Method Blank	Step 5	Solid	6010B SEP	51581
MB 140-51583/17-A	Method Blank	Step 6	Solid	6010B SEP	51583
LCS 140-51550/18-B ^5	Lab Control Sample	Step 5	Solid	6010B SEP	51581
LCS 140-51583/18-A	Lab Control Sample	Step 6	Solid	6010B SEP	51583

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QC Association Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Metals (Continued)

Analysis Batch: 51806 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCSD 140-51550/19-B ^5	Lab Control Sample Dup	Step 5	Solid	6010B SEP	51581
LCSD 140-51583/19-A	Lab Control Sample Dup	Step 6	Solid	6010B SEP	51583

Analysis Batch: 51840

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Step 7	Solid	6010B SEP	51609
140-23190-1	B-AP-1	Step 7	Solid	6010B SEP	51609
140-23190-2	B-G52S	Step 5	Solid	6010B SEP	51581
140-23190-2	B-G52S	Step 7	Solid	6010B SEP	51609
140-23190-2	B-G52S	Step 7	Solid	6010B SEP	51609
140-23190-2	B-G52S	Step 7	Solid	6010B SEP	51609
140-23190-3	B-G54L	Step 2	Solid	6010B SEP	51455
140-23190-3	B-G54L	Step 7	Solid	6010B SEP	51609
140-23190-3	B-G54L	Step 7	Solid	6010B SEP	51609
140-23190-3	B-G54L	Step 7	Solid	6010B SEP	51609
140-23190-3	B-G54L	Step 7	Solid	6010B SEP	51609
140-23190-4	B-G57L	Step 7	Solid	6010B SEP	51609
140-23190-4	B-G57L	Step 7	Solid	6010B SEP	51609
140-23190-4	B-G57L	Step 7	Solid	6010B SEP	51609
140-23190-4	B-G57L	Step 7	Solid	6010B SEP	51609
140-23190-5	B-G57S	Step 2	Solid	6010B SEP	51455
140-23190-5	B-G57S	Step 7	Solid	6010B SEP	51609
140-23190-5	B-G57S	Step 7	Solid	6010B SEP	51609
140-23190-5	B-G57S	Step 7	Solid	6010B SEP	51609
140-23190-5	B-G57S	Step 7	Solid	6010B SEP	51609
140-23190-6	B-G62L	Step 7	Solid	6010B SEP	51609
140-23190-6	B-G62L	Step 7	Solid	6010B SEP	51609
140-23190-6	B-G62L	Step 7	Solid	6010B SEP	51609
140-23190-7	B-G53S	Step 2	Solid	6010B SEP	51455
140-23190-7	B-G53S	Step 7	Solid	6010B SEP	51609
140-23190-7	B-G53S	Step 7	Solid	6010B SEP	51609
140-23190-7	B-G53S	Step 7	Solid	6010B SEP	51609
140-23190-7	B-G53S	Step 7	Solid	6010B SEP	51609
140-23190-8	B-G02S	Step 2	Solid	6010B SEP	51455
140-23190-8	B-G02S	Step 7	Solid	6010B SEP	51609
140-23190-8	B-G02S	Step 7	Solid	6010B SEP	51609
140-23190-8	B-G02S	Step 7	Solid	6010B SEP	51609
140-23190-8	B-G02S	Step 7	Solid	6010B SEP	51609
140-23190-9	B-G02L	Step 7	Solid	6010B SEP	51609
140-23190-9	B-G02L	Step 7	Solid	6010B SEP	51609
140-23190-9	B-G02L	Step 7	Solid	6010B SEP	51609
140-23190-9	B-G02L	Step 7	Solid	6010B SEP	51609
MB 140-51449/17-B ^3	Method Blank	Step 2	Solid	6010B SEP	51455
MB 140-51550/17-B ^5	Method Blank	Step 5	Solid	6010B SEP	51581
MB 140-51609/17-A	Method Blank	Step 7	Solid	6010B SEP	51609
LCS 140-51609/18-A	Lab Control Sample	Step 7	Solid	6010B SEP	51609
LCSD 140-51609/19-A	Lab Control Sample Dup	Step 7	Solid	6010B SEP	51609

Analysis Batch: 51841

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Total/NA	Solid	6010B	51423

QC Association Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Metals (Continued)

Analysis Batch: 51841 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Total/NA	Solid	6010B	51423
140-23190-2	B-G52S	Total/NA	Solid	6010B	51423
140-23190-2	B-G52S	Total/NA	Solid	6010B	51423
140-23190-2	B-G52S	Total/NA	Solid	6010B	51423
140-23190-3	B-G54L	Total/NA	Solid	6010B	51423
140-23190-3	B-G54L	Total/NA	Solid	6010B	51423
140-23190-3	B-G54L	Total/NA	Solid	6010B	51423
140-23190-3	B-G54L	Total/NA	Solid	6010B	51423
140-23190-4	B-G57L	Total/NA	Solid	6010B	51423
140-23190-4	B-G57L	Total/NA	Solid	6010B	51423
140-23190-4	B-G57L	Total/NA	Solid	6010B	51423
140-23190-5	B-G57S	Total/NA	Solid	6010B	51423
140-23190-5	B-G57S	Total/NA	Solid	6010B	51423
140-23190-5	B-G57S	Total/NA	Solid	6010B	51423
140-23190-6	B-G62L	Total/NA	Solid	6010B	51423
140-23190-6	B-G62L	Total/NA	Solid	6010B	51423
140-23190-6	B-G62L	Total/NA	Solid	6010B	51423
140-23190-6	B-G62L	Total/NA	Solid	6010B	51423
140-23190-7	B-G53S	Total/NA	Solid	6010B	51423
140-23190-7	B-G53S	Total/NA	Solid	6010B	51423
140-23190-7	B-G53S	Total/NA	Solid	6010B	51423
140-23190-7	B-G53S	Total/NA	Solid	6010B	51423
140-23190-8	B-G02S	Total/NA	Solid	6010B	51423
140-23190-8	B-G02S	Total/NA	Solid	6010B	51423
140-23190-8	B-G02S	Total/NA	Solid	6010B	51423
140-23190-9	B-G02L	Total/NA	Solid	6010B	51423
140-23190-9	B-G02L	Total/NA	Solid	6010B	51423
140-23190-9	B-G02L	Total/NA	Solid	6010B	51423
140-23190-9	B-G02L	Total/NA	Solid	6010B	51423
MB 140-51423/17-A	Method Blank	Total/NA	Solid	6010B	51423
LCS 140-51423/18-A	Lab Control Sample	Total/NA	Solid	6010B	51423
LCSD 140-51423/19-A	Lab Control Sample Dup	Total/NA	Solid	6010B	51423

Analysis Batch: 51877

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-2	B-G52S	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-3	B-G54L	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-4	B-G57L	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-5	B-G57S	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-6	B-G62L	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-7	B-G53S	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-8	B-G02S	Sum of Steps 1-7	Solid	6010B SEP	
140-23190-9	B-G02L	Sum of Steps 1-7	Solid	6010B SEP	

General Chemistry

Analysis Batch: 50473

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-1	B-AP-1	Total/NA	Solid	Moisture	
140-23190-2	B-G52S	Total/NA	Solid	Moisture	

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QC Association Summary

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

General Chemistry (Continued)

Analysis Batch: 50473 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23190-3	B-G54L	Total/NA	Solid	Moisture	
140-23190-4	B-G57L	Total/NA	Solid	Moisture	
140-23190-5	B-G57S	Total/NA	Solid	Moisture	
140-23190-6	B-G62L	Total/NA	Solid	Moisture	
140-23190-7	B-G53S	Total/NA	Solid	Moisture	
140-23190-8	B-G02S	Total/NA	Solid	Moisture	
140-23190-9	B-G02L	Total/NA	Solid	Moisture	
140-23190-3 DU	B-G54L	Total/NA	Solid	Moisture	

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-AP-1
Date Collected: 05/17/21 11:45
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: B-AP-1
Date Collected: 05/17/21 11:45
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-1
Matrix: Solid
Percent Solids: 58.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.514 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 14:44	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	3050B			0.514 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			51553	07/07/21 16:53	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:05	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 12:53	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:26	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 13:23	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:01	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 13:59	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 13:50	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 15:49	KNC	TAL KNX
	Instrument ID: DUO									

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Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-AP-1

Date Collected: 05/17/21 11:45
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-1

Matrix: Solid
Percent Solids: 58.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:07	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:02	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 14:56	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: B-G52S

Date Collected: 05/18/21 11:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-2

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: B-G52S

Date Collected: 05/18/21 11:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-2

Matrix: Solid
Percent Solids: 85.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.541 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 14:49	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:10	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 12:58	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			51841	07/18/21 15:06	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:31	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 13:28	KNC	TAL KNX
	Instrument ID: DUO									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G52S
Date Collected: 05/18/21 11:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-2
Matrix: Solid
Percent Solids: 85.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:06	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:04	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 13:55	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51840	07/17/21 12:08	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 15:55	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:12	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:07	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:01	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 16:45	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: B-G54L
Date Collected: 05/18/21 15:30
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G54L
Lab Sample ID: 140-23190-3
Date Collected: 05/18/21 15:30
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 83.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.549 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 14:54	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:15	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 13:03	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			51841	07/18/21 15:12	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			51841	07/18/21 15:17	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:36	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 13:33	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51840	07/17/21 11:04	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:10	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:09	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 14:01	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 16:00	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:17	KNC	TAL KNX
	Instrument ID: DUO									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G54L
Lab Sample ID: 140-23190-3
Date Collected: 05/18/21 15:30
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 83.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:12	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:06	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 16:50	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			51840	07/17/21 16:55	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: B-G57L
Lab Sample ID: 140-23190-4
Date Collected: 05/19/21 10:40
Matrix: Solid
Date Received: 05/21/21 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: B-G57L
Lab Sample ID: 140-23190-4
Date Collected: 05/19/21 10:40
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 79.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.515 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 14:59	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:20	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			51841	07/18/21 15:22	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			51841	07/18/21 16:22	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:41	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G57L
Lab Sample ID: 140-23190-4
Date Collected: 05/19/21 10:40
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 79.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 13:38	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:15	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		2			51768	07/14/21 15:47	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:14	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 14:06	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 16:04	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:22	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:17	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:11	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 17:00	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			51840	07/17/21 17:05	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: B-G57S
Lab Sample ID: 140-23190-5
Date Collected: 05/19/21 10:48
Matrix: Solid
Date Received: 05/21/21 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G57S
Date Collected: 05/19/21 10:48
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-5
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX

Client Sample ID: B-G57S
Date Collected: 05/19/21 10:48
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-5
Matrix: Solid
Percent Solids: 84.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.528 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:04	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:24	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 13:14	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			51841	07/18/21 15:26	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:45	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 14:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51840	07/17/21 11:09	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:20	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:18	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 14:11	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 16:09	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G57S

Date Collected: 05/19/21 10:48
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-5

Matrix: Solid
Percent Solids: 84.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:27	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:22	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:16	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 17:09	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			51840	07/17/21 17:14	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: B-G62L

Date Collected: 05/19/21 14:00
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-6

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: B-G62L

Date Collected: 05/19/21 14:00
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-6

Matrix: Solid
Percent Solids: 76.4

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.510 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:09	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:29	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 13:19	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			51841	07/18/21 15:31	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			51841	07/18/21 15:36	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G62L
Date Collected: 05/19/21 14:00
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-6
Matrix: Solid
Percent Solids: 76.4

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:50	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 14:26	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:25	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		2			51768	07/14/21 15:52	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:23	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 14:16	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 16:14	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:31	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:26	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 17:19	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G53S
Lab Sample ID: 140-23190-7
Date Collected: 05/19/21 16:15
Matrix: Solid
Date Received: 05/21/21 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: B-G53S
Lab Sample ID: 140-23190-7
Date Collected: 05/19/21 16:15
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 88.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.515 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:14	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:43	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 13:24	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			51841	07/18/21 15:57	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			51841	07/18/21 16:02	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:55	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 14:31	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51840	07/17/21 11:14	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:30	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:28	KNC	TAL KNX
	Instrument ID: DUO									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G53S

Date Collected: 05/19/21 16:15
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-7

Matrix: Solid
Percent Solids: 88.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 14:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 16:19	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:47	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:53	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:26	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 17:29	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			51840	07/17/21 17:43	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: B-G02S

Date Collected: 05/20/21 09:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-8

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: B-G02S

Date Collected: 05/20/21 09:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-8

Matrix: Solid
Percent Solids: 83.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.534 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:19	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:48	KNC	TAL KNX
	Instrument ID: DUO									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: B-G02S
Date Collected: 05/20/21 09:40
Date Received: 05/21/21 09:20

Lab Sample ID: 140-23190-8
Matrix: Solid
Percent Solids: 83.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 13:30	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			51841	07/18/21 16:07	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 12:10	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 14:46	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51840	07/17/21 11:19	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:45	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:43	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 14:35	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 16:34	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:52	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 13:58	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:31	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 17:48	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G02S
Lab Sample ID: 140-23190-8
Date Collected: 05/20/21 09:40
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 83.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			51840	07/17/21 17:53	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: B-G02L
Lab Sample ID: 140-23190-9
Date Collected: 05/20/21 10:30
Matrix: Solid
Date Received: 05/21/21 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			51877	07/19/21 15:03	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: B-G02L
Lab Sample ID: 140-23190-9
Date Collected: 05/20/21 10:30
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 78.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.519 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:24	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			51841	07/18/21 11:53	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 13:35	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			51841	07/18/21 16:11	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			51841	07/18/21 16:17	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 12:15	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 14:51	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 12:50	KNC	TAL KNX
	Instrument ID: DUO									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G02L
Lab Sample ID: 140-23190-9
Date Collected: 05/20/21 10:30
Matrix: Solid
Date Received: 05/21/21 09:20
Percent Solids: 78.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 14:48	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 14:40	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 16:39	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			51806	07/15/21 18:57	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			51840	07/17/21 14:03	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 15:36	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			51840	07/17/21 17:58	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			51840	07/17/21 18:02	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51236/21-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 11:36	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51421/17-B ^4
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51720	07/13/21 11:12	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51423/17-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 10:46	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51449/17-B ^3
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51720	07/13/21 13:08	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51840	07/17/21 10:54	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51456/17-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 11:46	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51499/17-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 13:44	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51550/17-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 13:36	KNC	TAL KNX
	Instrument ID: DUO									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51550/17-B ^5

Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51840	07/17/21 11:58	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51583/17-A

Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 15:35	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-51609/17-A

Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 12:43	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51236/22-A

Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	51236	06/25/21 10:16	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 11:40	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51421/18-B ^5

Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		5			51720	07/13/21 11:16	KNC	TAL KNX
	Instrument ID: DUO									

Electronic Filing: Received, Clerk's Office 06/20/2024

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51423/18-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 10:51	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51449/18-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		5			51720	07/13/21 13:13	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51456/18-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 11:51	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51499/18-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 13:49	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51550/18-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 13:41	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51583/18-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 15:40	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-51609/18-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 12:48	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51421/19-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51421	07/01/21 09:06	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51438	07/02/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		5			51720	07/13/21 11:21	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51423/19-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.00 g	50 mL	51423	07/02/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51841	07/18/21 10:56	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51449/19-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51449	07/02/21 09:00	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51455	07/02/21 14:02	JTB	TAL KNX
Step 2	Analysis	6010B SEP		5			51720	07/13/21 13:18	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51456/19-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5 g	25 mL	51456	07/06/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51501	07/07/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51768	07/14/21 11:56	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51499/19-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51499	07/07/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51551	07/08/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			51768	07/14/21 13:54	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51550/19-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51550	07/08/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51581	07/08/21 15:21	JTB	TAL KNX
Step 5	Analysis	6010B SEP		5			51806	07/15/21 13:45	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51583/19-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5 g	250 mL	51583	07/09/21 08:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			51806	07/15/21 15:45	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-51609/19-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1 g	50 mL	51609	07/12/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			51840	07/17/21 12:53	KNC	TAL KNX
	Instrument ID: DUO									

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Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Client Sample ID: B-G54L
Lab Sample ID: 140-23190-3 DU
Date Collected: 05/18/21 15:30
Matrix: Solid
Date Received: 05/21/21 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Electronic Filing: Received, Clerk's Office 06/20/2024

Accreditation/Certification Summary

Client: Golder Associates Inc.
Job ID: 140-23190-1
Project/Site: Duck Creek Power Station - Illinois

Laboratory: Eurofins TestAmerica, Knoxville

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
	AFCEE	N/A	
ANAB	Dept. of Defense ELAP	L2311	02-13-22
ANAB	Dept. of Energy	L2311.01	02-13-22
ANAB	ISO/IEC 17025	L2311	02-13-22
Arkansas DEQ	State	88-0688	06-17-21 *
California	State	2423	06-30-22
Colorado	State	TN00009	02-28-22
Connecticut	State	PH-0223	09-30-21
Florida	NELAP	E87177	06-30-22
Georgia (DW)	State	906	12-11-22
Hawaii	State	NA	12-11-21
Kansas	NELAP	E-10349	10-31-21
Kentucky (DW)	State	90101	12-31-21
Louisiana	NELAP	83979	06-30-22
Louisiana (DW)	State	LA019	12-31-21
Maryland	State	277	03-31-22
Michigan	State	9933	12-11-22
Nevada	State	TN00009	08-01-21
New Hampshire	NELAP	299919	01-17-22
New Jersey	NELAP	TN001	06-30-22
New York	NELAP	10781	03-31-22
North Carolina (DW)	State	21705	07-31-21
North Carolina (WW/SW)	State	64	12-31-21
Ohio VAP	State	CL0059	06-02-23
Oklahoma	State	9415	08-31-21
Oregon	NELAP	TNI0189	01-01-22
Pennsylvania	NELAP	68-00576	12-31-21
Tennessee	State	02014	12-11-22
Texas	NELAP	T104704380-18-12	08-31-21
US Fish & Wildlife	US Federal Programs	058448	07-31-21
USDA	US Federal Programs	P330-19-00236	08-20-22
Utah	NELAP	TN00009	07-31-21
Virginia	NELAP	460176	09-14-21
Washington	State	C593	01-19-22
West Virginia (DW)	State	9955C	01-02-22
West Virginia DEP	State	345	04-30-22
Wisconsin	State	998044300	08-31-21

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Electronic Filing: Received, Clerk's Office 06/20/2024

Method Summary

Client: Golder Associates Inc.
Project/Site: Duck Creek Power Station - Illinois

Job ID: 140-23190-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL KNX
6010B	SEP Metals (ICP) - Total	SW846	TAL KNX
6010B SEP	SEP Metals (ICP)	SW846	TAL KNX
Moisture	Percent Moisture	EPA	TAL KNX
3010A	Preparation, Total Metals	SW846	TAL KNX
3050B	Preparation, Metals	SW846	TAL KNX
Acid/Sulfide	Sequential Extraction Procedure, Acid/Sulfide Fraction	TAL-KNOX	TAL KNX
Carbonate	Sequential Extraction Procedure, Carbonate Fraction	TAL-KNOX	TAL KNX
Exchangeable	Sequential Extraction Procedure, Exchangeable Fraction	TAL-KNOX	TAL KNX
Metal Hydroxide	Sequential Extraction Procedure, Metal Hydroxide Fraction	TAL-KNOX	TAL KNX
Non-Crystalline	Sequential Extraction Procedure, Non-crystalline Materials	TAL-KNOX	TAL KNX
Organic-Bound	Sequential Extraction Procedure, Organic Bound Fraction	TAL-KNOX	TAL KNX
Residual	Sequential Extraction Procedure, Residual Fraction	TAL-KNOX	TAL KNX
Total	Preparation, Total Material	TAL-KNOX	TAL KNX

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And its Updates.

TAL-KNOX = TestAmerica Laboratories, Knoxville, Facility Standard Operating Procedure.

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Electronic Filing: Received, Clerk's Office 06/20/2024

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Phone: 865-291-3000 Fax: 865-584-4315

Chain of Custody Record

eurofins | Environment Testing America

Client Information	Sampler: Eric Schneider	Lab PM: Henry, Ryan	Carrier Tracking No(s):	COC No: 140-9342-2809.1
Client Contact: Jeffrey Ingram	Phone: 314-494-8192	E-Mail: williamr.henry@eurofinset.com	State of Origin:	Page: Page 1 of 2 1
Company: Golder Associates Inc.	PWSID:			Job #:
Address: 13515 Barrett Parkway Drive Suite 260	Due Date Requested:			
City: Ballwin	TAT Requested (days):			
State, Zip: MO, 63021	Compliance Project: Δ Yes Δ No			
Phone: 314-984-8800(Tel) 636-724-9323(Fax)	PO #: Purchase Order not required			
Email: Jeffrey_Ingram@golder.com	WO #:			
Project Name: Duck Creek Power Station - Illinois	Project #: 14006315			
Site: Duck Creek Power Station	SSOW#:			

Analysis Requested

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=wasteoil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010B_SEP - SEP Metals	6010B - Total Metals	Total Number of containers	Special Instructions/Note:
			Preservation Code:		X	X	N	N	X	
B-AP-1	5/17/21	1145	G	S	N	N	X	X		CUSTODY SEALS INTACT
B-652S	5/18/21	1130	G	S			X	X		RECEIVED AT RT 14/CTO.SC
B-654L	5/19/21	1530	G	S			X	X		6KD 5-21-21
B-657L	5/19/21	1040	G	S			X	X		1 COOLER FED X#1
B-657S	5/19/21	1048	G	S			X	X		7874 07529455 SD
B-662L	5/19/21	1400	G	S			X	X		
B-653S	5/19/21	1615	G	S			X	X		
B-607S	5/20/21	0940	G	S			X	X		
B-602L	5/20/21	1030	G	S			X	X		

140-23190 Chain of Custody

Possible Hazard Identification
☑ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☑ Disposal By Lab ☐ Archive For ____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Eric Schneider	5/20/21 1630	Golder Associates			
Eric Schneider	5/20/21 1630	Golder Associates			
[signature]	5/20/21 1630	Golder Associates	[signature]	5-21-21 TD-2 09:20	ETA KW X

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks: 5-21-21

Ver: 11/01/2020

Electronic Filing: Received, Clerk's Office 06/20/2024

Loc: 140
23190

EUROFINS/TESTAMERICA KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST **Log In Number:**

Review Items	Yes	No	NA	If No, what was the problem?
1. Are the shipping containers intact?	✓			☐ Containers, Broken
2. Were ambient air containers received intact?			✓	☐ Checked in lab
3. The coolers/containers custody seal if present, is it intact?	✓			☐ Yes ☐ NA
4. Is the cooler temperature within limits? (> freezing temp. of water to 6°C, VOST: 10°C) Thermometer ID : SC71 Correction factor: +0.1°C	✓			☐ Cooler Out of Temp, Client Contacted, Proceed/Cancel ☐ Cooler Out of Temp, Same Day Receipt
5. Were all of the sample containers received intact?	✓			☐ Containers, Broken
6. Were samples received in appropriate containers?	✓			☐ Containers, Improper; Client Contacted; Proceed/Cancel
7. Do sample container labels match COC? (IDs, Dates, Times)	✓			☐ COC & Samples Do Not Match ☐ COC Incorrect/Incomplete ☐ COC Not Received
8. Were all of the samples listed on the COC received?	✓			☐ Sample Received, Not on COC ☐ Sample on COC, Not Received
9. Is the date/time of sample collection noted?	✓			☐ COC; No Date/Time; Client Contacted
10. Was the sampler identified on the COC?	✓			☐ Sampler Not Listed on COC
11. Is the client and project name/# identified?	✓			☐ COC Incorrect/Incomplete
12. Are tests/parameters listed for each sample?	✓			☐ COC No tests on COC
13. Is the matrix of the samples noted?	✓			☐ COC Incorrect/Incomplete
14. Was COC relinquished? (Signed/Dated/Timed)	✓			☐ COC Incorrect/Incomplete
15. Were samples received within holding time?	✓			☐ Holding Time - Receipt
16. Were samples received with correct chemical preservative (excluding Encore)?			✓	☐ pH Adjusted, pH Included (See box 16A) ☐ Incorrect Preservative
17. Were VOA samples received without headspace?			✓	☐ Headspace (VOA only)
18. Did you check for residual chlorine, if necessary? (e.g. 1613B, 1668) Chlorine test strip lot number:			✓	☐ Residual Chlorine
19. For 1613B water samples is pH<9?			✓	☐ If no, notify lab to adjust
20. For rad samples was sample activity info. Provided?			✓	☐ Project missing info

Comments/Actions Taken

Labeling Verified by: **Date:**

pH test strip lot number:

	Box 16A: pH Preservation	Box 18A: Residual Chlorine
Preservative:		
Lot Number:		
Exp Date:		
Analyst:		
Date:		
Time:		

Project #: _____ PM Instructions: _____

Sample Receiving Associate: [signature] Date: 5·21·21

QA026R32.doc, 062719

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Document 14

Electronic Filing: Received, Clerk's Office 06/20/2024

Meade, Mallory

From: EPA.BOW.GWS.CCR
Sent: Monday, November 13, 2023 3:31 PM
To: Voelker, Brian; Hunt, Lauren; EPA.BOW.GWS.CCR
Cc: Morris, Phil; Fuller, Rhys; Modeer, Victor; Cravens, Stuart; Davies, Sam; Mitchell, David
Subject: RE: Duck Creek Power Plant ASD submittal notice

received. Thank you.

Lauren I. Hunt, M.S.
(she/they/he)
Environmental Protection Geologist III
Illinois Environmental Protection Agency
Bureau of Water
Groundwater Section
1021 N. Grand Avenue
PO Box 13
Springfield, IL 62702
D: 217-524-9048
C: 309-361-0037
Lauren.hunt@illinois.gov
Hours: 8:30 am to 5:30 pm Tuesday through Friday
8:30 am to 4 pm Mondays and alternating Mondays off
Working remotely Mondays and Fridays.

From: Voelker, Brian <Brian.Voelker@vistracorp.com>
Sent: Friday, November 10, 2023 11:35 AM
To: EPA.CCR.Part845.Coordinator <EPA.CCR.Part845.Coordinator@Illinois.gov>; EPA.CCR.Part845.Notify <EPA.CCR.Part845.Notify@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>; EPA.BOW.GWS.CCR <EPA.BOW.GWS.CCR@Illinois.gov>
Cc: Morris, Phil <Phil.Morris@vistracorp.com>; Fuller, Rhys <Rhys.Fuller@vistracorp.com>; Modeer, Victor <Victor.Modeer@vistracorp.com>; Cravens, Stuart <Stuart.Cravens@txu.com>; Davies, Sam <SAMANTHA.DAVIES@vistracorp.com>; Mitchell, David <David.Mitchell@vistracorp.com>
Subject: [External] Duck Creek Power Plant ASD submittal notice

As a courtesy this email is to provide notice that an ASD for the Duck Creek Power Plant GMF Pond was submitted/delivered to IEPA via FedEx on November 10, 2023, to the address provided below.

Illinois Environmental Protection Agency
Bureau of Water Permit Section #15
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794

It was also placed on the Luminant CCR public website, and you can access a copy there. The link below will take you to the website.
https://www.luminant.com/ccr/illinois-ccr/?dir=il-ccr%2FDuck-Creek%2F2023

Please let me know if you have questions or concerns.

Thanks,
Brian

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Document 15

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Voelker, Brian
To: EPA.CCR.Part845.Coordinator
Subject: [External] RE: Duck Creek/Hennepin Power Plant ASD submittal notice
Date: Tuesday, November 14, 2023 9:49:13 AM

Hello Josiah,
The Hennepin WAPS and Duck Creek GMF Pond ASDs were both sent via FedEx next day air on Thursday, November 9 with delivery scheduled before 10:30am Friday morning.
I received email notification on Monday that both were delivered. I have no idea why FedEx did not deliver on Friday as we selected and paid for next day air service.

The FedEx tracking numbers are:
Hennepin WAPS - 774057520028
Duck Creek GMF Pond – 774053052491

These are also available on the public website. The link is below. To view the ASDs go to the site, then select 2023 folder.
https://www.luminant.com/ccr/illinois-ccr/

Please let me know if you need anything else.

Thanks,
Brian

From: EPA.CCR.Part845.Coordinator <EPA.CCR.Part845.Coordinator@Illinois.gov>
Sent: Tuesday, November 14, 2023 8:58 AM
To: Voelker, Brian <Brian.Voelker@vistracorp.com>
Subject: RE: Duck Creek/Hennepin Power Plant ASD submittal notice

EXTERNAL EMAIL

Good morning Brian,

I have not received the hard copy for either of these locations. Did you happen to have a tracking number for these? Since it was sent by FedEx, I can look it up and see who checked it in. Thank you.

~Josiah

From: Voelker, Brian <Brian.Voelker@vistracorp.com>
Sent: Friday, November 10, 2023 11:35 AM
To: EPA.CCR.Part845.Coordinator <EPA.CCR.Part845.Coordinator@Illinois.gov>; EPA.CCR.Part845.Notify <EPA.CCR.Part845.Notify@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>; EPA.BOW.GWS.CCR <EPA.BOW.GWS.CCR@Illinois.gov>
Cc: Morris, Phil <Phil.Morris@vistracorp.com>; Fuller, Rhys <Rhys.Fuller@vistracorp.com>; Modeer, Victor <Victor.Modeer@vistracorp.com>; Cravens, Stuart <Stuart.Cravens@txu.com>; Davies, Sam

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<SAMANTHA.DAVIES@vistracorp.com>; Mitchell, David <David.Mitchell@vistracorp.com>
Subject: [External] Duck Creek Power Plant ASD submittal notice

As a courtesy this email is to provide notice that an ASD for the Duck Creek Power Plant GMF Pond was submitted/delivered to IEPA via FedEx on November 10, 2023, to the address provided below.

Illinois Environmental Protection Agency
Bureau of Water Permit Section #15
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794

It was also placed on the Luminant CCR public website, and you can access a copy there. The link below will take you to the website.
https://www.luminant.com/ccr/illinois-ccr/?dir=il-ccr%2FDuck-Creek%2F2023

Please let me know if you have questions or concerns.

Thanks,
Brian

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Document 16

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Voelker, Brian
To: Seif, Josiah
Subject: [External] RE: Duck Creek/Hennepin Power Plant ASD submittal notice
Date: Tuesday, November 14, 2023 11:07:40 AM

Good to hear, thanks for the follow up.

I do recommend we set up some kind of SharePoint site to easily transfer large files electronically.

Thanks,
Brian

From: Seif, Josiah <Josiah.Seif@Illinois.gov>
Sent: Tuesday, November 14, 2023 10:40 AM
To: Voelker, Brian <Brian.Voelker@vistracorp.com>
Subject: RE: Duck Creek/Hennepin Power Plant ASD submittal notice

EXTERNAL EMAIL

Brian,

I have located the hard copies of the submitted ASD's for Duck Creek and Hennepin. They ended up in a different area, so I just had to do some backtracking. Located though. Thank you.

~Josiah

From: Voelker, Brian <Brian.Voelker@vistracorp.com>
Sent: Tuesday, November 14, 2023 10:00 AM
To: Seif, Josiah <Josiah.Seif@Illinois.gov>
Subject: [External] RE: Duck Creek/Hennepin Power Plant ASD submittal notice

I have electronic versions, but the files are too large to send via email. We need to setup a SharePoint site where I can transfer ASDs and other reports?

A SharePoint site will also be useful for the 2023 annual part 845 consolidated report due by end of Jan 24. Is this something you can setup and send me a link to?

Thanks,
Brian

From: Seif, Josiah <Josiah.Seif@Illinois.gov>
Sent: Tuesday, November 14, 2023 9:54 AM
To: Voelker, Brian <Brian.Voelker@vistracorp.com>
Subject: RE: Duck Creek/Hennepin Power Plant ASD submittal notice

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EXTERNAL EMAIL

Brian,

Friday would have been a holiday in the office. If it was delivered, I am unsure who it would have been delievered to. I will look into this and see what happened to the documents. They did not arrive in the usual location on Monday morning. Will have to track down the documents. Do you happen to have the digital copy for the Duck Creek ASD? Thank you.

~Josiah

From: Voelker, Brian <Brian.Voelker@vistracorp.com>
Sent: Tuesday, November 14, 2023 9:49 AM
To: EPA.CCR.Part845.Coordinator <EPA.CCR.Part845.Coordinator@Illinois.gov>
Subject: [External] RE: Duck Creek/Hennepin Power Plant ASD submittal notice

Hello Josiah,
The Hennepin WAPS and Duck Creek GMF Pond ASDs were both sent via FedEx next day air on Thursday, November 9 with delivery scheduled before 10:30am Friday morning.
I received email notification on Monday that both were delivered. I have no idea why FedEx did not deliver on Friday as we selected and paid for next day air service.

The FedEx tracking numbers are:
Hennepin WAPS - 774057520028
Duck Creek GMF Pond – 774053052491

These are also available on the public website. The link is below. To view the ASDs go to the site, then select 2023 folder.
https://www.luminant.com/ccr/illinois-ccr/

Please let me know if you need anything else.

Thanks,
Brian

From: EPA.CCR.Part845.Coordinator <EPA.CCR.Part845.Coordinator@Illinois.gov>
Sent: Tuesday, November 14, 2023 8:58 AM
To: Voelker, Brian <Brian.Voelker@vistracorp.com>
Subject: RE: Duck Creek/Hennepin Power Plant ASD submittal notice

EXTERNAL EMAIL

Good morning Brian,

Electronic Filing: Received, Clerk's Office 06/20/2024

I have not received the hard copy for either of these locations. Did you happen to have a tracking number for these? Since it was sent by FedEx, I can look it up and see who checked it in. Thank you.

~Josiah

From: Voelker, Brian <Brian.Voelker@vistracorp.com>
Sent: Friday, November 10, 2023 11:35 AM
To: EPA.CCR.Part845.Coordinator <EPA.CCR.Part845.Coordinator@Illinois.gov>; EPA.CCR.Part845.Notify <EPA.CCR.Part845.Notify@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>; EPA.BOW.GWS.CCR <EPA.BOW.GWS.CCR@Illinois.gov>
Cc: Morris, Phil <Phil.Morris@vistracorp.com>; Fuller, Rhys <Rhys.Fuller@vistracorp.com>; Modeer, Victor <Victor.Modeer@vistracorp.com>; Cravens, Stuart <Stuart.Cravens@txu.com>; Davies, Sam <SAMANTHA.DAVIES@vistracorp.com>; Mitchell, David <David.Mitchell@vistracorp.com>
Subject: [External] Duck Creek Power Plant ASD submittal notice

As a courtesy this email is to provide notice that an ASD for the Duck Creek Power Plant GMF Pond was submitted/delivered to IEPA via FedEx on November 10, 2023, to the address provided below.

Illinois Environmental Protection Agency
Bureau of Water Permit Section #15
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794

It was also placed on the Luminant CCR public website, and you can access a copy there. The link below will take you to the website.
https://www.luminant.com/ccr/illinois-ccr/?dir=il-ccr%2FDuck-Creek%2F2023

Please let me know if you have questions or concerns.

Thanks,
Brian

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Document 17

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Hunt, Lauren
To: Dunaway, Lynn
Subject: Joppa ASD letter
Date: Thursday, November 16, 2023 9:02:52 AM
Attachments: Draft ASD JEAP NonConcurrence letter Oct 2023.docx

---

Here you go

Lauren I. Hunt, M.S.
(she/they/he)
Environmental Protection Geologist III
Illinois Environmental Protection Agency
Bureau of Water
Groundwater Section
1021 N. Grand Avenue
PO Box 13
Springfield, IL 62702
D: 217-524-9048
C: 309-361-0037
Lauren.hunt@illinois.gov
Hours: 8:30 am to 5:30 pm Tuesday through Friday
8:30 am to 4 pm Mondays and alternating Mondays off
Working remotely Mondays and Fridays.

State of Illinois - CONFIDENTIALITY NOTICE: The information contained in this communication is confidential, may be attorney-client privileged or attorney work product, may constitute inside information or internal deliberative staff communication, and is intended only for the use of the addressee. Unauthorized use, disclosure or copying of this communication or any part thereof is strictly prohibited and may be unlawful. If you have received this communication in error, please notify the sender immediately by return e-mail and destroy this communication and all copies thereof, including all attachments. Receipt by an unintended recipient does not waive attorney-client privilege, attorney work product privilege, or any other exemption from disclosure.

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

217-782-1020

June 11, 2024

Dianna Tickner
Electric Energy, Inc.
1500 Eastport Plaza drive
Collinsville, Illinois 62234

Re: Joppa Power Plant East Ash Pond; W1270100004-02
Alternative Source Demonstration Submittal

Dear Ms. Tickner:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Joppa East Ash Pond Alternative Source Demonstration (ASD) dated October 21, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the East Ash Pond must include total solids sampling in accordance with SW846.
    a. 35 IAC 845.650(e) states "the owner or operator of a CCRSI may…submit a demonstration to the Agency that a source other than the CCRSI caused the contamination and the CCRSI did not contribute to the contamination… Either type of ASD must include a report that contains the factual or evidentiary basis for any conclusions…"
        i. The Illinois EPA cannot concur with ASDs that do not include source characterization of the CCR with adequate sampling and analysis of the CCR which must characterize the CCR horizontally and vertically within the CCRSI.
2. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.
    a. 35 IAC 845.640(a) requires evidence of field collection methods and field and laboratory quality control and quality assurance.
    b. 35 IAC 845.650(e) requires alternative source data as evidence of the alternative source, see item 1(a)(i) above. SW846 chapter 1, incorporated by reference in 35 IAC 845, states that regulatory decisions must be made with environmental data.

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If you have any questions, please contact: **Lauren Hunt** Illinois EPA, Bureau of Water, WPC #15, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Lauren Hunt
Keegan MacDonna
WPC Files 06M
Jenny Cassel, EARTHJUSTICE

Electronic Filing: Received, Clerk's Office 06/20/2024

Document 19

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Hunt, Lauren
To: Summers, Michael
Cc: Dunaway, Lynn; Mullenax, Heather; Garee, Matthew J.; Bierwagen, Justin
Subject: Joppa ASD Non Concurrence Letter
Date: Thursday, November 16, 2023 9:08:12 AM
Attachments: Final ASD JEAP NonConcurrence letter Oct 2023.docx

Hi Mike.
We need this signed and sent off today. I will stop by with a printed copy shortly.
Thanks,
Lauren

Lauren I. Hunt, M.S.
(she/they/he)
Environmental Protection Geologist III
Illinois Environmental Protection Agency
Bureau of Water
Groundwater Section
1021 N. Grand Avenue
PO Box 13
Springfield, IL 62702
D: 217-524-9048
C: 309-361-0037
Lauren.hunt@illinois.gov
Hours: 8:30 am to 5:30 pm Tuesday through Friday
8:30 am to 4 pm Mondays and alternating Mondays off
Working remotely Mondays and Fridays.

State of Illinois - CONFIDENTIALITY NOTICE: The information contained in this communication is confidential, may be attorney-client privileged or attorney work product, may constitute inside information or internal deliberative staff communication, and is intended only for the use of the addressee. Unauthorized use, disclosure or copying of this communication or any part thereof is strictly prohibited and may be unlawful. If you have received this communication in error, please notify the sender immediately by return e-mail and destroy this communication and all copies thereof, including all attachments. Receipt by an unintended recipient does not waive attorney-client privilege, attorney work product privilege, or any other exemption from disclosure.

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Document 20

Electronic Filing: Received, Clerk's Office 06/20/2024

Meade, Mallory

From: Hunt, Lauren
Sent: Thursday, November 16, 2023 10:15 AM
To: Garee, Matthew J.
Cc: Dunaway, Lynn
Subject: Duck Creek ASD Response Letter

Hi Matt.
I am going to have you draft the letter for Duck Creek ASD. I will need it drafted and to me by November 29th. I will provide comments on the 1st or 5th and then we can send to Lynn on the 5th for review.
I am out of the office on the 30th and working from home on the 1st. I will be taking you along with me for the mailing process on the 7th.
Thanks. Lauren

Lauren I. Hunt, M.S.
(she/they/he)
Environmental Protection Geologist III
Illinois Environmental Protection Agency
Bureau of Water
Groundwater Section
1021 N. Grand Avenue
PO Box 13
Springfield, IL 62702
D: 217-524-9048
C: 309-361-0037
Lauren.hunt@illinois.gov
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Working remotely Mondays and Fridays.

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Document 21

Electronic Filing: Received, Clerk's Office 06/20/2024

Meade, Mallory

Subject: Matt to hand in Duck Creek ASD Letter

Start: Wed 11/29/2023 4:00 PM
End: Wed 11/29/2023 4:30 PM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Organizer: Hunt, Lauren
Required Attendees: Garee, Matthew J.

Putting this here as a reminder.
Thanks, Lauren

Electronic Filing: Received, Clerk's Office 06/20/2024

Document 22

Electronic Filing: Received, Clerk's Office 06/20/2024

Meade, Mallory

Subject: Matt and Justin to hand in ASD Letters

Start: Wed 11/29/2023 4:00 PM
End: Wed 11/29/2023 4:30 PM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Organizer: Hunt, Lauren
Required Attendees: Garee, Matthew J.; Bierwagen, Justin; Mullenax, Heather

Putting this here as a reminder.
Heather will review Justin's draft of Hennepin and I will review Matt's draft of Duck Creek. We will need a few days. Intention is to get letters to Lynn by COB on the 5th. Letters will be mailed by the 7th.
Thanks, Lauren

State of Illinois - CONFIDENTIALITY NOTICE: The information contained in this communication is confidential, may be attorney-client privileged or attorney work product, may constitute inside information or internal deliberative staff communication, and is intended only for the use of the addressee. Unauthorized use, disclosure or copying of this communication or any part thereof is strictly prohibited and may be unlawful. If you have received this communication in error, please notify the sender immediately by return e-mail and destroy this communication and all copies thereof, including all attachments. Receipt by an unintended recipient does not waive attorney-client privilege, attorney work product privilege, or any other exemption from disclosure.

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Electronic Filing: Received, Clerk's Office 06/20/2024

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

217-782-1020

June 11, 2024

Dianna Tickner
Electric Energy, Inc.
1500 Eastport Plaza drive
Collinsville, Illinois 62234

Re: Joppa Power Plant East Ash Pond; W1270100004-02
Alternative Source Demonstration Submittal

Dear Ms. Tickner:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Joppa East Ash Pond Alternative Source Demonstration (ASD) dated October 21, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the East Ash Pond must include total solids sampling in accordance with SW846.
    a. 35 IAC 845.650(e) states "the owner or operator of a CCRSI may…submit a demonstration to the Agency that a source other than the CCRSI caused the contamination and the CCRSI did not contribute to the contamination… Either type of ASD must include a report that contains the factual or evidentiary basis for any conclusions…"
        i. The Illinois EPA cannot concur with ASDs that do not include source characterization of the CCR with adequate sampling and analysis of the CCR which must characterize the CCR horizontally and vertically within the CCRSI.
2. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.
    a. 35 IAC 845.640(a) requires evidence of field collection methods and field and laboratory quality control and quality assurance.
    b. 35 IAC 845.650(e) requires alternative source data as evidence of the alternative source, see item 1(a)(i) above. SW846 chapter 1, incorporated by reference in 35 IAC 845, states that regulatory decisions must be made with environmental data.

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If you have any questions, please contact: **Lauren Hunt** Illinois EPA, Bureau of Water, WPC #15, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Lauren Hunt
Keegan MacDonna
Records Files 06M
Jenny Cassel, EARTHJUSTICE

Electronic Filing: Received, Clerk's Office 06/20/2024

Document 24

Electronic Filing: Received, Clerk's Office 06/20/2024

Meade, Mallory

Subject: Mail Duck Creek ASD Letter

Start: Thu 12/7/2023 9:00 AM
End: Thu 12/7/2023 9:05 AM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Organizer: Hunt, Lauren
Required Attendees: Dunaway, Lynn; Summers, Michael; Seif, Josiah; Garee, Matthew J.; Rompot, Derek

Lauren to Coordinate Letter signing with Mike Summers.

Duck Creek ASD Response Letter to include any comments from the Public response per Lynn and Mike.

Check with Derek and Josiah for public comments received. Letter to be provided to Sherri for mailing by 1 pm.

Electronic Filing: Received, Clerk's Office 06/20/2024

Document 25

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Seif, Josiah
To: EPA.BOW.GWS.CCR; Liska, Mark
Cc: Summers, Michael; Dunaway, Lynn; Rompot, Derek
Subject: 3rd Qtr. 2023, Duck Creek - Gypsum Management Facility(2022-EO-67783)
Date: Tuesday, November 28, 2023 12:58:33 PM

Hard copy of the **3rd Qtr. 2023, Duck Creek - Gypsum Management Facility(2022-EO-67783)**, has been received, scanned to the N:Drive, and hard copy placed in the Impoundment. If you have any questions, please feel free to ask.

Thank you,

Josiah M. Seif

Josiah M. Seif
CCR Office Coordinator
Bureau of Water
Illinois Environmental Protection Agency
217-782-0610
Josiah.Seif@illinois.gov

State of Illinois - CONFIDENTIALITY NOTICE: The information contained in this communication is confidential, may be attorney-client privileged or attorney work product, may constitute inside information or internal deliberative staff communication, and is intended only for the use of the addressee. Unauthorized use, disclosure or copying of this communication or any part thereof is strictly prohibited and may be unlawful. If you have received this communication in error, please notify the sender immediately by return e-mail and destroy this communication and all copies thereof, including all attachments. Receipt by an unintended recipient does not waive attorney-client privilege, attorney work product privilege, or any other exemption from disclosure.

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Document 26

Electronic Filing: Received, Clerk's Office 06/20/2024

From:	Jenny Cassel
To:	EPA.BOW.GWS.CCR@illinois.gov
Cc:	arehn; Faith Bugel; Mychal Ozaeta; Lauren Piette
Subject:	[External] Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek
Date:	Tuesday, November 28, 2023 2:08:46 PM
Attachments:	FINAL Earthjustice, PRN and SC comments on ASDs for Hennepin and Duck Creek 11.28.23.pdf

Ms. Mullenax and others it may concern,

Please see attached comments concerning the ASDs for Hennepin and Duck Creek. We appreciate your consideration of those comments and would be grateful to receive a copy of EPA's concurrence or denial of concurrence with those ASDs.

Best,
Jenny Cassel

Jenny Cassel
Senior Attorney, Clean Energy Program
Earthjustice
311 S. Wacker Drive, Suite 1400
Chicago, IL 60606
T: 312-500-2198 (direct)
jcassel@earthjustice.org

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Document 27

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November 28, 2023

Heather Mullenax and Groundwater Section staff
Illinois Environmental Protection Agency
EPA.BOW.GWS.CCR@illinois.gov

RE: Public Comments on Alternative Source Demonstrations for Hennepin West Ash Pond System and Duck Creek surface impoundments

Dear Ms. Mullenax and other Groundwater Section staff,

Pursuant to 35 I.A.C. § 845.650(e)(3), Earthjustice, Prairie Rivers Network, and Sierra Club (collectively, "Commenters") respectfully submit these public comments concerning the "alternative source demonstrations" submitted for the Hennepin and Duck Creek facilities.

Under the Part 845 rules, an alternative source demonstration ("ASD") is a:

> demonstration . . . that a source other than the CCR surface impoundment caused the contamination and the CCR surface impoundment *did not contribute* to the contamination, or that the exceedance . . . resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in potentiometric surface and groundwater flow direction.

35 I.A.C. § 845.650(e) (emphasis added).

Commenters urge Illinois EPA ("IEPA" or "the Agency") to deny the ASDs for two reasons. First, as explained below, IEPA should deny the ASDs due to the lack of an approved groundwater monitoring program at the sites under Part 845. Second, IEPA should deny the ASD for Hennepin because omissions in documentation submitted for the site render the purported "demonstration" inadequate to bypass corrective action mandates for cadmium.

First, IEPA should deny the ASDs for Hennepin and Duck Creek because IEPA has not yet, for either of these facilities, issued an operating permit that sets out an approved groundwater monitoring program. Without an approved groundwater monitoring program, the Agency cannot make a supported decision that the purported "demonstration" in fact establishes that the impoundment has not contributed to the contamination.

An approved groundwater monitoring program – which includes appropriate locations, depths, and number of background and downgradient monitoring wells, as well as satisfactory sampling procedures and determinations of which wells accurately represent "background" groundwater quality – is an essential prerequisite for any ASD. Without an approved program, owners/operators may be engaging in a variety of erroneous monitoring practices that result in contamination from the CCR surface impoundment not being fully detected or characterized. Among other flaws, owners or operators may have set up a groundwater monitoring system that is missing contaminant pathways; treating CCR-contaminated wells as "background" wells, resulting in pollution associated with the CCR surface impoundment improperly not being

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classified as an exceedance; or failing to account for "mounding" or other hydrogeological characteristics that affect groundwater flow direction. **In short, without an IEPA-approved program properly revealing what contamination is coming from a CCR surface impoundment, there is insufficient information for IEPA to determine—or for owners/operators to demonstrate—that pollution is NOT coming from the impoundment**.

Our concerns about serious flaws in groundwater monitoring performed by industry, absent review and approval (after public comment) from the Agency, are far from hypothetical. USEPA has reviewed the groundwater monitoring systems of multiple CCR surface impoundments – including one here in Illinois[1] – and found, or proposed to find, numerous grave errors in how that monitoring is being carried out.

Many of these evaluations have come in the form of USEPA's review of owners/operators' "Part A" applications. To obtain an extension of the deadline to cease receipt of CCR in a CCR surface impoundment that is required to close, owners/operators were required to demonstrate, among other things, full compliance with the CCR rule at the entire facility where the CCR surface impoundment is located.[2] As of this writing, USEPA has issued thirteen proposed decisions on Part A applications, one of which it finalized.[3] It evaluated compliance with the groundwater monitoring mandates of the CCR rule at eight of those facilities.[4]

At *every* site that USEPA reviewed as part of its Part A evaluations, it identified serious problems with facilities' groundwater monitoring systems:

- At the Gavin coal-fired power plant, USEPA found that the owner/operator failed to thoroughly characterize groundwater flow direction, failed to properly establish background wells, and lacked adequate downgradient wells, among other flaws.[5]

- At the Waukegan plant, USEPA proposed to find that Midwest Generation did not properly characterize groundwater flow direction, lacked sufficient wells to fully monitor potential contamination, improperly used "intrawell" statistical analysis of monitoring results, and used improper "background" wells that were dug through CCR.[6]

[1] *See* https://www.epa.gov/coalash/coal-combustion-residuals-ccr-part-implementation (noting proposed denial of Waukegan "Part A" application, with link to proposed denial).
[2] USEPA, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure, 85 Fed. Reg. 53,516 (Aug. 28, 2020).
[3] *See* https://www.epa.gov/coalash/coal-combustion-residuals-ccr-part-implementation (listing CCR surface impoundments for which USEPA has issued proposed and final decisions).
[4] *See id*. (noting proposed decisions, including complete and incomplete or ineligible applications).
[5] *See* final Gavin Part A decision at 45-54 and 70-76, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2021-0590-0100.
[6] *See* proposed Waukegan Part A decision at 31-47, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2023-0209-0001.

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- At the Ottumwa, Clifty Creek, and Spurlock plants, USEPA proposed to find that, among other deficiencies, the groundwater monitoring wells were too far apart or not properly sited, leaving potential contaminant pathways unmonitored.[7]

- At A.B. Brown, USEPA proposed to find, among other concerns, that the groundwater monitoring wells were not placed in sufficient locations to detect all potential contaminant pathways, that groundwater flow characterization was inadequate, and samples were improperly evaluated using "intrawell" statistical analysis.[8]

- At Mountaineer, USEPA proposed to find, among other flaws, that the company did not appropriately locate either background or downgradient wells, and improperly analyzed groundwater monitoring data, including by excluding so-called "outlier" data and by using intrawell analysis.[9]

- At the Calaveras plant, USEPA proposed to find, among other flaws, that groundwater monitoring wells are improperly spaced, inadequate in number, and not located at the waste boundary, and the company did not appropriately identify background wells.[10]

USEPA has likewise identified severe deficiencies in the groundwater monitoring programs at multiple CCR facilities in Alabama[11] and at one facility in Kansas to which it sent a letter summarizing conversations regarding compliance concerns.[12] In effect, *every time* USEPA has taken a close look at the groundwater monitoring program for a CCR surface impoundment or landfill, it has identified deficiencies that could lead to contamination from those CCR units being released undetected. There is no reason to believe those deficiencies are limited to sites outside of Illinois; indeed, as noted, one facility where USEPA found those deficiencies is the Waukegan plant. Until IEPA fulfills the critical oversight role assigned to it by the Coal Ash Pollution Prevention Act and Part 845, namely, it has reviewed and approved groundwater monitoring programs for Hennepin and Duck Creek, **ASDs for those sites should be denied**.

IEPA should also deny the ASD for Hennepin because site-specific concerns identified by IEPA underscore the inadequacy of groundwater monitoring at that site. In evaluating Dynegy's operating permit application for Hennepin, IEPA identified flaws in the hydrogeologic

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[7] *See* proposed Ottumwa Part A decision at 43-46, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2021-0593-0002; proposed Clifty Creek Part A decision at 44-45, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2021-0587-0023; and proposed Spurlock Part A decision at 55-56, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2021-0595-0002;

[8] *See* proposed A.B. Brown Part A decision at 31-47, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2022-0335-0001.

[9] *See* proposed Mountaineer Part A decision at 33-48, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2021-0842-0001.

[10] See proposed Calaveras Part A decision at 47-55, available at https://www.regulations.gov/document/EPA-HQ-OLEM-2022-0333-0001.

[11] Alabama: Denial of State Coal Combustion Residuals Permit Program, 88 Fed. Reg. 55,220, 55,239 - 55,241, 55,249 - 55,253, 55,260 - 55,267, and 55,271 - 55,272 (Aug. 14, 2023).

[12] USEPA, Letter re: Notice of Potential Violations/Opportunity to Confer, Tecumseh Energy Center, Tecumseh, Kansas, Enclosure 1 at 1-4 (Jan. 2021), attached hereto.

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site characterization for the Old West Ash Pond ("OWAP") and Old West Polishing Pond ("OWPP"), which make up the West Ash Pond System at the site.[13] Specifically, IEPA noted that the hydrogeologic site characterization fails to adequately identify potential migration pathways and does not include seasonal and temporal fluctuations in groundwater flow.[14]

Commenters reserve the right to provide additional comment on these or any other ASDs for Hennepin or Duck Creek once approved groundwater monitoring systems, set out in IEPA-approved operating permits, are in place.

Thank you kindly for taking these comments into consideration.

Best,



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On behalf of Earthjustice

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On behalf of Sierra Club

[13] See Dynegy Midwest Generation, Alternate Source Demonstration submittal for Hennepin West Ash Pond System (Nov. 10, 2023) at 4/11, pdf p. 7.
[14] IEPA Letter to Dynegy Midwest Generation, LLC, Re: Dynegy Midwest Generation, LLC – Hennepin Power Plnat, Initial Reviwe Letter – Part 845 Construction/Operating Permit Application(s), at 3 (Oct. 11, 2023).

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From: Dunaway, Lynn
To: Hunt, Lauren
Subject: FW: VN Response: Electric Energy, Inc (Joppa East) - W-2023-50186
Date: Thursday, November 30, 2023 3:04:37 PM
Attachments: 2023_11_30_PT_350186.pdf
Importance: High

In response to Tim's question below, I would assume we should invite Mike Brown? My understanding is he's supposed to become fully knowledgeable about the CCR program, so he may as well be shoved into the deep end of the CCRSI. Maybe when the full extent of CCR is more obvious to him, additional staff for all the other duties we have won't be such a bad idea.

From: Bejster, Timothy <Timothy.Bejster@Illinois.gov>
Sent: Thursday, November 30, 2023 1:29 PM
To: Hunt, Lauren <Lauren.Hunt@Illinois.gov>; Mullenax, Heather <Heather.Mullenax@Illinois.gov>
Cc: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>; Neibergall, Gabriel <Gabriel.Neibergall@illinois.gov>
Subject: VN Response: Electric Energy, Inc (Joppa East) - W-2023-50186
Importance: High

Attached is the response letter for Electric Energy, Inc – W-2023-50186. They have requested a meeting to discuss their proposed CCA.

Please have your calendars updated, and let me know who needs to attend (besides Gabe).

Thanks,

TIM BEJSTER
Illinois Environmental Protection Agency
Bureau of Water
Compliance Assurance Section
217-524-6672
Timothy.Bejster@Illinois.gov

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November 30, 2023

VIA E-MAIL AND CERTIFIED MAIL

Illinois EPA – Division of Water Pollution Control
Attn: Tim Bejster
P.O. Box 19276
Springfield, IL 62794-9276
Timothy.bejster@illinois.gov

Re: Response to Violation Notice No. W-2023-50186 (Settlement Confidential Communication)

Dear Mr. Bejster:

I write on behalf of Electric Energy, Inc. ("EEI") pursuant to 415 ILCS 5/31 and in response to the above-referenced Illinois Environmental Protection Agency ("IEPA" or the "Agency") violation notice ("VN"), received by EEI on October 16, 2023.

While EEI does not agree with the violations alleged in the notice, it nonetheless wishes to come to a mutually agreeable resolution of the VN with the Agency. Accordingly, below EEI explains why the violations alleged in the VN are without merit, but also proposes terms for a compliance commitment agreement ("CCA") with the Agency to address and resolve the VN allegations.

Background

The VN alleges violations of the 35 Ill. Admin. Code 845.600(a) Groundwater Protection Standards ("GWPS") for boron, arsenic, lead, cobalt and pH. It also alleges violations of 415 ILCS 5/12(a) and the groundwater quality standards ("GWQSs") in 35 Ill. Admin. Code 620.410(a) and (e) for boron, pH, lead and iron. The alleged violations are based on sampling conducted as part of Joppa Power Station East Ash Pond's ("Joppa EAP's") Supplemental Site Investigation to assess the nature, degree and extent of boron groundwater impacts downgradient of the Joppa EAP.

EEI submitted an operating permit application for the Joppa EAP, including a proposed groundwater monitoring plan, to IEPA on October 25, 2021. The groundwater monitoring plan identifies a network of 14 monitoring wells (two background and 12 downgradient) to be used to monitor for exceedances of the 845.600(a) GWPSs at the Joppa EAP waste boundary. *See* October 21, 2021 Operating Permit Application for Joppa East Ash Pond, Attachment I (Groundwater Monitoring Plant) at Table 2-1. The downgradient wells in the monitoring

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network are G03, G05, G06, G07, G08, G09, G10, G11, G51D, G52D, G53D, and G54D (the "waste boundary wells"). These monitoring wells are not the subject of the VN.

In its operating permit application, EEI also identified historical levels of boron above the GWPSs at the waste boundary of the Joppa EAP. Evidence indicated that the Joppa EAP could be contributing to those exceedances. Thus, while Joppa EAP does not yet have an approved Part 845 groundwater monitoring program, EEI started taking steps proactively to address the boron exceedances, including the completion of a Supplemental Site Investigation to characterize the nature and extent of the release and by providing notice to persons who own or reside on land directly overlying any part of the plume, consistent with 845.650(d)(1) and (2). As part of the Supplemental Site Investigation, EEI installed 31 additional monitoring wells to help define the boron plume (the "delineation wells"). It also installed two observation wells and a pumping well to facilitate aquifer pump testing within the upper aquifer. The allegations in the VN relate to samples taken from the delineation wells.

Additionally, while Joppa EAP's operating permit (including an approved groundwater monitoring plan) has not yet been issued, in May of 2023, EEI commenced quarterly sampling for exceedances of the 845.600(a) GWPSs, in accordance with the groundwater monitoring plan submitted with its operating permit application. This sampling found exceedances of the GWPS for boron at waste boundary wells G06, G07, G08, G09 and G10. It also found exceedances of the GWPS for cobalt at well G05 and the GWPS for pH at wells G11 and G51D. On October 21, 2023, EEI submitted an alternative source demonstration, in accordance with 35 Ill Admin. Code 845.650(e), demonstrating that the cobalt and pH contamination was caused by a source other than the Joppa EAP and that the Joppa EAP did not contribute to those exceedances.

For the boron exceedances, as discussed above, EEI has already begun taking and continues to take actions to investigate and address downgradient boron impacts in accordance with 35 Ill Admin. Code 845.650, .660, .670, and .680(a)(3).

I. The Alleged Violations Are Without Merit

a. Part 845 Allegations

As explained below, the alleged violations of 35 Ill. Admin. Code 845.600(a) in the VN are without merit

First, 35 Ill. Admin. Code 845.600(a) does not apply to the delineation wells. The GWPSs apply "at the waste boundary" of a CCR surface impoundment. 35 Ill Admin Code 845.600(a)(1) ("The groundwater protection standards at the waste boundary must be . . ."). The delineation wells are not indicative of or meant to monitor conditions at the waste boundary of the Joppa EAP. The only wells fitting that description are the waste boundary wells. All of the

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wells for which violations are alleged in the VN are delineation wells. Because 845.600(a) does not apply to those wells, any allegation of a violation of 845.600(a) in the VN is without merit.

Second, the mere existence of an exceedance of the GWPSs in 35 Ill Admin. Code 845.600(a) does not trigger a violation of that provision (or any other provision of 35 Ill. Admin. Code Part 845 for that matter). Again, 845.600(a) sets forth GWPSs that apply at the waste boundaries for existing and inactive CCR surface impoundments. 35 Ill. Admin. Code 845.600(a). No provision of Part 845, including 845.600(a), includes a prohibition against being in exceedance of the GWPSs, or otherwise states that finding or contributing to an exceedance of those standards by itself triggers a violation of law. Rather, if a CCR surface impoundment is contributing to an exceedance of the GWPSs at the waste boundary of a CCR surface impoundment, it triggers additional requirements under Part 845, such as (1) notifying the Agency of the exceedance and posting that notification in the facility's operating record; (2) characterizing the nature and extent of the release; (3) notifying persons who own or reside on the land that overlies any plume contamination; (4) initiating and performing an assessment of corrective measures; and (5) implementing a corrective action plan. Failure to engage in these additional requirements when triggered could be a violation of Part 845 but merely exceeding the GWPSs is not.

Finally, EEI has started taking steps consistent with Part 845 to address exceedances. As noted above, boron exceedances were found at the waste boundary of the Joppa EAP. EEI has been and continues to investigate and address this boron contamination, including by delineating the plume and notifying persons who own or reside on land overlying that plume. For cobalt and pH exceedances found at the waste boundary, EEI submitted an alternative source demonstration indicating another source is the cause of that contamination and that the Joppa EAP did not contribute to it. Evidence gathered by EEI demonstrates that cobalt contamination at the waste boundary is from naturally occurring cobalt in soil and that pH exceedances at the waste boundary are consistent with iron oxidization. The other 845.600(a) exceedances alleged in the VN are for arsenic and lead. However, sampling at the Joppa EAP waste boundary did not find any arsenic or lead exceedances. This is evidence that the Joppa EAP is not responsible for or contributing to arsenic or lead contamination in the delineation wells.

In conclusion, there is no such thing as a "violation" of the GWPSs in 845.600(a). Rather, an exceedance of a GWPS at a waste boundary monitoring well triggers additional actions that an owner/operator must undertake to address the exceedance. A GWPS exceedance at a delineation well, such as those identified in the VN, therefore, triggers no violation of Part 845 or any additional requirements under Part 845. EEI has been and continues to comply with its obligations to investigate and address any exceedances.

b. <u>415 ILCS 5/12(a) and 35 Ill. Adm. Code 620.410(a) and (e) Allegations</u>

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The alleged violations of 415 ILCS 5/12(a)[1] and 35 Ill. Admin. Code 620.410(a) and (e) are also without merit.

First, as IEPA explained during the course of the Part 845 rulemaking proceeding, for constituents that have GWPSs under Part 845, the GWQSs in 35 Ill. Admin. Code 620.410 do not apply until the end of the Part 845 post-closure care period. *See e.g*. IEPA's Response to Illinois Pollution Control Board's Prefiled Questions at 48 (Aug. 3, 2020), *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed new 35 Ill. Adm. Code 845*, R2020-19 ("Part 845 must be applied first for any constituent with a GWPS. For any constituent which has no GWPS, and after the active life of a CCR surface impoundment as defined by Part 845, the requirements of Part 620 are applicable."); Hrg. Transcript at 28-30 (Aug. 13, 2020, *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed new 35 Ill. Adm. Code 845,* R2020-19 ("Q. Let's use an example. Boron. There's a GWPS under 845 for boron, correct? A: right. Q: And there's also a corresponding GWQS under Part [620] for boron, correct? A: Correct. Q: So for boron, are the corresponding Part 620 standards applicable during the active life of a CCR surface impoundment? A: No, they're not. Q: And can you give me an example of a constituent where the Part 620 standards would be applicable during the active life of a CCR surface impoundment? A: An example would be nitrate.").

From a practical perspective, this makes sense. Under Part 845, the owner or operator of a CCR surface impoundment will already have an obligation to investigate and take corrective action to remedy contamination of an 845.600(a) constituent to which a CCR surface impoundment is contributing. It makes little sense to have dueling cleanup regimes in place.[2] Notably, 845.600(c) prohibits an owner or operator of a CCR surface impoundment from obtaining an alternative standard under Part 620.450(a)(4), which is available to constituents with a GWQS, for any constituent with a GWPS before the end of post-closure care under Section 845.780. This further supports the idea that Part 620 requirements are superseded for overlapping constituents while a unit is undergoing Part 845 closure and post-closure care.

The VN alleges violations of Part 620 GWPSs for boron, pH, lead and iron. All of these constituents, other than iron, have Part 845 GWPSs and thus, the Part 620 standards do not apply to those constituents (other than iron) while the Joppa EAP is subject to Part 845.

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[1] Given that the VN groups the allegation of violation of Section 12(a) of the Act together with the violations of 35 Ill. Admin. Code 620.410(a) and (e) without further detail, EEI assumes the Agency's allegations of Section 12(a) violations are based upon the alleged exceedances of the GWQSs in 620.410(a) and (e).

[2] Absent agreement from the Agency, CCR surface impoundments with exceedances of GWPS will likely have to apply for groundwater management zones to avoid situations like this creating an administrative quagmire for all parties.

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Second, for each of the constituents for which a violation of the GWQSs is alleged, the alleged exceedance(s) are either (1) already being addressed, (2) not supported by the evidence, and/or (3) not being caused by the Joppa Power Plant. Below each constituent is addressed, in turn.

Boron

The GWQS for boron, 2.0 mg/L, is the same as the GWPS for boron. The boron exceedances identified in the VN are already being addressed through additional investigation and corrective actions under Part 845. As noted above, EEI has already conducted a Supplemental Site Investigation (the results of which were used by IEPA as the basis for their VN) to characterize the nature and extent of the boron contamination downgradient of the Joppa EAP. EEI has also begun to evaluate the use of an extraction well system as a corrective action to address the boron impacts identified in the Supplemental Site Investigation. EEI will continue to investigate, plan and implement corrective action to address the boron exceedances identified in the VN, in accordance with Part 845.

pH

The prohibition against exceedances of GWQSs located in 35 Ill. Admin. Code 620.405 provides "no person shall cause, threaten or allow the release of any contaminant to groundwater so as to *cause* a GWQS set forth in this Subpart to be exceeded." (emphasis added). Section 620.410 further states that the GWQS apply "except due to natural causes." Thus, a person cannot be in violation of the water quality standards unless they caused the exceedance and the exceedance is the result of something other than natural causes.

Both the GWPSs and GWQSs set a pH range of 6.5 - 9.0 units. The alternative source demonstration conducted for the Joppa EAP demonstrated that the Joppa EAP is not the source of pH exceedances in the waste boundary wells and that the Joppa EAP did not contribute to that contamination. The Joppa EAP is also not the cause of pH exceedances identified in the delineation wells. Based on the location of the delineation wells, additional data collected as part of the Supplemental Site Investigation, and the lines of evidence within the alternative source demonstration dated October 21, 2023, the Joppa EAP is not the cause of the pH exceedances of the GWQSs and the exceedances are from natural causes.

Lead

First, an exceedance of the GWQS for lead was found only in one well (G13S) and only in one (January 2023) out of four total sampling events included in the Supplemental Site Investigation. One sample result is not reliable evidence of an exceedance. In the other three sampling events at well G13S, not only were lead concentrations below the 0.0075 mg/L GWQS,

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lead was not even detected at concentrations above the reporting levels.[3] Additionally, sampling at the waste boundary of the Joppa EAP did not identify any exceedances of the 0.0075 mg/L lead standard. Thus, there is no evidence of an ongoing exceedance of lead at G13S in need of corrective action, with the one-time exceedance being a statistical outlier unrelated to the Joppa EAP or the Joppa Power Plant.

Iron

Similar to lead, an exceedance of the GWQS for iron was found only in one well (G24D) and in one (November 2022) out of two total sampling events. Again, one sample result is not reliable evidence of an exceedance. Significantly, the most recent sampling event at well G24D did not show an exceedance of the 5.0 mg/L GWQS for iron. Thus, there is no evidence of an ongoing iron exceedance in need of corrective action.

Additionally, the Joppa Power Plant did not cause the iron exceedance found in delineation well G24D. This is evidenced by the location of this well and concentrations of iron found in upgradient wells. G24D is one of the most distant monitoring wells from the Joppa EAP and the Joppa facility property boundary. The well is bounded vertically above by well G24S (which has iron concentrations less than 0.2 mg/L) and is bounded laterally to the west, northwest, and north-northeast by seven delineation wells that all have iron concentrations below the GWQS. Rather, the source of the iron exceedance in that well is entirely from natural causes

Proposed Compliance Commitment Agreement

As noted above, while EEI does not agree with the violations alleged by IEPA, it would like to amicably resolve the allegations in the VN. Thus, EEI proposes the following terms for a CCA with the Agency.

1. Investigation activities

    a. EEI will continue to conduct monitoring under 35 Ill. Admin. Code section 845.650(b) in accordance with the proposed groundwater monitoring plan and sampling methodologies provided in the operating permit application for the Joppa East Ash Pond, until it receives an approved operating permit under 35 Ill. Admin. Code Part 845. After that time, it will conduct monitoring in accordance with its approved Part 845 operating permit.

[3] The groundwater protection standard for lead under 845.600(a) is also 0.0075 mg/L. Reporting limits for the four completed water quality samples in the Supplemental Site Investigation ranged from <0.001 to <0.005mg/L.

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ArentFox Schiff

November 30, 2023

b. In Q1 2024, EEI will conduct an additional round of monitoring of the following 16 delineation monitoring wells as part of its characterization of the nature and extent of the boron release consistent with 35 Ill. Admin. Code 845.650(d)(1): G12S, G12D, G13S, G13D, G16S, G18S, G19S, G19D, G20S, G20D, G21S, G21D, G22S, G22D, G23S, and G24S.

c. EEI will complete its assessment of corrective measures for boron exceedances in accordance with 35 Ill. Admin. Code 845.660, including but not limited to assessing the extraction well system for treating groundwater.

2. Corrective action planning and implementation

a. By year-end 2024, EEI will start operation of the extraction well system as a preliminary corrective action to address boron exceedances.

b. EEI will submit a corrective action plan in accordance with 35 Ill Admin. Code 845.670 to address boron exceedances and implement the corrective action plan in accordance with 845.680.

c. In any instance where results of monitoring conducted in accordance with the Joppa EAP's applicable groundwater monitoring plan (i.e. the groundwater monitoring plan included with the Joppa East Ash Pond's operating permit application or, after Joppa East Ash Pond receives an operating permit, the monitoring plan implemented in accordance with that permit) indicate an exceedance of the 35 Ill Admin. Code 845.600(a) groundwater protection standards at the waste boundary, EEI will commence with the additional steps required under 35 Ill. Admin. Code sections 845.650(d), 845.650(e), 845.660, 845.670 and 845.680(a).

EEI believes its proposed CCA elements address the violations alleged in the VN and are consistent with the recommendations provided by IEPA. Pursuant to 415 ILCS 5/31(a)(2), EEI requests a meeting with IEPA regarding the VN. EEI looks forward to discussing its proposed CCA elements with IEPA and reaching an amicable resolution of the VN.

Please contact me at (312)258-5605 or via email (bina.joshi@afslaw.com) should you have any questions and to facilitate further discussions.

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November 30, 2023

Sincerely,

Bina Joshi

Bina Joshi

cc (via email): David Mitchell
Joshua More
Stuart Cravens
Cynthia Vodopivec
Victor Modeer
Phil Morris

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From: Garee, Matthew J.
To: Hunt, Lauren
Subject: Duck Creek ASD Draft
Date: Thursday, November 30, 2023 4:02:04 PM
Attachments: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx

---

Good afternoon Lauren,

I have attached the ASD letter draft. The two main items of concern were the lack of data provided to characterize the CCR and the peat that was cited as the potential alternative source. Only data for CCR characterization was data collected from one well located in the southwest corner of the impoundment. No data was provided from the peat unit that they identified as the alternate source. I do have a question as far as their first line of evidence relating to the CCR impoundment liner. Since the liner appears to have been in use at the site since the pond has been in place would be take that into account, or would it not matter since they still didn't provide us with proper data?

Thanks,

Matthew J. Garee
Environmental Protection Geologist 1
Illinois Environmental Protection Agency
Bureau of Water
Division of Public Water Supplies
Groundwater Section
1021 N. Grand Avenue
Springfield, IL 62702
~~~~~~~~~~~~~~~~~~
You can contact me:
Cell: 309-531-2893
Matthew.Garee@illinois.gov
Hours: 8:30 am to 5:00 pm Monday-Friday

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Document 31

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

217-782-1020

June 11, 2024

Dianna Tickner
Electric Energy, Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Re: Duck Creek Power Plant GMF Pond – W0578010001-04
Alternative Source Demonstration Submittal

Dear Ms. Tickner:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Duck Creek GMF Pond Alternative Source Demonstration (ASD) dated November 11, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the GMF Pond must include total solids sampling in accordance with SW846.
2. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.

If you have any questions, please contact: Matthew Garee Illinois EPA, Bureau of Water, PWS #13, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Matthew Garee
Francisco Herrera
WPC Files 06M

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Document 32

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Fuller, Rhys
To: Liska, Mark
Subject: [External] RE: IL0055620 - Duck Creek Modification
Date: Monday, December 4, 2023 9:20:20 AM

Mark,

Any updates on this permit? Just want to make sure we didn't miss it in the mail.

I was in the process of leaving you a voicemail as well but my call apparently dropped.

Thanks,

Rhys Fuller
618-975-1799

From: Liska, Mark <Mark.Liska@Illinois.gov>
Sent: Thursday, June 8, 2023 3:33 PM
To: Fuller, Rhys <Rhys.Fuller@vistracorp.com>
Subject: IL0055620 - Duck Creek Modification

EXTERNAL EMAIL

Rhys, I've attached the pre-public notice draft of the modified Duck Creek NPDES Permit. Please look it over and give me any comments you have. I'll hold this from 30-day public notice until you give me either comments or an all-clear.

Mark E. Liska
Environmental Protection Engineer
Industrial Permits Section, Bureau of Water
Illinois Environmental Protection Agency
1021 N. Grand Ave. East, P.O. Box 19276
Springfield, IL 62794-9276
Phone: (217) 782-0610
Fax: (217) 782-9891

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Document 33

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Liska, Mark
To: Fuller, Rhys
Subject: RE: IL0055620 - Duck Creek Modification
Date: Monday, December 4, 2023 9:44:30 AM
Attachments: IL0055620 Mod.pdf

Here's the final modification. Let me know if you have any questions.

Mark E. Liska
Environmental Protection Engineer
Industrial Permits Section, Bureau of Water
Illinois Environmental Protection Agency
1021 N. Grand Ave. East, P.O. Box 19276
Springfield, IL 62794-9276
Phone: (217) 782-0610
Fax: (217) 782-9891

From: Fuller, Rhys <Rhys.Fuller@vistracorp.com>
Sent: Monday, December 4, 2023 9:20 AM
To: Liska, Mark <Mark.Liska@Illinois.gov>
Subject: [External] RE: IL0055620 - Duck Creek Modification

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Thanks,

Rhys Fuller
618-975-1799

From: Liska, Mark <Mark.Liska@Illinois.gov>
Sent: Thursday, June 8, 2023 3:33 PM
To: Fuller, Rhys <Rhys.Fuller@vistracorp.com>
Subject: IL0055620 - Duck Creek Modification

EXTERNAL EMAIL

Rhys, I've attached the pre-public notice draft of the modified Duck Creek NPDES Permit. Please look it over and give me any comments you have. I'll hold this from 30-day public notice until you give me either comments or an all-clear.

Mark E. Liska
Environmental Protection Engineer

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Industrial Permits Section, Bureau of Water
Illinois Environmental Protection Agency
1021 N. Grand Ave. East, P.O. Box 19276
Springfield, IL 62794-9276
Phone: (217) 782-0610
Fax: (217) 782-9891

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 North Grand Avenue East, P.O. Box 19276, Springfield, Illinois 62794-9276 · (217) 782-3397
JB Pritzker, Governor
John J. Kim, Director

217/782-0610

November 08, 2023

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, IL 61520

Re: Illinois Power Resources Generating, LLC
Duck Creek Power Plant
NPDES Permit No. IL0055620
Bureau ID: W0578010001
Final Permit (after public notice)

Dear Permittee:

The Illinois Environmental Protection Agency has reviewed the request for modification of the above-referenced NPDES Permit and issued a public notice based on that request. The final decision of the Agency is to modify the Permit as follows:

1. Monitoring for Chromium and Nickel has been removed from Outfall 001 and Special Condition 13 referring to the Chromium and Nickel monitoring has been removed from the permit.

2. Special Condition 8 has been removed from the permit and the special conditions below it have been renumbered.

3. The 30-day average concentration limit for Boron at Outfall 002 has been changed to 7.6 mg/L.

Enclosed is a copy of the modified Permit. You have the right to appeal this modification to the Illinois Pollution Control Board within a 35 day period following the modification date shown on the first page of the permit.

Should you have questions concerning the Permit, please contact Mark E. Liska at 217/782-0610.

Sincerely,

Darin E. LeCrone, P.E.
Manager, Permit Section
Division of Water Pollution Control

DEL:MEL:23051101.docx

Attachment: Final Permit

cc: Records
Compliance Assurance Section
Peoria Region
Billing

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NPDES Permit No. IL0055620

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Modified(NPDES) Permit

Expiration Date: February 28, 2027

Issue Date: February 15, 2022
Effective Date: March 1, 2022
Modification Date: November 08, 2023

Name and Address of Permittee:

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, IL 61520

Name and Address of Facility:

Duck Creek Power Plant
17751 North Cilco Road
Canton, IL 61520
(Fulton County)

Discharge Number and Name:	Receiving Waters:
001 Dam Seepage Collection System	Duck Creek tributary to Illinois River
002 Cooling Pond Overflow (at EL 565.0)	Duck Creek tributary to Illinois River
004 Cooling Pond Overflow (at EL 562.5)	Illinois River

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of Ill. Adm. Code, Subtitle C and/or Subtitle D, Chapter 1, and the Clean Water Act (CWA), the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Darin E. LeCrone, P.E.
Manager, Permit Section
Division of Water Pollution Control

DEL:MEL:23051101.docx

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Modification Date: November 08, 2023

NPDES Permit No. IL0055620

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/L 30 DAY AVERAGE	CONCENTRATION LIMITS mg/L DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 001 – Dam Seepage Collection System (DAF = 0.038 MGD)						
Flow (MGD)	See Special Condition 1.				Measure When Discharging	
pH				Monitor Only	1/Month	Grab
Total Suspended Solids				Monitor Only	1/Month	Grab
Iron (Total)				Monitor Only	1/Month	Grab
Boron			7.6	Monitor Only	1/Month	Grab

Outfall 002 – Cooling Pond Overflow (at EL. 565.0)
(Intermittent Discharge – See Special Condition 13)

The discharge consists of :

1. Coal Pile & Limestone Storage Area Runoff
2. Station Yard and Roof Drainage & Stormwater Runoff
3. GMF System Unwaters/Dewaters
4. Cooling Pond Dewatering (Intermittent)

Flow (MGD)	See Special Condition 1.				Measure When Discharging	
pH	See Special Condition 2.				1/Month	Grab
Total Suspended Solids			15	30	1/Month	Grab
Iron (Total)			2	4	1/Month	Grab
Boron			7.6	Monitor Only	1/Month	Grab
Mercury*				Monitor Only	2/Year	Grab
Ammonia			3.0	6.0	1/Month	Grab

* See Special Condition 10.

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Modification Date: November 08, 2023

NPDES Permit No. IL0055620

Effluent Limitations and Monitoring

1. From the modification date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/L 30 DAY AVERAGE	CONCENTRATION LIMITS mg/L DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall 004 – Cooling Pond Overflow (at EL. 562.5) (Intermittent Discharge)						
The discharge consists of: 1. Coal Pile & Limestone Storage Area Runoff 2. Station Yard and Roof Drainage & Stormwater Runoff 3. GMF System Unwaters/Dewaters						
Flow (MGD)	See Special Condition 1.				Measure When Discharging	
pH	See Special Condition 2.				1/Month	Grab
Total Suspended Solids			15	30	1/Month	Grab
Iron (Total)			2	4	1/Month	Grab
Boron*				Monitor Only	1/Month	Grab
Mercury**			Report	0.000012***	1/Month	Grab
Ammonia			3.0	6.0	1/Month	Grab

*See Special Condition 11.
** See Special Condition 10.
***This is an annual average.

Special Conditions

SPECIAL CONDITION 1. Flow shall be measured in units of Million Gallons per Day (MGD) and reported as a monthly average and a daily maximum on the monthly Discharge Monitoring Report.

SPECIAL CONDITION 2. The pH shall be in the range 6.0 to 9.0. The monthly minimum and monthly maximum values shall be reported on the DMR form.

SPECIAL CONDITION 3. Samples taken in compliance with the effluent monitoring requirements shall be taken at a point representative of the discharge, but prior to entry into the receiving stream.

SPECIAL CONDITION 4. If an applicable effluent standard or limitation is promulgated under Sections 301(b)(2)(C) and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act and that effluent standard or limitation is more stringent than any effluent limitation in the permit or controls a pollutant not limited in the NPDES Permit, the Agency shall revise or modify the permit in accordance with the more stringent standard or prohibition and shall so notify the permittee.

SPECIAL CONDITION 5. The Permittee shall record monitoring results on Discharge Monitoring Report (DMR) electronic forms using one such form for each outfall each month.

In the event that an outfall does not discharge during a monthly reporting period, the DMR Form shall be submitted with no discharge indicated.

The Permittee is required to submit electronic DMRs (NetDMRs) instead of mailing paper DMRs to the IEPA unless a waiver has been granted by the Agency. More information, including registration information for the NetDMR program, can be obtained on the IEPA website, https://www2.illinois.gov/epa/topics/water-quality/surface-water/netdmr/Pages/quick-answer-guide.aspx.

The completed Discharge Monitoring Report forms shall be submitted to IEPA no later than the 25th day of the following month, unless otherwise specified by the permitting authority.

Permittees that have been granted a waiver shall mail Discharge Monitoring Reports with an original signature to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
Attention: Compliance Assurance Section, Mail Code # 19
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

SPECIAL CONDITION 6. The Agency has determined that the effluent limitations in this permit constitute BAT/BCT for storm water which is treated in the existing treatment facilities for purposes of this permit reissuance, and no pollution prevention plan will be required for such storm water. In addition to the chemical specific monitoring required elsewhere in this permit, the permittee shall conduct an annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity, and determine whether any facility modifications have occurred which result in previously-treated storm water discharges no longer receiving treatment. If any such discharges are identified the permittee shall request a modification of this permit within 30 days after the inspection. Records of the annual inspection shall be retained by the permittee for the term of this permit and be made available to the Agency on request.

SPECIAL CONDITION 7. There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

SPECIAL CONDITION 8. This permit may be modified to include different final effluent limitations or requirements which are consistent with applicable laws, regulations, or judicial orders. The Agency will public notice the permit modification. Should the permittee wish to discharge chemical metal cleaning wastes to waters of the state, the permittee shall submit to the Agency an application indicating such intention. The Agency may then issue a modified permit, following public notice and opportunity for public comment.

SPECIAL CONDITION 9. Proper operation and maintenance - the permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up, or auxiliary facilities, or similar systems which are installed by a permittee only when necessary to achieve compliance with the conditions of the permit.

SPECIAL CONDITION 10. All samples for mercury must be analyzed by EPA Method 1631E using the digestion procedure described in Section 11.1.1.2 of 1631E, which dictates that samples must be heated at 50°C for 6 hours in a bromine chloride (BrCl) solution in closed vessels.

SPECIAL CONDITION 11. Allowed mixing is recognized for boron at outfall 004 extending 497 feet downstream. Within the allowed mixing, 20.9:1 dilution is afforded.

Special Conditions

SPECIAL CONDITION 12. The Permittee shall monitor the effluent from Outfall 002 for the following parameters on a 2/year basis. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The sample shall be a grab except as otherwise specifically provided below and the results shall be submitted on the DMR's to IEPA. The parameters to be sampled and the minimum reporting limits to be attained are as follows:

STORET CODE	PARAMETER	Minimum reporting limit
10197	Antimony	5.0 ug/L
01002	Arsenic	0.05 mg/L
01007	Barium	0.5 mg/L
01027	Cadmium	0.001 mg/L
01032	Chromium (hexavalent)	0.01 mg/L
01034	Chromium (total)	0.05 mg/L
01042	Copper	0.005 mg/L
00718	Cyanide (weak acid dissociable)	5.0 ug/L
00720	Cyanide	5.0 ug/L
00951	Fluoride	0.1 mg/L
01045	Iron (total)	0.5 mg/L
01046	Iron (Dissolved)	0.5 mg/L
01051	Lead	0.05 mg/L
01055	Manganese	0.5 mg/L
01067	Nickel	0.005 mg/L
32730	Phenols	0.005 mg/L
01147	Selenium	0.005 mg/L
01077	Silver (total)	0.003 mg/L
10159	Thallium	5.0 ug/L
01092	Zinc	0.025 mg/L

Unless otherwise indicated, concentrations refer to the total amount of the constituent present in all phases, whether solid, suspended or dissolved, elemental or combined, including all oxidation states.

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Attachment H

Standard Conditions

Definitions

Act means the Illinois Environmental Protection Act, 415 ILCS 5 as Amended.

Agency means the Illinois Environmental Protection Agency.

Board means the Illinois Pollution Control Board.

Clean Water Act (formerly referred to as the Federal Water Pollution Control Act) means Pub. L. 92-500, as amended. 33 U.S.C. 1251 et seq.

NPDES (National Pollutant Discharge Elimination System) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318 and 405 of the Clean Water Act.

USEPA means the United States Environmental Protection Agency.

Daily Discharge means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurements, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

Maximum Daily Discharge Limitation (daily maximum) means the highest allowable daily discharge.

Average Monthly Discharge Limitation (30 day average) means the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Discharge Limitation (7 day average) means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Aliquot means a sample of specified volume used to make up a total composite sample.

Grab Sample means an individual sample of at least 100 milliliters collected at a randomly-selected time over a period not exceeding 15 minutes.

24-Hour Composite Sample means a combination of at least 8 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over a 24-hour period.

8-Hour Composite Sample means a combination of at least 3 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over an 8-hour period.

Flow Proportional Composite Sample means a combination of sample aliquots of at least 100 milliliters collected at periodic intervals such that either the time interval between each aliquot or the volume of each aliquot is proportional to either the stream flow at the time of sampling or the total stream flow since the collection of the previous aliquot.

(1) **Duty to comply**. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action, permit termination, revocation and reissuance, modification, or for denial of a permit renewal application. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirements.

(2) **Duty to reapply**. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. If the permittee submits a proper application as required by the Agency no later than 180 days prior to the expiration date, this permit shall continue in full force and effect until the final Agency decision on the application has been made.

(3) **Need to halt or reduce activity not a defense**. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

(4) **Duty to mitigate**. The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

(5) **Proper operation and maintenance**. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up, or auxiliary facilities, or similar systems only when necessary to achieve compliance with the conditions of the permit.

(6) **Permit actions**. This permit may be modified, revoked and reissued, or terminated for cause by the Agency pursuant to 40 CFR 122.62 and 40 CFR 122.63. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

(7) **Property rights**. This permit does not convey any property rights of any sort, or any exclusive privilege.

(8) **Duty to provide information**. The permittee shall furnish to the Agency within a reasonable time, any information which the Agency may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee shall also furnish to the Agency upon request, copies of records required to be kept by this permit.

(9) **Inspection and entry**. The permittee shall allow an authorized representative of the Agency or USEPA (including an authorized contractor acting as a representative of the Agency or USEPA), upon the presentation of credentials and other documents as may be required by law, to:

(a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records

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must be kept under the conditions of this permit;
(b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
(c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
(d) Sample or monitor at reasonable times, for the purpose of assuring permit compliance, or as otherwise authorized by the Act, any substances or parameters at any location.

(10) **Monitoring and records.**
(a) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
(b) The permittee shall retain records of all monitoring information, including all calibration and maintenance records, and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of this permit, measurement, report or application. Records related to the permittee's sewage sludge use and disposal activities shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503). This period may be extended by request of the Agency or USEPA at any time.
(c) Records of monitoring information shall include:
(1) The date, exact place, and time of sampling or measurements;
(2) The individual(s) who performed the sampling or measurements;
(3) The date(s) analyses were performed;
(4) The individual(s) who performed the analyses;
(5) The analytical techniques or methods used; and
(6) The results of such analyses.
(d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit. Where no test procedure under 40 CFR Part 136 has been approved, the permittee must submit to the Agency a test method for approval. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals to ensure accuracy of measurements.

(11) **Signatory requirement.** All applications, reports or information submitted to the Agency shall be signed and certified.
(a) **Application.** All permit applications shall be signed as follows:
(1) For a corporation: by a principal executive officer of at least the level of vice president or a person or position having overall responsibility for environmental matters for the corporation:
(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
(3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.
(b) **Reports.** All reports required by permits, or other information requested by the Agency shall be signed by a person described in paragraph (a) or by a duly authorized representative of that person. A person is a duly authorized representative only if:
(1) The authorization is made in writing by a person described in paragraph (a); and
(2) The authorization specifies either an individual or a position responsible for the overall operation of the facility, from which the discharge originates, such as a plant manager, superintendent or person of equivalent responsibility; and
(3) The written authorization is submitted to the Agency.
(c) **Changes of Authorization.** If an authorization under (b) is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of (b) must be submitted to the Agency prior to or together with any reports, information, or applications to be signed by an authorized representative.
(d) **Certification.** Any person signing a document under paragraph (a) or (b) of this section shall make the following certification:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

(12) **Reporting requirements.**
(a) **Planned changes.** The permittee shall give notice to the Agency as soon as possible of any planned physical alterations or additions to the permitted facility.
Notice is required when:
(1) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source pursuant to 40 CFR 122.29 (b); or
(2) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements pursuant to 40 CFR 122.42 (a)(1).
(3) The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.
(b) **Anticipated noncompliance.** The permittee shall give advance notice to the Agency of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.
(c) **Transfers.** This permit is not transferable to any person except after notice to the Agency.
(d) **Compliance schedules.** Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.
(e) **Monitoring reports.** Monitoring results shall be reported at the intervals specified elsewhere in this permit.
(1) Monitoring results must be reported on a Discharge Monitoring Report (DMR).

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(2) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR 136 or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR.

(3) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Agency in the permit.

(f) **Twenty-four hour reporting.** The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24-hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and time; and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The following shall be included as information which must be reported within 24-hours:

(1) Any unanticipated bypass which exceeds any effluent limitation in the permit.

(2) Any upset which exceeds any effluent limitation in the permit.

(3) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Agency in the permit or any pollutant which may endanger health or the environment.

The Agency may waive the written report on a case-by-case basis if the oral report has been received within 24-hours.

(g) **Other noncompliance.** The permittee shall report all instances of noncompliance not reported under paragraphs (12) (d), (e), or (f), at the time monitoring reports are submitted. The reports shall contain the information listed in paragraph (12) (f).

(h) **Other information.** Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to the Agency, it shall promptly submit such facts or information.

(13) **Bypass.**

(a) Definitions.

(1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

(2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

(b) Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs (13)(c) and (13)(d).

(c) Notice.

(1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

(2) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in paragraph (12)(f) (24-hour notice).

(d) Prohibition of bypass.

(1) Bypass is prohibited, and the Agency may take enforcement action against a permittee for bypass, unless:

(i) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(iii) The permittee submitted notices as required under paragraph (13)(c).

(2) The Agency may approve an anticipated bypass, after considering its adverse effects, if the Agency determines that it will meet the three conditions listed above in paragraph (13)(d)(1).

(14) **Upset.**

(a) Definition. Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

(b) Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (14)(c) are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

(c) Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An upset occurred and that the permittee can identify the cause(s) of the upset;

(2) The permitted facility was at the time being properly operated; and

(3) The permittee submitted notice of the upset as required in paragraph (12)(f)(2) (24-hour notice).

(4) The permittee complied with any remedial measures required under paragraph (4).

(d) Burden of proof. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

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(15) **Transfer of permits.** Permits may be transferred by modification or automatic transfer as described below:

(a) Transfers by modification. Except as provided in paragraph (b), a permit may be transferred by the permittee to a new owner or operator only if the permit has been modified or revoked and reissued pursuant to 40 CFR 122.62 (b) (2), or a minor modification made pursuant to 40 CFR 122.63 (d), to identify the new permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

(b) Automatic transfers. As an alternative to transfers under paragraph (a), any NPDES permit may be automatically transferred to a new permittee if:

(1) The current permittee notifies the Agency at least 30 days in advance of the proposed transfer date;

(2) The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage and liability between the existing and new permittees; and

(3) The Agency does not notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement.

(16) All manufacturing, commercial, mining, and silvicultural dischargers must notify the Agency as soon as they know or have reason to believe:

(a) That any activity has occurred or will occur which would result in the discharge of any toxic pollutant identified under Section 307 of the Clean Water Act which is not limited in the permit, if that discharge will exceed the highest of the following notification levels:

(1) One hundred micrograms per liter (100 ug/l);

(2) Two hundred micrograms per liter (200 ug/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/l) for 2,4-dinitrophenol and for 2-methyl-4,6 dinitrophenol; and one milligram per liter (1 mg/l) for antimony.

(3) Five (5) times the maximum concentration value reported for that pollutant in the NPDES permit application; or

(4) The level established by the Agency in this permit.

(b) That they have begun or expect to begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the NPDES permit application.

(17) All Publicly Owned Treatment Works (POTWs) must provide adequate notice to the Agency of the following:

(a) Any new introduction of pollutants into that POTW from an indirect discharge which would be subject to Sections 301 or 306 of the Clean Water Act if it were directly discharging those pollutants; and

(b) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.

(c) For purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

(18) If the permit is issued to a publicly owned or publicly regulated treatment works, the permittee shall require any industrial user of such treatment works to comply with federal requirements concerning:

(a) User charges pursuant to Section 204 (b) of the Clean Water Act, and applicable regulations appearing in 40 CFR 35;

(b) Toxic pollutant effluent standards and pretreatment standards pursuant to Section 307 of the Clean Water Act; and

(c) Inspection, monitoring and entry pursuant to Section 308 of the Clean Water Act.

(19) If an applicable standard or limitation is promulgated under Section 301(b)(2)(C) and (D), 304(b)(2), or 307(a)(2) and that effluent standard or limitation is more stringent than any effluent limitation in the permit, or controls a pollutant not limited in the permit, the permit shall be promptly modified or revoked, and reissued to conform to that effluent standard or limitation.

(20) Any authorization to construct issued to the permittee pursuant to 35 Ill. Adm. Code 309.154 is hereby incorporated by reference as a condition of this permit.

(21) The permittee shall not make any false statement, representation or certification in any application, record, report, plan or other document submitted to the Agency or the USEPA, or required to be maintained under this permit.

(22) The Clean Water Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a civil penalty not to exceed $25,000 per day of such violation. Any person who willfully or negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318 or 405 of the Clean Water Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than one year, or both.
Additional penalties for violating these sections of the Clean Water Act are identified in 40 CFR 122.41 (a)(2) and (3).

(23) The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both.

(24) The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

(25) Collected screening, slurries, sludges, and other solids shall be disposed of in such a manner as to prevent entry of those wastes (or runoff from the wastes) into waters of the State. The proper authorization for such disposal shall be obtained from the Agency and is incorporated as part hereof by reference.

(26) In case of conflict between these standard conditions and any other condition(s) included in this permit, the other condition(s) shall govern.

(27) The permittee shall comply with, in addition to the requirements of the permit, all applicable provisions of 35 Ill. Adm. Code, Subtitle C, Subtitle D, Subtitle E, and all applicable orders of the Board or any court with jurisdiction.

(28) The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit is held invalid, the remaining provisions of this permit shall continue in full force and effect.

(Rev. 7-9-2010 bah)

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Document 35

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Fuller, Rhys
To: Liska, Mark
Subject: [External] RE: IL0055620 - Duck Creek Modification
Date: Monday, December 4, 2023 9:52:41 AM

Thanks

From: Liska, Mark <Mark.Liska@Illinois.gov>
Sent: Monday, December 4, 2023 9:45 AM
To: Fuller, Rhys <Rhys.Fuller@vistracorp.com>
Subject: RE: IL0055620 - Duck Creek Modification

EXTERNAL EMAIL

Here's the final modification. Let me know if you have any questions.

Mark E. Liska
Environmental Protection Engineer
Industrial Permits Section, Bureau of Water
Illinois Environmental Protection Agency
1021 N. Grand Ave. East, P.O. Box 19276
Springfield, IL 62794-9276
Phone: (217) 782-0610
Fax: (217) 782-9891

From: Fuller, Rhys <Rhys.Fuller@vistracorp.com>
Sent: Monday, December 4, 2023 9:20 AM
To: Liska, Mark <Mark.Liska@Illinois.gov>
Subject: [External] RE: IL0055620 - Duck Creek Modification

Mark,

Any updates on this permit? Just want to make sure we didn't miss it in the mail.

I was in the process of leaving you a voicemail as well but my call apparently dropped.

Thanks,

Rhys Fuller
618-975-1799

From: Liska, Mark <Mark.Liska@Illinois.gov>
Sent: Thursday, June 8, 2023 3:33 PM
To: Fuller, Rhys <Rhys.Fuller@vistracorp.com>
Subject: IL0055620 - Duck Creek Modification

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EXTERNAL EMAIL

Rhys, I've attached the pre-public notice draft of the modified Duck Creek NPDES Permit. Please look it over and give me any comments you have. I'll hold this from 30-day public notice until you give me either comments or an all-clear.

Mark E. Liska
Environmental Protection Engineer
Industrial Permits Section, Bureau of Water
Illinois Environmental Protection Agency
1021 N. Grand Ave. East, P.O. Box 19276
Springfield, IL 62794-9276
Phone: (217) 782-0610
Fax: (217) 782-9891

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Document 36

Electronic Filing: Received, Clerk's Office 06/20/2024

From:	Jenny Cassel
To:	EPA.BOW.GWS.CCR@illinois.gov
c:	arehn; Faith Bugel; Mychal Ozaeta; Lauren Piette
Subject:	[External] RE: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek
Date:	Tuesday, December 5, 2023 1:40:25 PM

Ms. Mullenax and others,

Thank you for sending the decision letters concerning the ASDs for Newton and Baldwin. I would be grateful if you would provide IEPA's concurrence or non-concurrence with the ASD via email, as Ms. Hunt did with the Joppa non-concurrence, as I often am not in the office and will be even less so over the holidays.

Thanks in advance,
Jenny Cassel

From: Jenny Cassel <jcassel@earthjustice.org>
Sent: Tuesday, November 28, 2023 2:09 PM
To: EPA.BOW.GWS.CCR@illinois.gov
Cc: arehn <arehn@prairierivers.org>; Faith Bugel <fbugel@gmail.com>; Mychal Ozaeta <mozaeta@earthjustice.org>; Lauren Piette <lpiette@earthjustice.org>
Subject: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek

Ms. Mullenax and others it may concern,

Please see attached comments concerning the ASDs for Hennepin and Duck Creek. We appreciate your consideration of those comments and would be grateful to receive a copy of EPA's concurrence or denial of concurrence with those ASDs.

Best,
Jenny Cassel

Jenny Cassel
Senior Attorney, Clean Energy Program
Earthjustice
311 S. Wacker Drive, Suite 1400
Chicago, IL 60606
T: 312-500-2198 (direct)
jcassel@earthjustice.org

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 · (217) 782-3397
JB PRITZKER, GOVERNOR
JOHN J. KIM, DIRECTOR

217-782-1020

November 7, 2023

Phil Morris
Illinois Power Generating Company
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Re: Newton Power Plant Primary Ash Pond – W079807001-01
Alternative Source Demonstration Submittal

Dear Mr. Morris:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Newton Primary Ash Pond Alternative Source Demonstration (ASD) dated October 6, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the Primary Ash Pond must include total solids sampling in accordance with SW846.
2. Hydraulic conductivities from laboratory or in-situ testing must be collected, analyzed, and presented with hydrogeologic characterization of bedrock unit.
3. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.

If you have any questions, please contact: **Heather Mullenax** Illinois EPA, Bureau of Water, PWS #13, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Heather Mullenax
Francisco Herrera
WPC Files 06M

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Document 38

Electronic Filing: Received, Clerk's Office 06/20/2024

From:	Jenny Cassel
To:	EPA.BOW.GWS.CCR
Cc:	arehn; Faith Bugel; Mychal Ozaeta; Lauren Piette
Subject:	[External] RE: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek
Date:	Tuesday, December 5, 2023 2:07:27 PM

Thanks very much! I should have clarified – I did receive those letters when I got into the office today, but would be grateful if you could send future ASD decisions via email.

Best,
Jenny Cassel

From: EPA.BOW.GWS.CCR <EPA.BOW.GWS.CCR@Illinois.gov>
Sent: Tuesday, December 5, 2023 2:05 PM
To: Jenny Cassel <jcassel@earthjustice.org>
Cc: arehn <arehn@prairierivers.org>; Faith Bugel <fbugel@gmail.com>; Mychal Ozaeta <mozaeta@earthjustice.org>; Lauren Piette <lpiette@earthjustice.org>
Subject: RE: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek

External Sender

Good afternoon all,

I have attached an email copy of the decision letters for the Newton and Baldwin ASDs. Please let me know if you need anything else.

Thanks,

Heather D. Mullenax, M.S.

From: Jenny Cassel <jcassel@earthjustice.org>
Sent: Tuesday, December 5, 2023 1:40 PM
To: EPA.BOW.GWS.CCR <EPA.BOW.GWS.CCR@Illinois.gov>
Cc: arehn <arehn@prairierivers.org>; Faith Bugel <fbugel@gmail.com>; Mychal Ozaeta <mozaeta@earthjustice.org>; Lauren Piette <lpiette@earthjustice.org>
Subject: [External] RE: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek

Ms. Mullenax and others,

Thank you for sending the decision letters concerning the ASDs for Newton and Baldwin. I would be grateful if you would provide IEPA's concurrence or non-concurrence with the ASD via email, as Ms. Hunt did with the Joppa non-concurrence, as I often am not in the office and will be even less so over the holidays.

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Thanks in advance,
Jenny Cassel

From: Jenny Cassel <jcassel@earthjustice.org>
Sent: Tuesday, November 28, 2023 2:09 PM
To: EPA.BOW.GWS.CCR@illinois.gov
Cc: arehn <arehn@prairierivers.org>; Faith Bugel <fbugel@gmail.com>; Mychal Ozaeta <mozaeta@earthjustice.org>; Lauren Piette <lpiette@earthjustice.org>
Subject: Comments of Earthjustice, Prairie Rivers Network, and Sierra Club on ASDs for Hennepin and Duck Creek

Ms. Mullenax and others it may concern,

Please see attached comments concerning the ASDs for Hennepin and Duck Creek. We appreciate your consideration of those comments and would be grateful to receive a copy of EPA's concurrence or denial of concurrence with those ASDs.

Best,
Jenny Cassel

Jenny Cassel
Senior Attorney, Clean Energy Program
Earthjustice
311 S. Wacker Drive, Suite 1400
Chicago, IL 60606
T: 312-500-2198 (direct)
jcassel@earthjustice.org

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Strauss, Rebecca Y.

From: Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Sent: Tuesday, December 5, 2023 3:00 PM
To: Mullenax, Heather; Garee, Matthew J.; Bierwagen, Justin
Subject: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx
Attachments: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx

Hi all.
Please see attached for an example CC list for the ASDs (in the ASD letters). We are getting comments for ASDs from Earth Justice, Prairie Network and Sierra Club via email and can respond to them via email. The emails of the individuals involved are in the BOW GWS CCR email from Jenny Cassel.
Also, each of these folks will need a PDF copy from us (like the GWS person in charge of the site) when we issue the letter to the O/O.
Thanks. Lauren

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

217-782-1020

June 11, 2024

Dianna Tickner
Electric Energy, Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Re: Duck Creek Power Plant GMF Pond – W0578010001-04
Alternative Source Demonstration Submittal

Dear Ms. Tickner:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Duck Creek GMF Pond Alternative Source Demonstration (ASD) dated November 11, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the GMF Pond must include total solids sampling in accordance with SW846.
2. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.

If you have any questions, please contact: Matthew Garee Illinois EPA, Bureau of Water, PWS #13, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Matthew Garee
Lauren Hunt
Francisco Herrera
WPC Files 06M

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CC2: Jenny Cassel via email
Andrew Rehn via email
Faith Bugel via email
Mychal Ozaeta via email
Lauren Piette via email

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Document 41

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Meade, Mallory

From: Hunt, Lauren
Sent: Tuesday, December 5, 2023 3:45 PM
To: Mullenax, Heather; Garee, Matthew J.; Bierwagen, Justin
Subject: RE: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx

Hi all.
We need to make sure we are filing ASDs on the N Drive under GW Submittals in the Part 845 folder.
Thanks, Lauren

Lauren I. Hunt, M.S.
(she/they/he)
Environmental Protection Geologist III
Illinois Environmental Protection Agency
Bureau of Water
Groundwater Section
1021 N. Grand Avenue
PO Box 13
Springfield, IL 62702
D: 217-524-9048
C: 309-361-0037
Lauren.hunt@illinois.gov
Hours: 8:30 am to 5:30 pm Tuesday through Friday
8:30 am to 4 pm Mondays and alternating Mondays off
Working remotely Mondays and Fridays.

From: Hunt, Lauren
Sent: Tuesday, December 5, 2023 3:00 PM
To: Mullenax, Heather <Heather.Mullenax@Illinois.GOV>; Garee, Matthew J. <Matthew.Garee@illinois.gov>; Bierwagen, Justin <Justin.Bierwagen@Illinois.GOV>
Subject: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx

Hi all.
Please see attached for an example CC list for the ASDs (in the ASD letters). We are getting comments for ASDs from Earth Justice, Prairie Network and Sierra Club via email and can respond to them via email. The emails of the individuals involved are in the BOW GWS CCR email from Jenny Cassel.
Also, each of these folks will need a PDF copy from us (like the GWS person in charge of the site) when we issue the letter to the O/O.
Thanks. Lauren

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Document 42

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Strauss, Rebecca Y.

From: Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Sent: Tuesday, December 5, 2023 3:47 PM
To: Dunaway, Lynn
Cc: Garee, Matthew J.
Subject: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx
Attachments: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx

Hi Lynn.
Here is the ASD for Duck Creek for review. We need to send this out on Thursday.
Thanks, Lauren

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Electronic Filing: Received, Clerk's Office 06/20/2024

From:	Dunaway, Lynn
To:	Hunt, Lauren
c:	Garee, Matthew J.
Subject:	RE: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx
Date:	Tuesday, December 5, 2023 4:41:54 PM

It looks ok to me.

From: Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Sent: Tuesday, December 5, 2023 3:47 PM
To: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>
Cc: Garee, Matthew J. <Matthew.Garee@Illinois.gov>
Subject: Draft ASD Duck Creek NonConcurrence letter Dec 2023.docx

Hi Lynn.
Here is the ASD for Duck Creek for review. We need to send this out on Thursday.
Thanks, Lauren

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Electronic Filing: Received, Clerk's Office 06/20/2024

From: Garee, Matthew J.
To: Summers, Michael
Cc: Dunaway, Lynn; Hunt, Lauren
Subject: Duck Creek ASD
Date: Wednesday, December 6, 2023 9:42:33 AM
Attachments: Final ASD Duck Creek NonConcurrence letter Dec 2023.docx

---

Good morning Mike,

Here is the final draft for the Duck Creek ASD. It's ready for your signature when you get a chance. Once it's signed if you could make a PDF and send it back my way and get a hard copy to Sherry to send out I would appreciate it. Once I have the signed PDF I'll get it on the N-Drive and get it sent out to the other people cc'd.

Thanks,

Matthew J. Garee
Environmental Protection Geologist 1
Illinois Environmental Protection Agency
Bureau of Water
Division of Public Water Supplies
Groundwater Section
1021 N. Grand Avenue
Springfield, IL 62702
~~~~~~~~~~~~~~~~~~
You can contact me:
Cell: 309-531-2893
Matthew.Garee@illinois.gov
Hours: 8:30 am to 5:00 pm Monday-Friday

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

217-782-1020

June 11, 2024

Dianna Tickner
Electric Energy, Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Re: Duck Creek Power Plant GMF Pond – W0578010001-04
Alternative Source Demonstration Submittal

Dear Ms. Tickner:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Duck Creek GMF Pond Alternative Source Demonstration (ASD) dated November 11, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the GMF Pond must include total solids sampling in accordance with SW846.
2. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.

If you have any questions, please contact: Matthew Garee Illinois EPA, Bureau of Water, PWS #13, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Matthew Garee
Lauren Hunt
Francisco Herrera
WPC Files 06M

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CC2: Jenny Cassel via email
Andrew Rehn via email
Faith Bugel via email
Mychal Ozaeta via email
Lauren Piette via email

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Document 46

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From: Summers, Michael
To: Garee, Matthew J.
Subject: RE: Duck Creek ASD
Date: Wednesday, December 6, 2023 9:53:14 AM

Has Lynn signed off on it?

From: Garee, Matthew J. <Matthew.Garee@Illinois.gov>
Sent: Wednesday, December 6, 2023 9:43 AM
To: Summers, Michael <Michael.Summers@Illinois.gov>
Cc: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Subject: Duck Creek ASD

Good morning Mike,

Here is the final draft for the Duck Creek ASD. It's ready for your signature when you get a chance. Once it's signed if you could make a PDF and send it back my way and get a hard copy to Sherry to send out I would appreciate it. Once I have the signed PDF I'll get it on the N-Drive and get it sent out to the other people cc'd.

Thanks,

Matthew J. Garee
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Groundwater Section
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From:	Dunaway, Lynn
To:	Garee, Matthew J.; Summers, Michael
Cc:	Hunt, Lauren
Subject:	RE: Duck Creek ASD
Date:	Wednesday, December 6, 2023 9:53:40 AM
Attachments:	Final ASD Duck Creek NonConcurrence letter Dec 2023.docx

Mike,
I did review this letter and it appears to be ready for signature.

Lynn

From: Garee, Matthew J. <Matthew.Garee@Illinois.gov>
Sent: Wednesday, December 6, 2023 9:43 AM
To: Summers, Michael <Michael.Summers@Illinois.gov>
Cc: Dunaway, Lynn <LYNN.DUNAWAY@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>
Subject: Duck Creek ASD

Good morning Mike,

Here is the final draft for the Duck Creek ASD. It's ready for your signature when you get a chance. Once it's signed if you could make a PDF and send it back my way and get a hard copy to Sherry to send out I would appreciate it. Once I have the signed PDF I'll get it on the N-Drive and get it sent out to the other people cc'd.

Thanks,

Matthew J. Garee
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CC2: Jenny Cassel via email
Andrew Rehn via email
Faith Bugel via email
Mychal Ozaeta via email
Lauren Piette via email

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Document 48

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Richardson, Sherri L
To: Rehn, Andrew
Cc: Garee, Matthew J.
Subject: Alternative Source Demonstration Submittal
Date: Wednesday, December 6, 2023 1:14:15 PM
Attachments: Scanned from a Xerox Multifunction Printer.pdf

Please see the attached Alternative Source Demonstration Submittal for Duck Creek Power Plant GMF Pond.

Sherri Richardson

Division of Public Water Supplies
Bureau of Water
Illinois Environmental Protection Agency

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JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

217-782-1020

December 6, 2023

Dianna Tickner
Electric Energy, Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Re: Duck Creek Power Plant GMF Pond – W0578010001-04
Alternative Source Demonstration Submittal

Dear Ms. Tickner:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Duck Creek GMF Pond Alternative Source Demonstration (ASD) dated November 11, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the GMF Pond must include total solids sampling in accordance with SW846.
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If you have any questions, please contact: Matthew Garee Illinois EPA, Bureau of Water, PWS #13, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Matthew Garee
Lauren Hunt
Francisco Herrera
WPC Files 06M

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Document 50

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Garee, Matthew J.
To: jcassel@earthjustice.org; arehn@prairierivers.org; mozaeta@earthjustice.org; lpiette@earthjustice.org; fbugel@gmail.com
Subject: Duck Creek ASD Non-concurrence letter
Date: Wednesday, December 6, 2023 1:50:00 PM
Attachments: Signed ASD Duck Creek NonConcurrence letter Dec 2023.pdf

Good afternoon,

Please find the attached email copy of the decision letter for the Duck Creek ASD. Please let me know if you need anything else.

Thanks,

Matthew J. Garee
Environmental Protection Geologist 1
Illinois Environmental Protection Agency
Bureau of Water
Division of Public Water Supplies
Groundwater Section
1021 N. Grand Avenue
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cc: Matthew Garee
Lauren Hunt
Francisco Herrera
WPC Files 06M

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Document 52

Electronic Filing: Received, Clerk's Office 06/20/2024

From: Hunt, Lauren
To: Dunaway, Lynn; Summers, Michael; Seif, Josiah; Garee, Matthew J.; Rompot, Derek
Subject: Canceled: Mail Duck Creek ASD Letter
Importance: High

Lauren to Coordinate Letter signing with Mike Summers.

Duck Creek ASD Response Letter to include any comments from the Public response per Lynn and Mike.

Check with Derek and Josiah for public comments received. Letter to be provided to Sherri for mailing by 1 pm.

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