SITE-SPECIFIC RULE FOR THE CLOSURE OF AMEREN COMPANY ASH PONDS: PROPOSED NEW 35 ILL. ADM. CODE 840, SUBPART B

TECHNICAL SUPPORT DOCUMENT

Executive Summary

This technical support document ("TSD") presents the rationale, documentation, and methodology developed by Ameren Energy Resources ("AER") in support of this proposal for a site-specific rule for the closure of surface impoundments located at the Coffeen, Duck Creek, E.D. Edwards, Grand Tower, Hutsonville, Joppa, and Meredosia, and Newton Power Stations located in various counties in Illinois.

Of the impoundments within the AER system that may be subject to closure under the proposed rulemaking, three went into service in the 1950s, two in the 1960s, eight in the 1970s, three in the 1980s, and one in 2000. Ash pond closures are site-specific. Each large, multi-acre project must be tailored to each facility and individually designed.

The phased closure approach based on risk to human health and the environment proposed in this submittal is considered reasonable, attainable, and cost-effective. The proposed rule requires AER to perform an initial assessment to categorize the ash ponds for a phased closure. Sites imposing the greatest risk to human health and the environment will close first and the least riskiest will fall to a lower category requiring closure during a later phase. Should conditions change over time, the rule provides for recategorization based on risk. The proposed rule requires each ash pond to be covered and capped with a geosynthetic membrane. The geosynthetic membrane will cover the impounded ash so that it is no longer subject to precipitation and surface water infiltration. When fully implemented, the proposed cap and closure scenario will improve groundwater quality around surface impoundments showing impacts to groundwater.

The TSD consists of several reports generated by several parties in preparation for this proposal, each document is incorporated into the TSD as chapters and each page has been bates stamped to allow interested parties to easily reference the page. In addition to site maps, the TSD includes the following documents:

- Map of AER Power Stations in Illinois – This map shows where the eight energy centers are located in Illinois.
- Risk-Based Evaluation of the Site-Specific Rule for the Closure of Ameren Company Ash Ponds – This document evaluates the risk- based approach of the proposed rule. The assessment concludes that the proposed rule, from prioritizing the surface impoundments for closure to the closure plan and associated activities, will be protective of human health and the environment.
- Hydrogeological Assessment Reports – These reports analyze the available groundwater monitoring data and describe existing physical conditions, including the character of the area involved, at the Coffeen, Duck Creek, Edwards, Grand Tower, and Meredosia Power Stations. The reports evaluate groundwater quality data at the various surface impoundments located at these facilities and evaluate possible adverse impacts. Finally, the reports recommend future actions related to groundwater quality management.
- Affidavit of Duane Harley – Mr. Harley's affidavit discusses AER's basis for the proposed rulemaking and background information regarding each energy center and the surface impoundments at those energy centers that could close under the proposed rule. Mr. Harley also discusses the estimated costs of closure in place for each site.
- Maps of Individual Energy Centers – These maps show the location of ash ponds located at each energy center.

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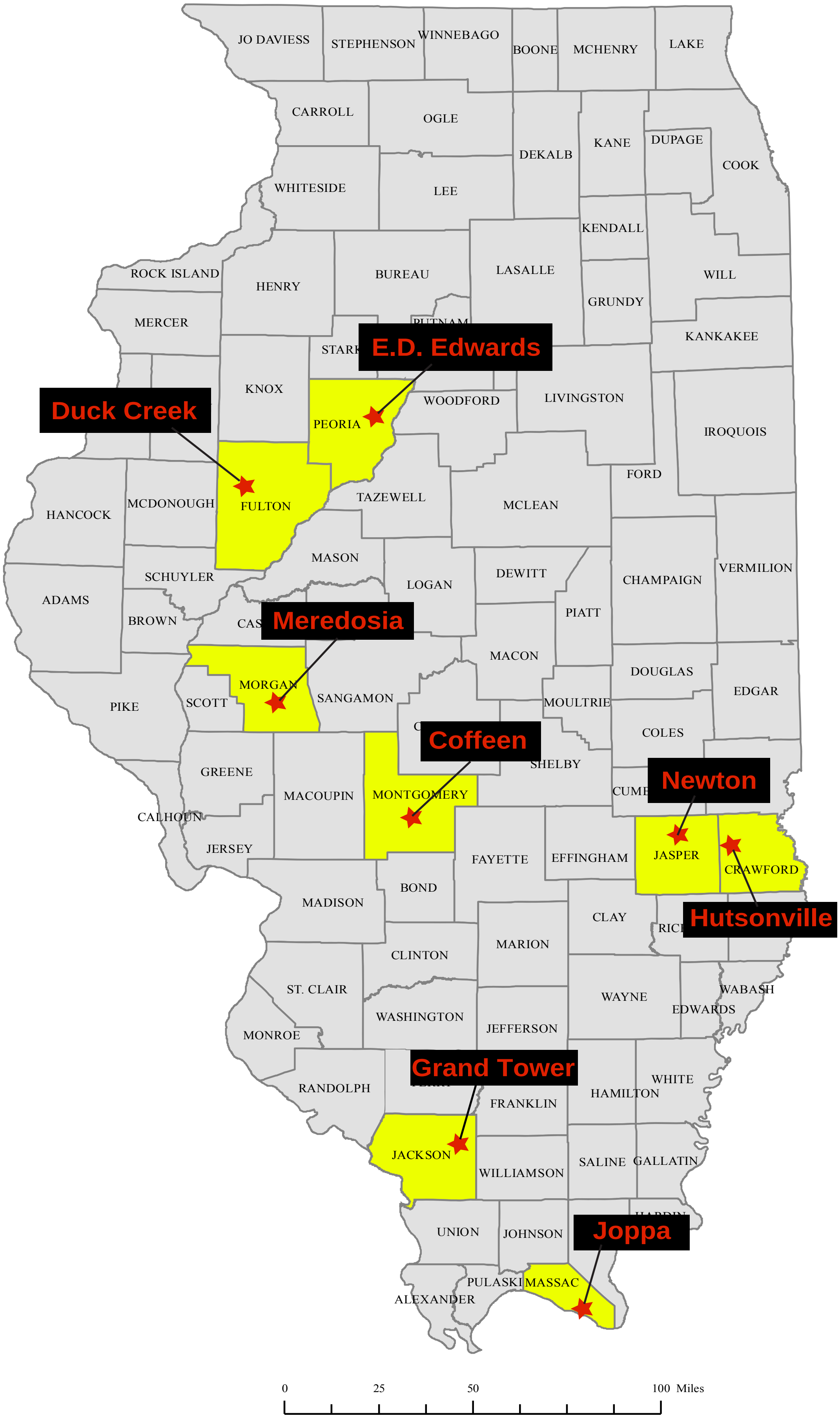
CHAPTER 1

MAP OF AER POWER STATIONS IN ILLINOIS


E.D. Edwards
Duck Creek
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Hutsonville
Grand Tower
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OGLE
DEKALB
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CHAPTER 2

AECOM REPORT

Risk-Based Evaluation of the Site-Specific Rule for the Closure of Ameren Company Ash Ponds

Lisa JN Bradley, Ph.D., DABT, Vice President and Senior Toxicologist, AECOM

The purpose of this report is to provide a toxicologist's and risk assessor's perspective on the Ameren Companies (Ameren Energy Generating Company, Ameren Energy Resources Generating and Electric Energy Inc.) proposed site-specific regulations to address the closure of certain coal combustion surface impoundments (referred to herein as "surface impoundments") located at the power plant sites in Illinois. Ameren intends that these closures be protective of human health and the environment. To that end, the proposed regulations contemplate prioritizing the closure sequence of the impoundments addressed by the regulations to ensure that any impoundments that may pose a current or imminent threat to human health or the environment are addressed in a timely manner.

Risk assessment is the tool that is used both by the federal U.S. Environmental Protection Agency (USEPA) (see USEPA, 1989) and the Illinois Environmental Protection Agency (IEPA) (see the Tiered Approach to Corrective Action Objectives – TACO – at IL Code 35 at Part 742) to determine if actions are protective of human health and the environment. Risk assessment can be defined as the estimation of the risk of harm to human health or the environment posed by chemicals that are present at, or that may have moved away from, industrial materials management sites. Risk assessments include the evaluation of:

- The nature and occurrence of constituents present in the industrial material (**Hazard Identification**),
- The ways that constituents may move within the environment and whether or not impact may occur to environmental media to which human or environmental receptors may be exposed (**Exposure Assessment**),
- The potential toxicity that may be posed by these constituents under specific conditions of exposure (**Toxicity or Dose-Response Assessment**),

- And should exposure occur, what risk to human health and or the environment may ensue (**Risk Characterization**).

Risk assessments and evaluation of exposure, toxicity and risk are used routinely in regulatory and remedial closure settings to evaluate potential impact to human health and the environment.

These issues are considered here in the context of the development of this specific rule-making in Illinois for the closure of surface impoundments owned and/or operated by the Ameren companies. In the first section, the fundamental concepts of risk assessment are reviewed. The use of the conceptual site model for evaluating environmental settings is described, and the components are discussed in the context of this rulemaking in Section 2. As this rulemaking focuses on drinking water uses of groundwater and surface water resources, state and federal drinking water quality standards are discussed in Section 3. These risk-based concepts have been used in the development of the methodology to categorize each surface impoundment with respect to priority for closure, based on the real or potential impact of drinking water resources; this categorization is summarized in Section 4. A summary is provided in Section 5, and references are in Section 6.

1.0 THE RELATIONSHIP BETWEEN TOXICITY, EXPOSURE AND RISK

Toxicity is a measure of how harmful a given constituent may be to humans. Each constituent has a specific toxicity. Toxicology, simply put, is the study of poisons, or the types of toxic effects constituents may have on humans. Paracelsus, the father of modern toxicology, said it best in the 1500s:

> "*All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy*."

For example, aspirin is common in many home medicine cabinets. It can be taken safely and effectively, 2 tablets every 4 hours, for aches and pains or to control a fever. If taken for an extended period of time, this same dosage may cause stomach problems, or ringing in the ears. However, consuming an entire bottle of aspirin can be lethal. So, aspirin can be safe and effective at a low dose (2 tablets), and yet toxic at a very high dose (an entire bottle).

The USEPA uses this type of dose/response information to derive numeric estimates of the toxicity of a wide range of constituents. These numeric estimates are used in risk assessments to evaluate exposures by humans to constituents in the environment.

Risk can be defined as the likelihood (or probability) that a given chemical exposure or series of exposures may be toxic to exposed individuals (people). Some chemicals have or may present a risk of toxicity (for example, household cleaning products). However, it is only through direct exposure to the chemicals in household cleaning products in certain quantities and over a certain duration that can result in toxic effects. Not all exposures result in toxicity. For example, household cleaning products are safe when used as directed (e.g., bleach); however, they can pose a risk if they are swallowed. Whether or not an adverse health effect will occur depends on how much is swallowed and whether it happens once or multiple times. Ultimately, the risk of a toxic effect depends on both exposure and toxicity.

Risk assessment is the tool used by regulatory agencies and environmental scientists to determine if exposure to something in the environment may have toxic effects. Risk assessment is a step-wise process that makes a quantitative estimate of risk by combining information on 1) exposure--how someone may be exposed to a material or constituent in the environment and at what level of exposure, with 2) a quantitative estimate of the toxicity of that material or constituent. The result is a quantitative estimate of risk.

> *Thus: Risk = Exposure x Toxicity.*

For there to be a significant risk of an adverse effect, there must be *both* a direct exposure to a constituent and that exposure must be at a high enough level to result in an adverse effect. It is very important to understand:

> *If there is no exposure to a chemical constituent or material, then there is no risk,*
>
> *and, if there is no toxicity at that level of exposure, there is no risk.*

This concept is fundamental to the IEPA TACO program (see Section 742.300), which allows for exposure route exclusion if it is demonstrated that there is not a complete exposure pathway between a constituent source and point of human exposure, i.e., if there is no exposure. This is the concept underlying the development of a conceptual site model, as discussed below.

Risk assessment is also used to develop screening levels for constituents, for example, tapwater, and also serves as the basis for drinking water standards such as the Illinois Class I Groundwater

Standards (35 Ill. Adm. Code 620), and the Public and Food Processing Water Supply Standards (35 Ill. Adm. Code 302).

2.0 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) is used to identify appropriate exposure settings for evaluation in a risk assessment. The purpose of the CSM is to identify:

1) Areas that may serve as sources of constituents to the environment,
2) Potential migration pathways of constituents from source areas to environmental media (e.g., soil and water) where potential exposure can occur, and
3) Potential human or environmental receptors.

In the course of developing a CSM, a risk assessor identifies potentially complete exposure pathways for further evaluation in the risk assessment. For an exposure pathway to be complete, the following conditions must exist (USEPA, 1989):

1) A source and mechanism of constituent release to the environment;
2) An environmental transport medium (e.g., air, water, soil);
3) A point of potential receptor contact with the medium; and
4) A human or ecological exposure route at the contact point (e.g., inhalation, ingestion, dermal contact).

The concept of the complete exposure pathway is fundamental to risk assessment. *If there is no complete exposure pathway, then there is no exposure by humans or environmental receptors to the constituents, and there is no risk to human health or the environment.* Thus, unless all of the four listed conditions are met for a given environmental scenario, there is no complete exposure pathway, and there will be no human health or environmental risk posed by that scenario.

The categorization of the surface impoundments contemplated by this proposed rule is based on the current understanding of the CSM for these units. The general CSM is discussed below, organized by the four components listed above.

2.1 A SOURCE AND MECHANISM OF CONSTITUENT RELEASE TO THE ENVIRONMENT

The source is the coal ash that is stored in the surface impoundments. Coal ash is the unburned/unburnable residuals from the combustion of coal. In a modern coal-fired power plant, combustion of organic materials in the coal is nearly complete, leaving the inorganic minerals and elements in the ash (coal ash). The two most common types of coal ash are bottom ash, which settles out at the bottom of the boiler, and fly ash, which is captured in the flue gas by air pollution control equipment.

The makeup of coal ash is very similar to the makeup of naturally occurring soils and rock. Coal ash, soil and rocks mainly consist of oxides of silica and aluminum and other minor elements (EPRI, 2010). Less than 1% of coal ash, soil, or rock is made up of what are called trace elements; it is these trace elements that are most commonly the focus of environmental investigations.

Concentrations of constituents in coal ash have been published by the U.S. Geological Survey (USGS, 2011). The report provides coal ash data from a range of U.S. power plants, each utilizing coal from different U.S. coal provinces. Another source of information on the constituent concentrations in coal ash is the database maintained by the Electric Power Research Institute (EPRI) from reports by various coal-fired power plants across the nation; their results are summarized in the report “Comparison of Coal Combustion Products to Other Common Materials” (EPRI, 2010). The constituent concentration ranges from these two separate sources are similar.

It is important to note that all of the constituents in coal ash are also naturally present in the soils and groundwater in our environment. The USGS has also studied the background levels of these constituents in soils. Because these constituents are present naturally in soils, they are also commonly present in the food we eat.

Thus, while it is important to include these constituents in an environmental investigation such as for the surface impoundments, it is also important to know that humans are naturally exposed to these constituents on a daily basis.

The primary mechanism of release of constituents in coal ash from surface impoundments is via leaching of the constituents into the impoundment water. This is discussed in more detail in the next section.

2.3 ENVIRONMENTAL TRANSPORT: GROUNDWATER AND SURFACE WATER

Environmental transport pathways for constituent release from surface impoundments include leaching to underlying groundwater and discharge of groundwater to surface water.

2.3.1 LEACHING TO GROUNDWATER

Leaching may occur for material in a surface impoundment, where constituents can leach from the coal ash into the contacting water. The water in contact with the material, or “leachate” can leave the surface impoundment by percolating down through the underlying soils. During this transit through the soil column, constituents can adsorb, or attach, onto soil particles thereby decreasing the concentrations in the water phase through the process called adsorption. Constituents in the leachate may reach the water table, where the constituents are mixed and diluted into the groundwater, further decreasing concentrations. Once in groundwater, constituents can move as the plume moves through the soils in the subsurface, and concentrations in groundwater can further decrease due to the processes of adsorption and dispersion. For each surface impoundment, it will be important to identify what directions in groundwater are downgradient, cross-gradient, and upgradient of the impoundment.

As noted above, constituents in coal and coal ash are naturally present in soils, therefore, there are also background levels of these constituents in groundwater already. Because of background levels, groundwater upgradient and cross-gradient of a surface impoundment will likely exhibit naturally occurring concentrations of constituents that can also be present in coal ash. One aspect of the hydrogeologic site investigation outlined in the proposed rule is to understand groundwater flow directions, background levels of constituents in groundwater, and identify areas that may be impacted by leaching from the surface impoundments.

2.3.2 DISCHARGE TO SURFACE WATER

When groundwater flows into a surface water body, the constituents in the groundwater are further diluted when the water is mixed into the surface water; the extent of mixing is determined by the size and nature of the surface water body.

2.4 A POINT OF CONTACT WITH THE MEDIUM AND ROUTES OF EXPOSURE

There are two main exposure pathways for constituents in coal ash. The first is the potential for direct contact with the coal ash itself, and the second is the potential for leaching of constituents from the coal ash into underlying groundwater and the potential contact with groundwater, and/or the discharge of groundwater to surface water and the potential contact with constituents in the surface water. These pathways are discussed below.

2.4.1 Evaluation Of Direct Contact Exposures

The surface impoundments that are the subject of this rule-making are part of an industrial process and are located on land owned and controlled by the Ameren Companies. Only authorized personnel may enter a plant property, the perimeter of which is fenced and subject to strict security measures. Unescorted general public access is prohibited. Thus the direct contact exposure pathway would be identified as incomplete for risk assessment purposes. Accordingly, there is no direct contact risk for exposure to coal ash[1] at these facilities.

2.4.2. Drinking Water

For each surface impoundment, the source(s) of drinking water, groundwater and/or surface water, in the vicinity of the facility will be identified.

Groundwater. Humans can be exposed to constituents in groundwater if groundwater is used as a source of drinking water. Thus for each surface impoundment, the area(s) downgradient of the location used as source(s) of drinking water will be identified, including locations of private drinking water wells and municipal water supply wells. The setback zone of each existing groundwater supply will be identified (415 ILCS 5/3.450).

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[1] The range of concentrations of the constituents in coal ash as reported by USGS (2011) has been compared to USEPA risk-based screening levels for residential soil (USEPA, 2012), and to USGS background levels (as summarized by EPRI, 2010) in a report for the American Coal Ash Association (ACAA) titled “Coal Ash Material Safety: A Health Risk-Based Evaluation of USGS Coal Ash Data from Five US Power Plants” (AECOM, 2012). These risk-based screening levels are considered by USEPA to be protective for daily exposure by humans (including sensitive groups) over a lifetime. By making this comparison, it is assumed that coal ash could completely replace the soil in a residential yard. The comparisons represent a residential scenario where coal ash would be available instead of soil for exposure by children and adults on a daily basis. The results indicate that with few exceptions constituent concentrations in coal ash are below of the screening levels for residential soils, and are similar in concentration to background levels in naturally occurring U.S. soils. Figure 1 in the attachment shows the comparison for fly ash, and Figure 2 shows the comparison for bottom ash. Of the 17 constituents shown on the graphs, concentrations in coal ash (shown by vertical purple bars) of only five constituents range to above the residential soil screening level (shown by a horizontal green bar): arsenic, chromium, cobalt, thallium, and vanadium. Moreover, concentrations at the high end of the range are only slightly above the screening levels. Finally, these constituent concentrations in coal ash are similar to constituent concentrations in background soil (shown by vertical grey bars). More details can be found in the ACAA report (AECOM, 2012):

Surface Water. Surface water can also be a source of municipal drinking water. If this is the case, it is important to determine if that surface water body can be impacted by the surface impoundment. The location of the municipal water intake needs to be identified as either upstream or downstream of the coal ash disposal facility. Even if a municipal surface water intake is located downstream of a coal ash surface impoundment, that intake may not be impacted to a discernible level due to the dilution that occurs in the surface water source, such as rivers and streams.

2.4.3 Surface Water

Surface water can also be used for human recreational activities, and it is an ecological resource. These non-drinking water uses of surface water will be evaluated as part of the hydrogeologic site investigation (Section 840.214 of the proposed rule).

3.0 DRINKING WATER STANDARDS

The use of groundwater as drinking water is the important consideration for human health. Drinking water standards are used to evaluate whether a water resource is suitable for use as a potential source of drinking water. USEPA develops drinking water standards, called Maximum Contaminant Levels, or MCLs (USEPA, 2012). These standards have been incorporated into the Illinois Class I Groundwater Standards (35 Ill. Adm. Code 620), and the Public and Food Processing Water Supply Standards (35 Ill. Adm. Code 302). It is important to note that these standards apply to the specific drinking water location.

3.1 GROUNDWATER

Leachate concentrations can be much higher than the standards and still not pose an adverse risk, because of all of the subsurface processes discussed above that serve to attenuate or decrease the constituent concentrations as they transit through the subsurface and through groundwater. Thus, comparing leachate concentrations directly to drinking water standards can identify constituents whose concentrations are below the standards and are, therefore, not of concern. However, the presence of leachate concentrations that are above drinking water standards do not mean that there is a health risk, only that additional evaluation is warranted.

The same applies to constituent data from groundwater monitoring wells. Comparing groundwater concentrations from well samples directly to drinking water standards can identify constituents whose concentrations are below the standards and are, therefore, not of concern; but the presence of concentrations that are above drinking water standards do not mean that there is a health risk, only that additional evaluation is warranted. Further evaluation may include plume size and location, and the proximity of drinking water wells. All of these considerations, including potential impact to ecological resources, will be addressed in the hydrogeological site investigation required by the proposed rule. (Section 840.214 of the proposed rule.)

3.2 SURFACE WATER

If the surface water is used for drinking water, then drinking water standards can be used to evaluate constituent concentrations. It must be noted that the standards apply to the location where the surface water is withdrawn by a municipal water supply, thus all of the processes of attenuation from a surface impoundment to groundwater to surface water and ultimately downstream to the drinking water intake apply.

Where a municipal water supply is present, the Public and Food Processing Water Supply Standards (35 Ill. Adm. Code 302) apply at the point of withdrawal. Where a municipal water supply is not present, but the water body could be used as such, the standards apply outside of the mixing zone where groundwater discharges to and mixes with the surface water.

4.0 CATEGORIZATION

The categorization methodology provided in the proposed rule uses the application of a CSM and the consideration of complete drinking water exposure pathways to prioritize the closure of the Ameren surface impoundments. The key elements of the methodology are consideration of exposure routes, contaminants of concern, land use, and water use. The methodology is based on evaluation of whether there is a real or potential impact of a release from a surface impoundment to a drinking water source, where impoundments that are currently impacting a drinking water source at concentrations above applicable Class I drinking water standards are given the highest priority, and those that could impact a drinking water source but do not do so currently are given second priority. Impoundments that impact off-site groundwater that is not used as a source of drinking water are given a lower priority, and impoundments that impact only on-site groundwater are given lowest priority (unless that groundwater is used as a source of drinking water, and in that case it would be of first priority). There are two categories of priority for surface water impacts. Impoundments where there is demonstrated impact of an off-site surface water body used for drinking water at the point of withdrawal are given first priority, and those where off-site water bodies not currently used for drinking water and where impacts to surface water above applicable Part 302 standards are demonstrated outside of a mixing zone are given second priority.

5.0 SUMMARY

In summary, the proposed rule for the site-specific closure of surface impoundments located at Ameren power plant sites in Illinois provides for a risk-based program of closure where priority is given to actual or potential impact to current drinking water resources. The approach is technically sound and based in the science of exposure and risk assessment. The categorization is based on the protection of human health and sources of drinking water, and importantly also addresses potential ecological impacts to surface waters.

6.0 REFERENCES

AECOM. 2012. Coal Ash Material Safety – A Risk-Based Evaluation. Prepared for the American Coal Ash Association. Available at: http://www.acaa-usa.org/associations/8003/files/ACAA_CoalAshMaterialSafety_June2012.pdf

EPRI. 2010. Comparison of Coal Combustion Products to Other Common Materials. September 2010. Report No. 1020556. The Electric Power Research Institute. Available for download at www.epri.com.

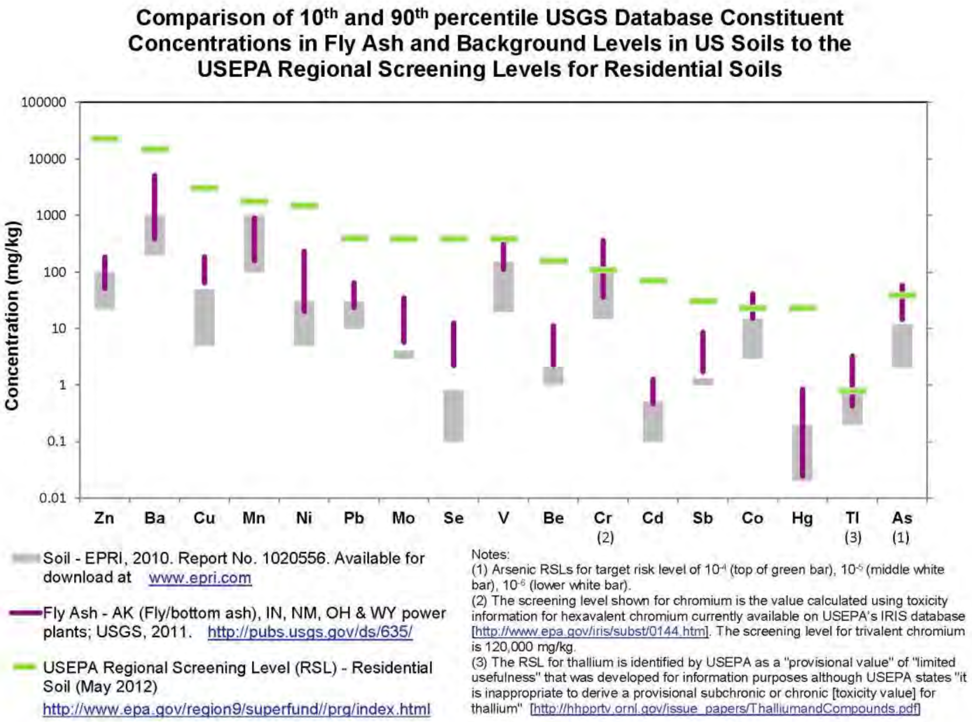
USEPA. 1989. Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington, D.C. EPA 540/1-89/002.

USEPA. 2012. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. May 2012. U.S. Environmental Protection Agency. Available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

USGS. 2011. Geochemical Database of Feed Coal and Coal Combustion Products (CCPs) from Five Power Plants in the United States. Data Series 635. U.S. Geological Survey. Available at: http://pubs.usgs.gov/ds/635/.

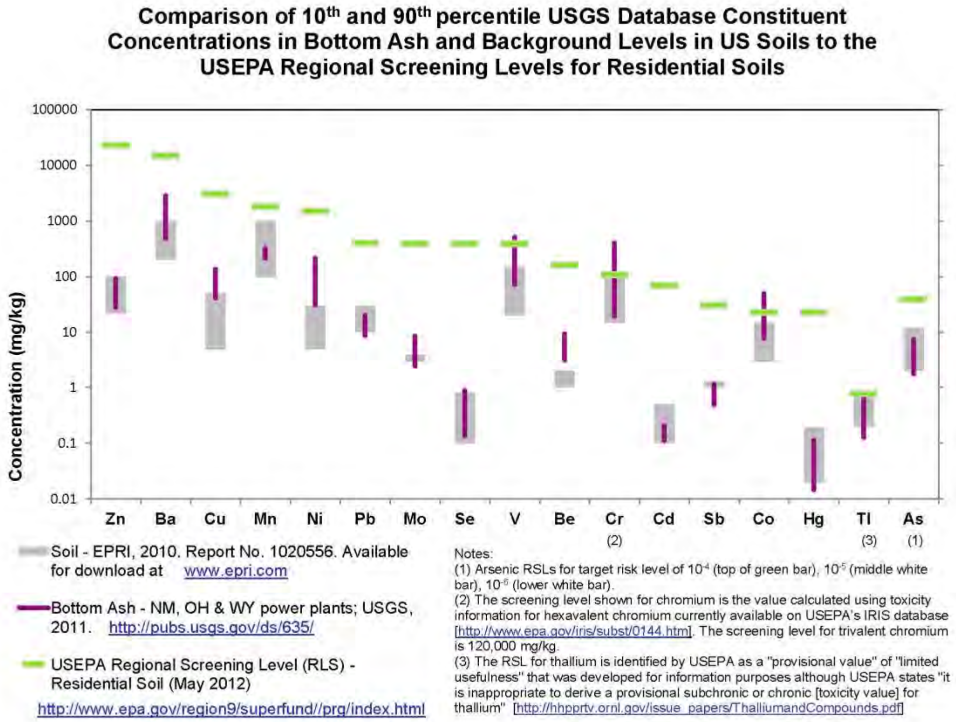
ATTACHMENT

Figure 1. Fly Ash.



Notes:
(1) Arsenic RSLs for target risk level of 10^{-4} (top of green bar), 10^{-5} (middle white bar), 10^{-6} (lower white bar).
(2) The screening level shown for chromium is the value calculated using toxicity information for hexavalent chromium currently available on USEPA's IRIS database [http://www.epa.gov/iris/subst/0144.htm]. The screening level for trivalent chromium is 120,000 mg/kg.
(3) The RSL for thallium is identified by USEPA as a "provisional value" of "limited usefulness" that was developed for information purposes although USEPA states "it is inappropriate to derive a provisional subchronic or chronic [toxicity value] for thallium" [http://hhpprtv.ornl.gov/issue_papers/ThalliumandCompounds.pdf]

Figure 2. Bottom Ash.



Comparison of 10th and 90th percentile USGS Database Constituent Concentrations in Bottom Ash and Background Levels in US Soils to the USEPA Regional Screening Levels for Residential Soils

▬ Soil - EPRI, 2010. Report No. 1020556. Available for download at www.epri.com

▬ Bottom Ash - NM, OH & WY power plants; USGS, 2011. http://pubs.usgs.gov/ds/635/

▬ USEPA Regional Screening Level (RLS) - Residential Soil (May 2012)
http://www.epa.gov/region9/superfund//prg/index.html

Notes:
(1) Arsenic RSLs for target risk level of 10^{-4} (top of green bar), 10^{-5} (middle white bar), 10^{-6} (lower white bar).
(2) The screening level shown for chromium is the value calculated using toxicity information for hexavalent chromium currently available on USEPA's IRIS database [http://www.epa.gov/iris/subst/0144.htm]. The screening level for trivalent chromium is 120,000 mg/kg.
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CHAPTER 3

NRT REPORTS

ENVIRONMENTAL CONSULTANTS

PHASE 1 HYDROGEOLOGICAL ASSESSMENT REPORT

COAL COMBUSTION PRODUCT IMPOUNDMENTS
COFFEEN ENERGY CENTER
MONTGOMERY COUNTY, ILLINOIS

Project No. 2121

Prepared For:

AMEREN ENERGY GENERATING COMPANY

Prepared By:

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March 19, 2013

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APPENDICES

1 INTRODUCTION

Ameren Energy Generating Company (Ameren) owns and operates the Coffeen Energy Center in Montgomery County, Illinois (Figure 1). The coal-fired plant currently operates two active impoundments and one landfill for coal combustion product (CCP) management. A closed, inactive CCP impoundment is also located at the site. The landfill used for fly ash management and an active impoundment used for FGD gypsum management are lined, while an active impoundment used for bottom ash management and the inactive impoundment formerly used for fly ash management are unlined. The landfill and lined impoundment have a groundwater monitoring program. To assess the potential for constituent migration from the unlined impoundments, as requested by the Illinois Environmental Protection Agency (Agency) in their correspondence dated March 29, 2009, Ameren has commissioned a hydrogeologic study, water well survey, development of a groundwater monitoring plan, and an initial groundwater quality assessment.

The objectives of this report are to:

- Summarize hydrogeologic information pertinent to the site.
- Evaluate groundwater quality data at the unlined impoundments to evaluate possible adverse impacts.
- Determine the potential for off-site migration and whether or not there are potential groundwater receptors in the event of a release.

2 SETTING

Portions of the information in this section were previously presented and modified from in the site characterization and groundwater monitoring plan developed by Rapps Engineering & Applied Services (November 2009).

2.1 Power Plant and CCP Management Facilities

The Coffeen Energy Center (Coffeen) is located in Montgomery County in central Illinois, approximately 2 miles south of the city of Coffeen (Figure 2). The plant is located between the east and west channels of Coffeen Lake and has two unlined coal ash impoundments, one active and one inactive, which are the subject of this hydrogeologic investigation. The impoundments are located in the southwest quarter of Section 11, Township 7 North, Range 7 East.

The active unlined impoundment (Bottom Ash/Recycle Pond) covers an area of 23 acres, has berms 41 feet above the surrounding land surface, and has a volume of 300 acre-feet. It primarily receives bottom ash from Coffeen’s two coal-fired cyclone boilers, and low volume wastes from floor drains in the main power block building. Several years ago, air heater wash and boiler chemical cleaning wastes were directed to the Bottom Ash/Recycle Pond but this practice was discontinued. This impoundment (formerly known as Ash Pond 1) is a reclaimed ash pond that was reconstructed utilizing the existing earthen berms with reinforcement, as provided by Water Pollution Control Permit 1978-EA-389 issued by the Agency on May 26, 1978. The bottom ash is periodically removed for beneficial uses, such as grit blasting and roofing shingles, by a third-party contractor.

The closed CCP impoundment (Ash Pond 2) has a surface area of approximately 60 acres and has berms 47 feet higher than the surrounding land surface. Ash Pond 2 was removed from service and capped in the mid 1980’s. Prior to capping, this pond was identified as Outfall 004 in the facility NPDES operating permit, IL0000108. A clay and soil cap was placed on the surface of the pond with contouring and drainage provided to direct storm water to four engineered revetment down drain structures.

A gypsum management facility (GMF), consisting of a 77-acre gypsum stack and 17-acre gypsum stack recycle pond, receives blowdown from the air emission scrubbers and has been in operation since 2010. Construction of the GMF was per Water Pollution Control Permit 2008-EA-4661 and features a double HDPE liner with a leachate collection system between the liners. Fly ash is managed in a lined landfill. A groundwater monitoring program is in effect for the GMF units and landfill, and these management units are not included in this Phase 1 Hydrogeologic Assessment.

2.2 Regional Geology

The Quaternary deposits in the Coffeen area consist mainly of diamictons and intercalated outwash deposits that were deposited during Illinoian and Pre-Illinoian glaciations. Along East Fork Shoal Creek valley, east of the site, the glacial deposits are overlain by modern day channel and floodplain deposits belonging to the Cahokia Formation (Berg and Kempton, 1987; Lineback, 1979). The Quaternary deposits are underlain by Pennsylvanian age bedrock, primarily shale, of the Bond Formation. Additional detail is provided in Appendix A.

2.3 Water Resources

2.3.1 Surface Water

The major surface water body in the vicinity of the site is Coffeen Lake. Coffeen Lake covers an area of 1100 acres and was formed when a 70 foot high, 1,300 foot long dam was constructed in 1963 across McDavid Branch, a tributary to the East Fork of Shoal Creek. The lake is maintained at an elevation of about 590 feet, based on USGS topographic information. The east branch of the lake is less than 500 feet east of the unlined CCP impoundments, and the plant’s discharge channel, which discharges to the east branch of Coffeen Lake, lies between the unlined impoundments (north of the Bottom Ash/Recycle Pond and south of Ash Pond 2).

The next largest surface water body in the area is the 75-acre serpentine cooling pond which is approximately 600 feet east of Ash Pond 2. The serpentine cooling pond does not receive waste or water from the CCP management system.

The East Fork of Shoal Creek is approximately three-quarters to one mile east of the unlined impoundments, and Bearcat Creek is four to five miles west of the unlined impoundments. In addition, minor streams and drainage channels cut across the drift plain in the area.

2.3.2 Groundwater

No surficial aquifers, i.e., aquifers that are present or exposed at the ground surface, are present in the study area. Berg, Kempton and Cartwright (1984) classified the area as B2 (sand and gravel within 20 feet of surface, overlain and underlain by relatively impermeable till, other fine-grained material, and/or bedrock). Aquifers in the area of the site fall under two broad categories: (1) unconsolidated sediments that are glacial or alluvial in origin and contain mostly sand and gravel deposits interbedded with clay and silt, and (2) bedrock aquifers composed of sandstone and fractured limestone, which vary widely in permeability. Groundwater available from bedrock units is mostly mineralized and rarely used as a source for potable water. Glacial deposits generally provide enough water for rural and residential water supplies.

Sand and gravel deposits within the Glasford Formation and the Pearl Formation have been extensively developed for public water supplies in small villages in Montgomery County including Waggoner, Nokomis, Fillmore, and Raymond. Locally occurring discontinuous sand and gravel deposits exist along the bottomlands of the East Fork of Shoal Creek that can sustain domestic and farm groundwater supplies. The only groundwater bearing zones in the vicinity of the site are a sandy horizon that occurs intermittently within the Glasford Formation and the Hagarstown Member of the Pearl Formation.

2.3.3 Well Search

Public records were searched to identify water supply wells located within 2,500 feet of the unlined impoundments. The Coffeen property boundary is located in Township 7 North, Range 8 West, and the unlined impoundments are located in the southwest quarter of Section 11. The 2,500 foot boundary spans across Sections 10, 11, 14, and 15. All wells within Sections 10, 11, 14, and 15 are shown on Figure 3 and tabulated in Appendix B.

The following sources of information were queried to identify well locations.

- Illinois State Geological Survey's Illinois Water Well (ILWATER) Internet Map Service
- Illinois State Water Survey Domestic Well Database
- Illinois EPA's web-based Geographic Information System (GIS) files
- Illinois Department of Public Health
- Montgomery County Health Department

Twenty-six water well records were identified within the four sections surrounding the unlined impoundments, and are numbered 1 through 26 on Figure 3. Based on state records there are two non-community water supply (NCWS) wells, one industrial/commercial well, ten monitoring wells (associated with the White and Brewer facility), and 13 farm/domestic water wells within the four section search area (Figure 3 and Appendix B). The Coffeen Energy Center does not have any water supply wells. The two NCWS wells, points 25 and 26, are located within Sections 10 and 15 outside of the 2,500 feet boundary of the impoundments (Figure 3 and Appendix B). There are no maximum setback zones for these two NCWS wells.

All except one of the wells identified in the well search are east or west of Coffeen Lake. The only well located between the east and west branches of the lake is well 22, which was reportedly installed in 1981 and completed in sand and gravel at a depth of 39 feet. If the location of this well was reported correctly, it would be near the northeast corner of ash pond 2. This is property that Ameren and its predecessor companies owned prior to 1981, which indicates that the location information for well 22 is not accurate, and there is no well at this location.

Public water supply (PWS) wells within a ten mile radius of the Coffeen CCP impoundments were identified via a search of the Illinois State Water Survey's Illinois Water Inventory Program (IWIP) database (not available on-line) by RAPPS (2009). Three wells belonging to the Village of Fillmore are located within the search radius, the closest one is approximately eight miles northeast of the impoundments.

3 MONITORING WELL INSTALLATION, DEVELOPMENT AND SAMPLING

3.1 Monitoring Well Installation and Development

The monitoring network for the unlined CCP impoundments consists of four wells screened within the uppermost water bearing unit, including one background (Well G200) and three downgradient wells (APW-2, APW-3, and APW-4). The background well is located 3,950 north of the northwest corner of closed Ash Pond 2, adjacent to an unnamed road along the north boundary of the Coffeen property. The three downgradient wells are located approximately 1,000 feet apart on the south (APW-4) and southeast (APW-3) sides of the Bottom Ash/Recycle Pond and on the southeast (APW-2) side of Ash Pond 2 (Figure 1).

Background well G200 was installed on February 25, 2008 by Testing Service Corporation under the direction of Hansen Professional Services, Inc. The well was installed to a depth of 18 feet using 8" hollow-stem auger and was constructed of 2" inside diameter PVC with a five foot screen. The groundwater level at G200 was 7.32 feet below top of casing when measured on November 15, 2010. The well completion report is provided in Appendix C. A boring log was not available.

The three downgradient monitoring wells (APW-2, APW-3, and APW-4) were installed between August 26 and August 27, 2010 by Geotechnology, Inc. Borings were advanced to 20 feet with hollow-stem augers and soil was continuously sampled. In general, the soil types encountered were medium stiff to hard silty clays with thin sand seams. Drilling and sampling equipment was decontaminated before sampling and between sample locations to prevent cross contamination. Monitoring wells APW-2, APW-3, and APW-4 were constructed of 2" inside diameter schedule 40 PVC with 10 foot screen lengths and steel above-ground well covers. The wells were constructed consistent with monitoring well construction standards per Title 35, Section 811.318. The monitoring wells were surveyed by a licensed surveyor. Monitoring well survey data are summarized in Table 1. Boring logs and well completion reports are provided in Appendix C. A cross-sectional view of the four monitoring wells showing ground surface and relative well screen elevations is provided in Figure 4.

Monitoring wells APW-2, APW-3, and APW-4 were developed on November 10, 2010, by surging and pumping a minimum of five well volumes and until specific conductivity stabilized or the wells were pumped dry. The depth to groundwater was measured in each monitoring well using an electronic water level indicator. Groundwater levels typically range from approximately 1 to 6 feet below ground surface (bgs) at G200 and from 0 to 8 feet bgs at wells APW-2, APW-3, and APW-4. Groundwater elevation data are summarized on Table 2.

3.2 Groundwater Sampling and Chemical Analysis

The monitoring wells were sampled during eight consecutive quarterly monitoring events from December 2010 through July 2012 in order to establish a statistical baseline for groundwater quality. The first round of groundwater sampling at monitoring wells APW-2, APW-3, and APW-4 was conducted by Geotechnology, Inc. on December 1, 2010. Subsequent quarterly monitoring events at these wells were conducted by PDC Inc. (8 sampling events total). Quarterly sampling of the background well, G200, for the purposes of this investigation began in November 2010.

Each monitoring well was purged using disposable bailers until three well volumes were removed. Water quality parameters monitored in the field included pH, specific conductivity and temperature.

The groundwater samples were filtered using 0.45 micron filters and then transferred into laboratory provided containers, labeled, and placed in an ice-filled cooler. The samples were transported, using standard chain-of-custody procedures, to Accutest Laboratories located in Marlborough, MA for the analysis of inorganic constituents listed under Title 35, 620.410 with the exception of radium 226 and 228. Table 3 lists the field and inorganic constituents monitored and analytical methods utilized during the baseline sampling.

4 SITE HYDROGEOLOGY

4.1 Lithology

Two distinct hydrostratigraphic units have been identified at the site. The upper hydrostratigraphic unit consists of the combined Peoria Silt, Sangamon Soil, Hagarstown Member, and Teneriffe Silt (where present), plus the upper, fractured, portion of the Vandalia Member diamicton. This is the uppermost water bearing unit at the site. The lower hydrostratigraphic unit consists of the lower, unfractured, Vandalia Member diamicton, Smithboro Member diamicton, and the undifferentiated Banner Formation. Geologic media encountered in the three monitoring well boreholes adjacent to the unlined impoundments consisted of silty clay with occasional seams of silt and sand.

4.2 Groundwater Flow

Historic groundwater elevations (potentiometric levels) obtained from measurements in monitoring wells installed for the landfill, as documented in the permit application for the Coffeen Landfill (IEPA Bureau of Land Application Log No. 1996-393), indicated that water levels in that area ranged from 603 feet to 623 feet MSL.

The water table is often a subdued reflection of the surface topography. Groundwater flow will also be locally influenced by recharge from pond exfiltration and discharge to local ditches, streams, and Coffeen Lake. Groundwater elevations in APW-2, APW-3, and APW-4 mimic the screened elevations of the wells, with APW-4 highest in screen elevation and groundwater level, and APW-2 lowest in screen elevation and groundwater level (Figure 5). This relationship suggests that the groundwater elevation monitored at the site monitoring wells mimics land surface topography. However, groundwater elevation in APW-4 is higher than in background well G200, suggesting that groundwater level in APW-4 may also be influenced by hydraulic head from the Bottom Ash/Recycle Pond.

Potentiometric maps submitted as part of the landfill permit application indicate that groundwater flow at the landfill site is from west to east, with flow converging on the tributary valleys leading to Coffeen Lake on the east and west sides of the property. A conceptual groundwater flow model developed by Rapps Engineering based on those data suggest that the primary direction of groundwater flow near the unlined impoundments is southward, and discharges to the east and west branches of Coffeen Lake, which is at an elevation of about 590 feet (Figure 6). However, the discharge channel is also at a lower elevation, between 590 and 600 feet, than groundwater at the monitoring wells, and likely receives some, if not all groundwater from beneath the southern portion of Ash Pond 2. Since the discharge channel is also at lower elevation than groundwater at APW-3 and APW-4, it may also be the discharge point for groundwater beneath the northern portion of the Bottom Ash/Recycle Pond.

These observations suggest that the discharge channel and Coffeen Lake are the discharge points for groundwater flowing from beneath the unlined impoundments, in which case there is no potential for off-site migration from the unlined impoundments. However, the East Fork of Shoal Creek is less than a mile to the east and is at lower elevation (~540 ft msl) than Coffeen Lake (~590 ft MSL), indicating potential for groundwater flow and off-site migration toward the area of low hydraulic head that likely occurs along the creek, unless there is a groundwater divide along the ridge that separates the lake and the creek.

4.3 Potential For Groundwater Receptors

A potential groundwater receptor is a water supply well located in a position that can be interpreted as downgradient from the unlined impoundments, and screened within a geologic formation that can reasonably be expected to be a groundwater migration pathway in the event of a release.

Figure 3 shows water wells located within the vicinity of the unlined impoundments. As described in Section 2.3.3, all except one of these wells are located east or west of Coffeen Lake. The only well reported between the east and west branches of the lake and close to the unlined impoundments (point 22 on Figure 3) is not correctly located, and there is no well at this location. Since well 22 does not exist, the closest water supply wells to the unlined impoundments are off-site and on the opposite (east) side of Coffeen Lake.

As noted in Section 4.2, there is no potential for off-site migration except in the unlikely event that groundwater either flows through or beneath the discharge channel and east branch of Coffeen Lake toward the East Fork of Shoal Creek. Flow beneath the lake is unlikely because groundwater elevations mapped at the site are higher than lake elevations, and as a result groundwater is expected to discharge to the lake. Groundwater flow through the lake cannot be ruled out with the available data, but if this occurs, groundwater flowing east from the lake will have the chemical composition of lake water (0.35 mg/L boron and 55 mg/L sulfate as reported in Ameren’s July 27, 2012 NPDES permit IL0000108 renewal application) rather than groundwater. Therefore, there is no reasonable potential for groundwater receptors downgradient of the unlined impoundments at Coffeen.

5 GROUNDWATER CHEMISTRY

5.1 Overview

The purpose of the sampling and inorganic analysis of groundwater from monitoring wells at the Coffeen unlined CCP impoundments was to assess background and downgradient groundwater quality; to evaluate elevated concentrations and those exceeding groundwater standards; and to identify primary factors potentially influencing groundwater quality changes spatially and temporally.

All of the groundwater quality data collected and analyzed for both field and laboratory parameters, including the full list of inorganic constituents listed in IAC 35 Part 620 Section 410 except for Radium 226/228 are provided in Appendix D for the eight quarters of monitoring conducted from November 2010 through July 2012 for G-200, APW-2, APW-3, and APW-4.

A statistical summary of all of the water quality data at each of the four monitoring wells is provided in Table 4, including the mean, median, maximum, minimum, and percent non-detects. Although shallow groundwater in the uppermost water-bearing unit may meet the classification criteria of a Class II (General Resource) groundwater, for the purposes of this report the Class I groundwater standards are shown on Table 4 and concentrations exceeding Class I groundwater standards are highlighted on the table.

5.2 Comparison of Groundwater Quality to Class I Standards

A listing of all exceedances of Class I groundwater quality standards, sorted by constituent, well location, and sample date, is provided in Appendix E. Constituents with exceedances are also highlighted in Table 4. Constituents with Class I groundwater quality exceedances were:

- pH: APW-2 (1 of 8 samples), APW-3 (2 of 8), APW-4 (1 of 8)
- Boron: APW-2 (8 of 8), APW-3 (3 of 8); APW-4 (8 of 8)
- Iron: APW-2 (1 of 8)
- Manganese: APW-2 (7 of 8), APW-3 (8 of 8); APW-4 (8 of 8)
- Sulfate: APW-2 (7 of 8), APW-3 (7 of 8); APW-4 (8 of 8)
- TDS: APW-2 (8 of 8), APW-3 (8 of 8); APW-4 (5 of 8)

With one exception, the pH values that were lower than the 6.5 SU standard occurred only in the first quarter monitoring event and are likely the result of instrument calibration issues or non-stabilized groundwater geochemistry at the time of sampling. Coal ash leachate tends to be alkaline and is therefore not a source of low pH. Similarly, the single exceedance for iron in APW-2 is orders of magnitude greater than the next highest value at that well and appears to be a result of a laboratory or reporting error. The manganese exceedances are a result of local redox conditions.

Boron consistently exceeded its Class I standard in samples from APW-2 and APW-4, and occasionally exceeded its standard in APW-3, while sulfate and TDS consistently exceeded their standards in the three downgradient wells. The source of these exceedances is likely the unlined CCP impoundments.

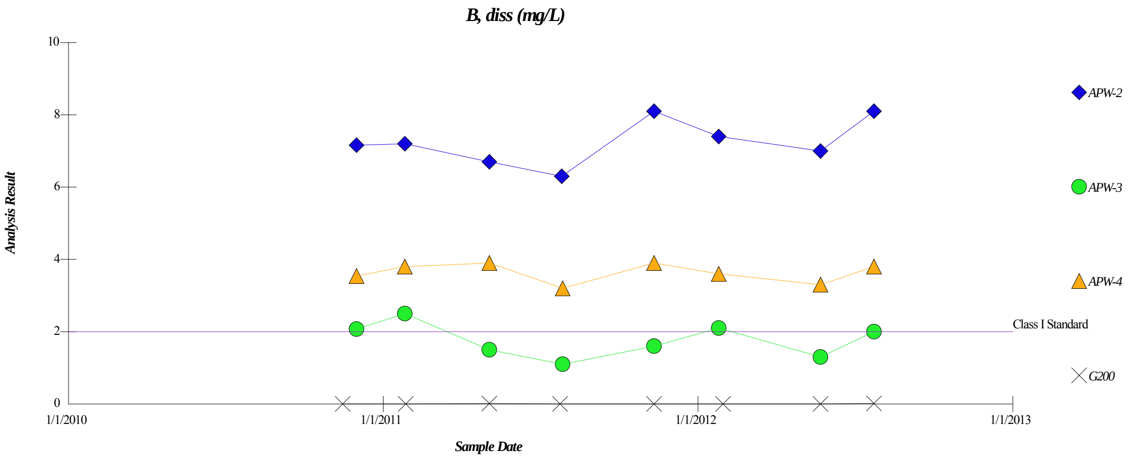
5.3 Groundwater Quality Analysis

5.3.1 Primary Coal Ash Leachate Indicators

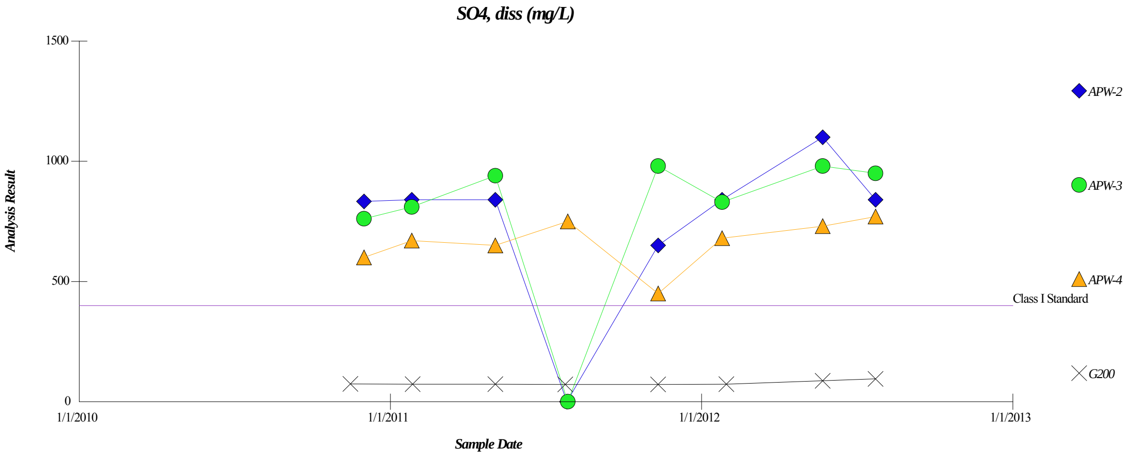
Boron and sulfate are the primary indicator parameters for coal ash leachate. Median boron and sulfate concentrations in all downgradient monitoring wells (APW-2, APW-3, and APW-4) were higher than in the background well (G200).

	Median Concentration	
Well No.	**Boron mg/L**	**Sulfate mg/L**
APW-2	7.2	840
APW-3	1.8	945
APW-4	3.7	675
G200 (Background)	<0.01	73
IL Class I Standard	*2.0*	*400*

Background monitoring well G200 had only two samples where boron concentration was higher than the reporting limit at 0.011 mg/L and 0.014 mg/L. Sulfate concentrations at the three downgradient wells ranged from 450 to 1,100 mg/L versus a median concentration of 73 mg/L in the background well. The boron and sulfate concentrations in APW-2, APW-3, and APW-4 indicate that the unlined CCP impoundments have impacted nearby groundwater. There is no apparent trend in boron and sulfate concentrations over the eight sample events.



Graph showing boron concentrations versus time. Non-detects are plotted as zero.



Graph showing sulfate concentrations versus time. The reporting limit for APW-2 and APW-3 was 1000 mg/L in the sample of July 2011, and following the convention used in this report, concentrations lower than the reporting limit are plotted as zero.

Boron and sulfate have low concentrations in Coffeen Lake (0.35 mg/L B and 55 mg/L SO_4 as reported in Ameren's July 27, 2012 NPDES permit IL0000108 renewal application). These low concentrations indicate that groundwater discharge to the lake from the unlined impoundments is not significantly affecting lake water quality.

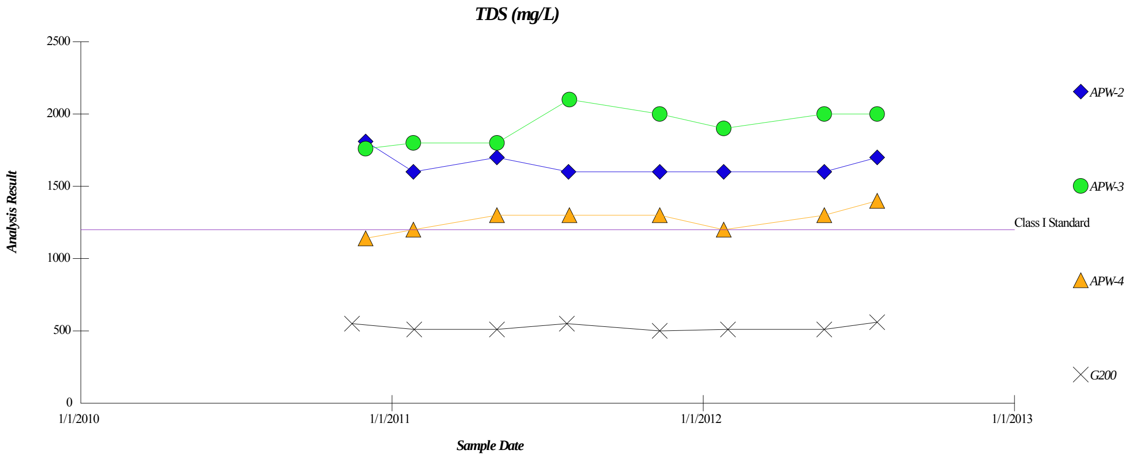
NATURAL RESOURCE TECHNOLOGY

5.3.2 Other Constituents Potentially Impacted by Coal Ash Leachate

Total dissolved solids (TDS) and nickel concentrations were higher than in background well G200, although nickel concentrations were lower than the Class I standard.

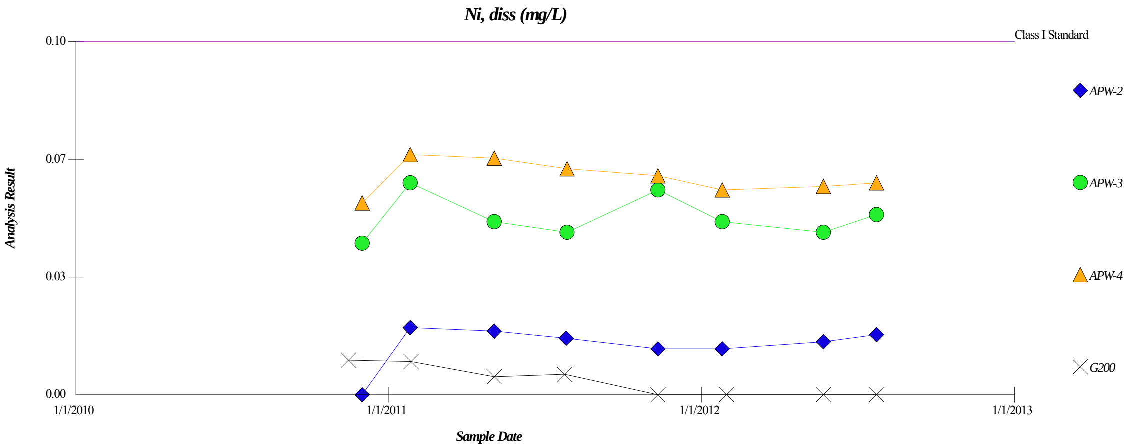
Well No.	**Median Concentration**	
	TDS mg/L	**Nickel mg/L**
APW-2	1,600	0.017
APW-3	1,950	0.049
APW-4	1,300	0.061
G200 (Background)	510	0.005
IL Class I Standard	*1,200*	*0.1*

TDS is the sum of dissolved constituents in water, and the concentrations in downgradient groundwater at APW-2, APW-3, and APW-4 reflect sulfate concentrations in these wells.



Graph showing total dissolved solids concentrations versus time.

Nickel concentrations do not correlate with boron when all downgradient data are grouped. However, there are two potential correlations if APW-2 (north of the discharge channel), is evaluated separately from APW-3 and APW-4 (south of the discharge channel) (see Figure 7). The two correlations between boron and nickel suggest a potential relationship, where both constituents originate from the unlined impoundments, although with different boron to nickel ratios in the leachates.



Graph showing nickel concentrations versus time. Non-detects are plotted as zero.

5.3.3 Constituents with Elevated Concentrations Due to Causes Other than Coal Ash Leachate

Iron and manganese have higher concentration in the downgradient wells than in the background well. However, the highest iron concentration (13 mg/L at APW-2) is more than two orders of magnitude higher than the next highest concentration at that well (0.035 mg/L) and appears to be a result of a laboratory or reporting error.

Well No.	**Median Concentration**	
	Iron mg/L	**Manganese mg/L**
APW-2	0.030	0.41
APW-3	1.3	0.78
APW-4	0.14	0.76
G200 (Background)	0.015	0.023
IL Class I Standard	*5.0*	*0.15*

Iron and manganese concentrations do not correlate with concentrations of the coal ash leachate indicator constituent, boron (Figure 7). This lack of correlation suggests that the observed iron and manganese concentrations in APW-2, APW-3, and APW-4 may be due to local redox conditions rather than leachate from the impoundments.

5.3.4 Constituents with Concentrations Near or Below Background

Median dissolved barium, chloride, nitrate, and selenium concentrations in downgradient groundwater were lower than in the background well, indicating that observed concentrations for these constituents are not associated with coal ash leachate.

Well No.	Median Concentration			
	Barium mg/L	**Chloride mg/L**	**Nitrate-N mg/L**	**Selenium mg/L**
APW-2	0.018	3.1	0.060	0.003
APW-3	0.020	30	0.047	0.004
APW-4	0.026	28	0.030	0.002
G200 (Background)	0.058	51	4.2	0.012
IL Class I Standard	*2.0*	*200*	*10*	*0.05*

Chloride appears to be the primary anion affecting TDS in background groundwater. Nitrate concentrations in G200 likely reflect agricultural activity in the region.

Median dissolved copper and zinc concentrations in downgradient groundwater were similar to the background median, again indicating no impacts associated with the unlined CCP impoundments. Arsenic and cobalt concentrations were slightly higher in APW-3 than in the other monitoring wells; however, APW-3 had lower boron concentrations than APW-2 and APW-4, suggesting less coal ash impacts than the other downgradient wells, and the pH at APW-3 was slightly lower than at the other monitoring wells. Since the solubility of arsenic and cobalt is affected by pH, these slight differences are attributed to pH differences rather than the CCP impoundment.

Well No.	Median Concentration			
	Arsenic mg/L	**Cobalt mg/L**	**Copper mg/L**	**Fluoride mg/L**
APW-2	<0.001	<0.002	<0.003	0.43
APW-3	0.004	0.005	<0.003	0.27
APW-4	<0.001	0.002	0.003	0.50
G200 (Background)	<0.001	<0.002	<0.003	0.38
IL Class I Standard	*0.01*	*1.0*	*0.65*	*4.0*

The median pH values were neutral, ranging from 6.84 to 7.26. The lowest individual values at wells APW-2, APW-3, and APW-4, ranging from 5.66 to 6.24, occurred in the first quarterly sampling event. No similarly low pH readings were observed in the subsequent seven quarters of monitoring. Given this observation, it appears that the field instrumentation used to measure the pH was not calibrated accurately, leading to a systematic error of low pH readings in all of the groundwater samples in December 2010.

Well No.	**Median pH SU**
APW-2	7.00
APW-3	6.84
APW-4	7.26
G200 (Background)	7.25
IL Class I Standard	*6.5 - 9.0*

5.3.5 Constituents That Were Infrequently or Not Detected

Antimony, beryllium, cadmium, chromium, cyanide, lead, mercury, silver, and thallium concentrations were below their respective reporting limits in all monitoring wells during all eight sample events. Zinc concentrations were below the reporting limit in five to seven of the eight sample events, with a maximum concentration of 0.027 mg/L at APW-2 during the first sample event in December 2010.

6 CONCLUSIONS

6.1 Conclusions

The primary conclusion from voluntary monitoring of groundwater at the Coffeen Energy Center unlined CCP impoundments is that operation of the impoundments has caused exceedances of Class I groundwater quality standards for boron, sulfate, and TDS. The Class I standard for iron, manganese, and pH is also exceeded in downgradient groundwater, although these exceedances are not associated with impoundment operation.

Furthermore:

- Groundwater elevations at the site mimic land surface topography and do not provide an indication of horizontal groundwater flow direction. However, groundwater elevations in the wells are higher than water elevation in the discharge channel and Coffeen Lake, which indicates that groundwater flows toward these surface water features.
- Boron and sulfate concentrations in Coffeen Lake are low, and show no evidence that groundwater impacts near the unlined impoundments are affecting water quality in the lake.
- The unlined impoundments are situated in an area of fine-grained soils, greater than 20 feet thick, where groundwater migration is typically restricted by low hydraulic conductivity. Furthermore, the unlined impoundments are bordered in the probable directions of groundwater flow by the plant discharge channel and Coffeen Lake. These observations indicate that migration in groundwater from the unlined impoundments will be limited to the Coffeen property.
- The closest water supply wells to the unlined impoundments are 2,000 feet to the east and on the opposite side of the east branch of Coffeen Lake. The conceptual model of groundwater flow indicates groundwater at the unlined impoundments discharges to Coffeen Lake, and there is no reasonable pathway for migration from the unlined impoundments to these wells.
- Nickel concentrations were higher than background, but lower than the Class I standard, and correlated with boron suggesting a low level concentration increase for this element associated with operation of the unlined impoundments. Concentrations of the other monitored trace elements were not affected by the unlined CCP impoundments.
- The unlined CCP impoundment monitoring wells are screened in clay-rich soil which may have hydraulic conductivity lower than 1 x 10^{-4} cm/s. If low hydraulic conductivity is confirmed, then groundwater monitored by these wells may be most-appropriately categorized as Class II groundwater. If classified as Class II, manganese concentrations do not exceed the groundwater quality standard. The Class II standards for boron, iron, sulfate, and TDS are the same as Class I, so exceedances of these constituents are not affected by the groundwater class.

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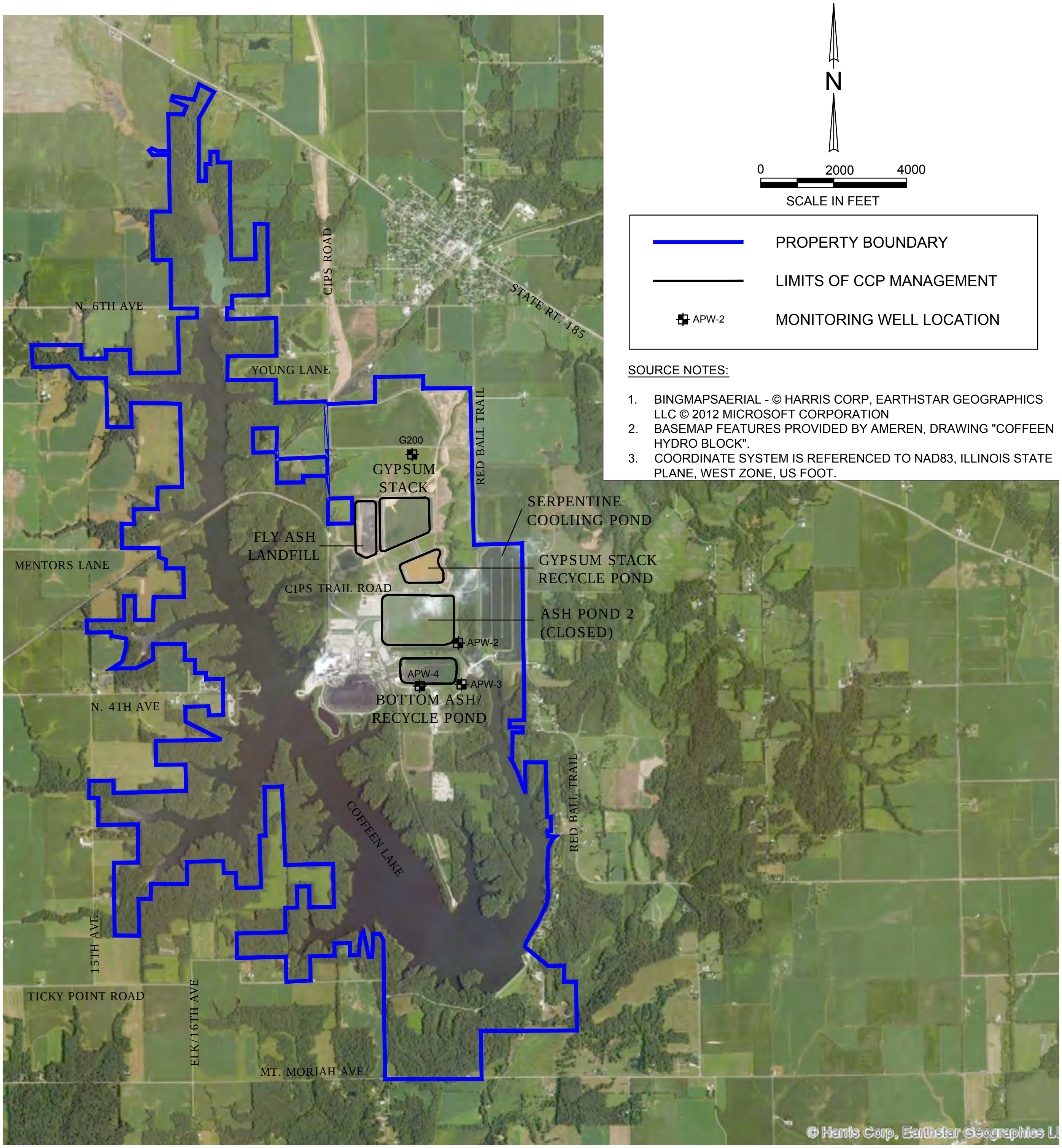
FIGURES



SOURCE NOTES:

1. BINGMAPSAERIAL - © HARRIS CORP, EARTHSTAR GEOGRAPHICS LLC © 2012 MICROSOFT CORPORATION
2. BASEMAP FEATURES PROVIDED BY AMEREN, DRAWING "COFFEEN HYDRO BLOCK".
3. COORDINATE SYSTEM IS REFERENCED TO NAD83, ILLINOIS STATE PLANE, WEST ZONE, US FOOT.

SITE OVERVIEW MAP

NATURAL
RESOURCE
TECHNOLOGY

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
COFFEEN ENERGY CENTER
MONTGOMERY COUNTY, ILLINOIS

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

PROJECT NO.
2121/2.0

DRAWING NO.
2121-2-A01C-SITE OVER

FIGURE NO.
1

Mar 05, 2013 11:20am PLOTTED BY: ndraskovich SAVED BY: ndraskovich
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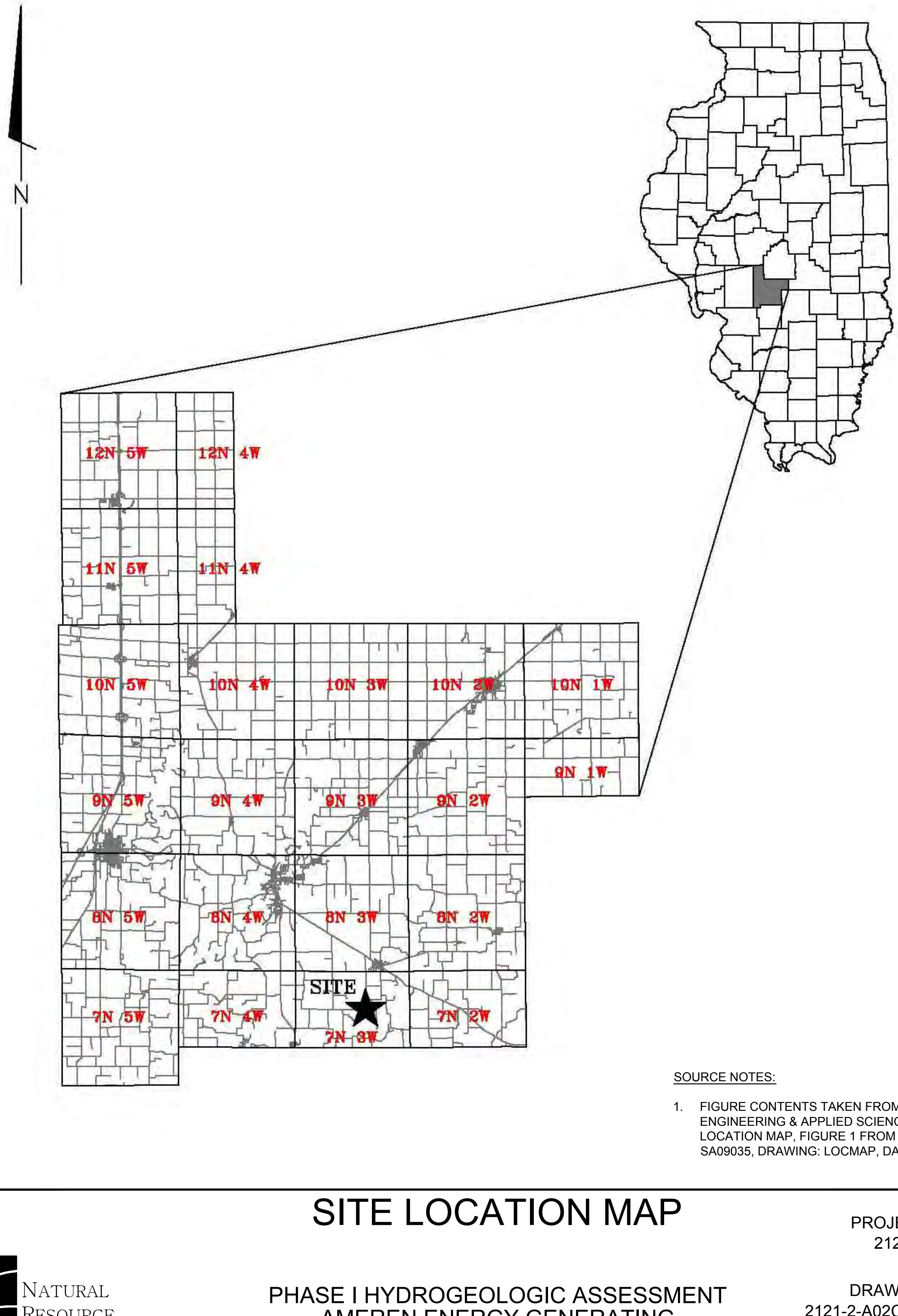

SOURCE NOTES:

1. FIGURE CONTENTS TAKEN FROM RAPPS ENGINEERING & APPLIED SCIENCE, INC. SITE LOCATION MAP, FIGURE 1 FROM PROJECT: SA09035, DRAWING: LOCMAP, DATED 11/09.

SITE LOCATION MAP

NATURAL
RESOURCE
TECHNOLOGY

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
COFFEEN ENERGY CENTER
MONTGOMERY COUNTY, ILLINOIS

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

PROJECT NO.
2121/2.0

DRAWING NO.
2121-2-A02C-SITE LOCAT

FIGURE NO.
2

Mar 05, 2013 11:19am PLOTTED BY: ndraskovich SAVED BY: ndraskovich
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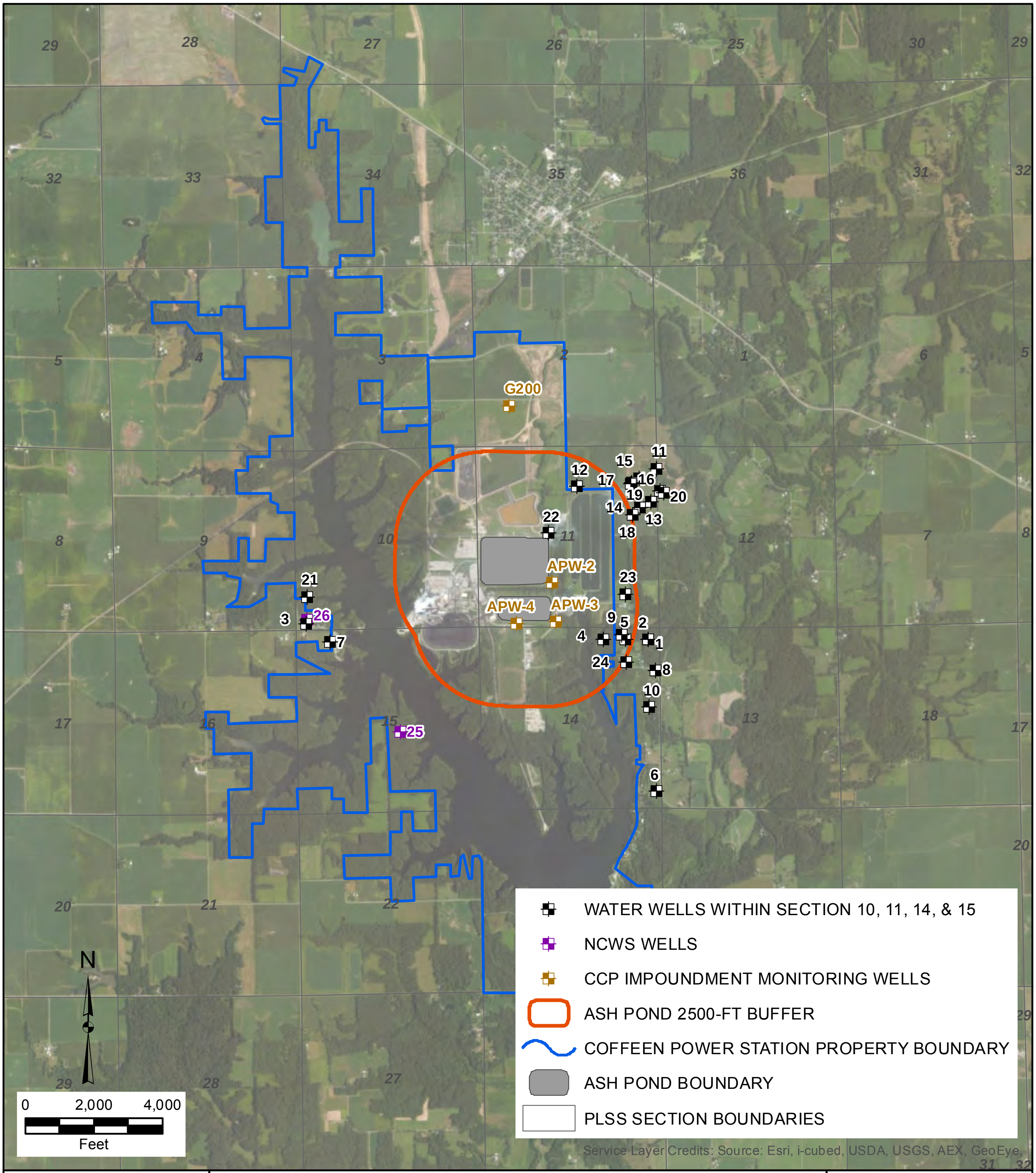

Y:\Mapping\Projects\21\2121\MXD\Fig 3. Well Search Results-Coffeen.mxd Author: nkron; Date/Time: 2/28/2013, 8:45:00 AM

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NDK 2/12/13
REVIEWED BY/DATE:
TDC 2/12/13
APPROVED BY/DATE:
BRH 2/13/13

WELL SEARCH RESULTS

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
COFFEEN ENERGY CENTER
MONTGOMERY COUNTY, ILLINOIS

PROJECT NO: 2121

FIGURE NO: 3

NATURAL
RESOURCE
TECHNOLOGY

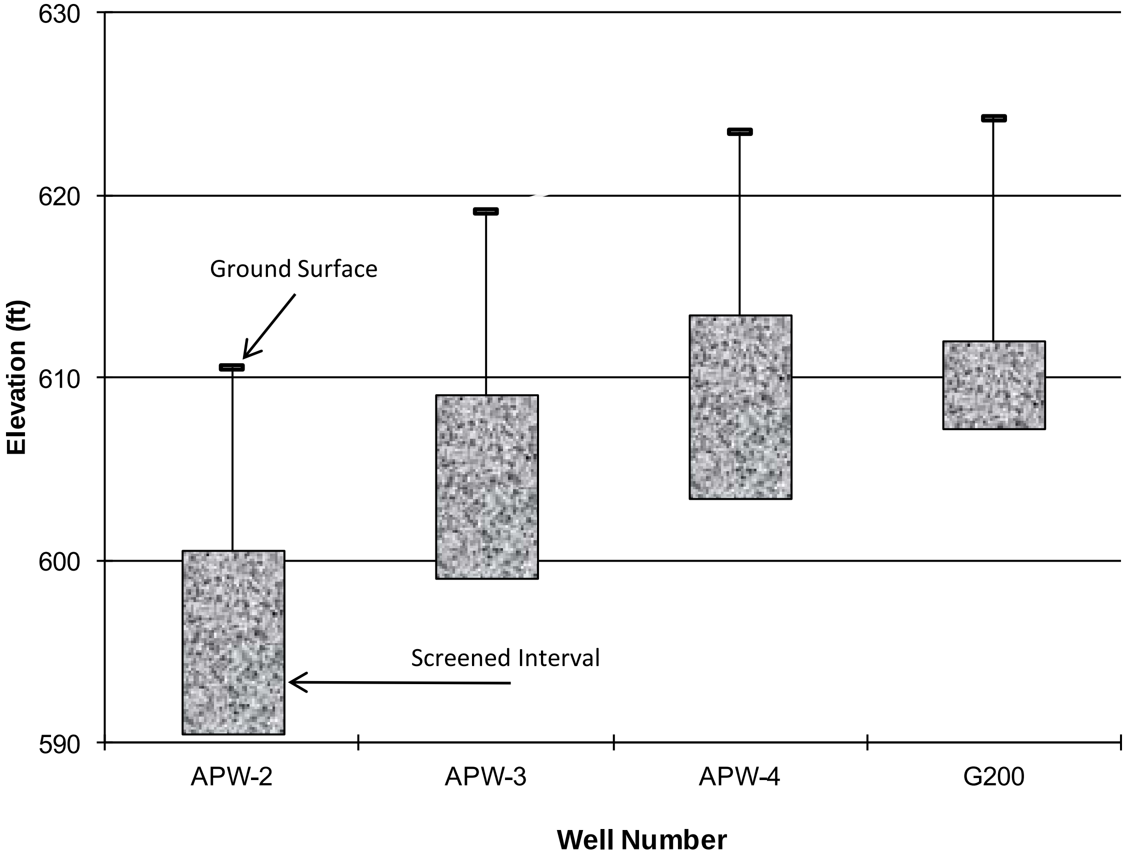


Figure 4. Monitoring Well Screen Elevations.

NATURAL
RESOURCE
TECHNOLOGY

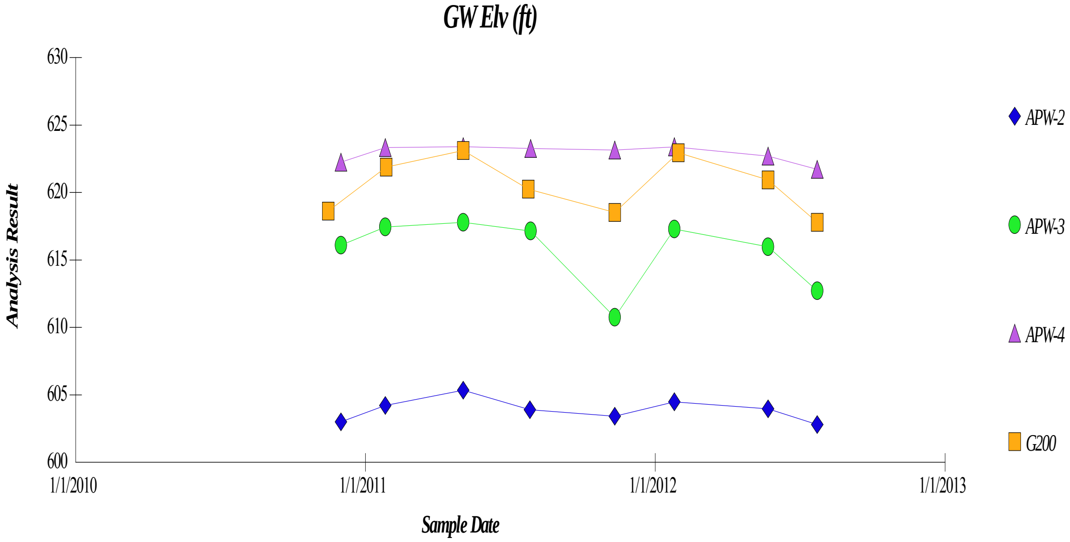
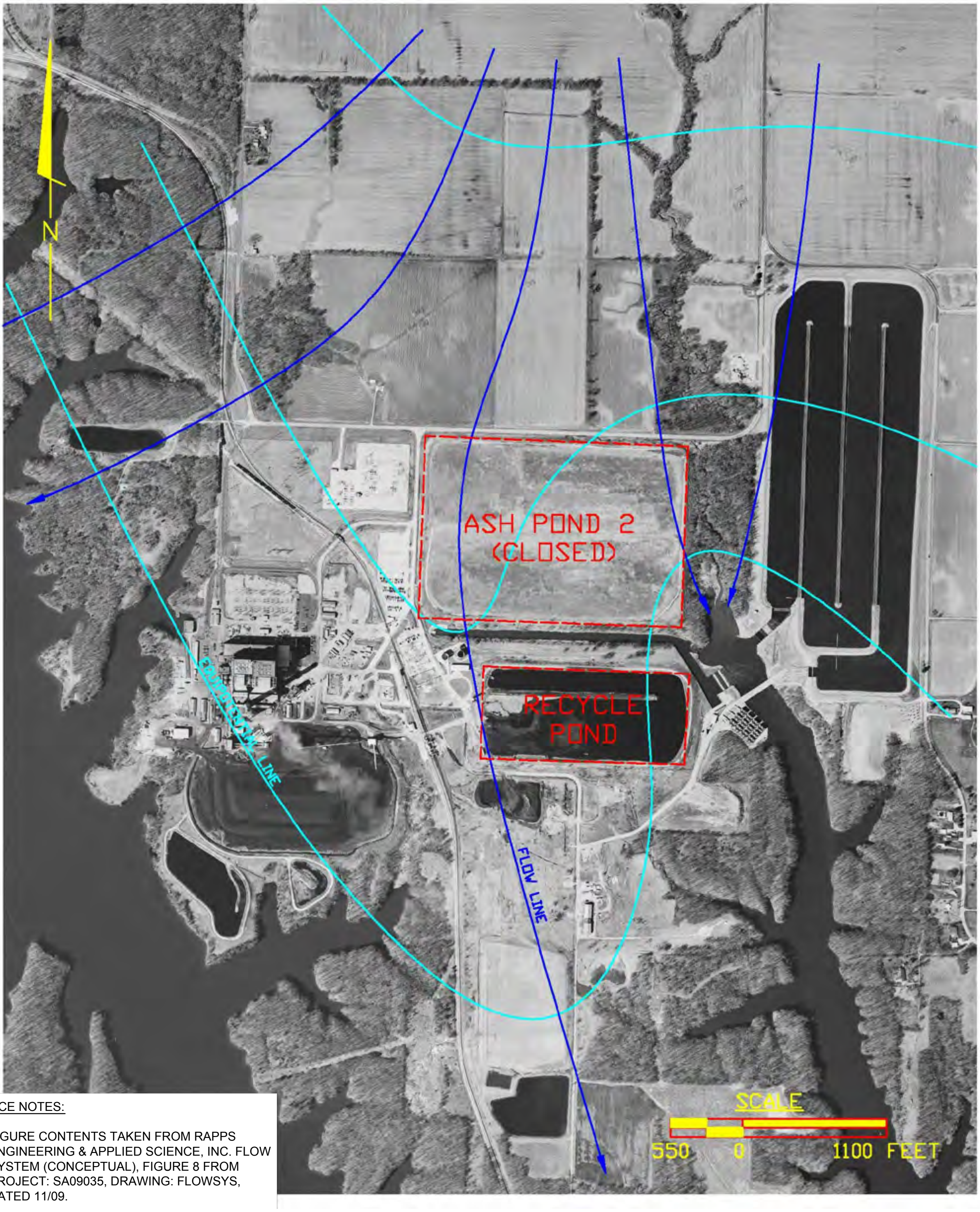


Figure 5. Groundwater Elevation Time Series.

Natural
Resource
Technology



SOURCE NOTES:

1. FIGURE CONTENTS TAKEN FROM RAPPS ENGINEERING & APPLIED SCIENCE, INC. FLOW SYSTEM (CONCEPTUAL), FIGURE 8 FROM PROJECT: SA09035, DRAWING: FLOWSYS, DATED 11/09.

FLOW SYSTEM
(CONCEPTUAL)

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
COFFEEN ENERGY CENTER
MONTGOMERY COUNTY, ILLINOIS

NATURAL
RESOURCE
TECHNOLOGY

DRAWN: NWD DATE: 02/14/13 CHK'D: BRH DATE: 02/14/13 APP'D: BRH DATE: 03/05/13

PROJECT NO.
2121/2.0

DRAWING NO.
2121-2-A06C-FLOW SYS

FIGURE NO.
6

Mar 05, 2013 11:19am PLOTTED BY: ndraskovich SAVED BY: ndraskovich
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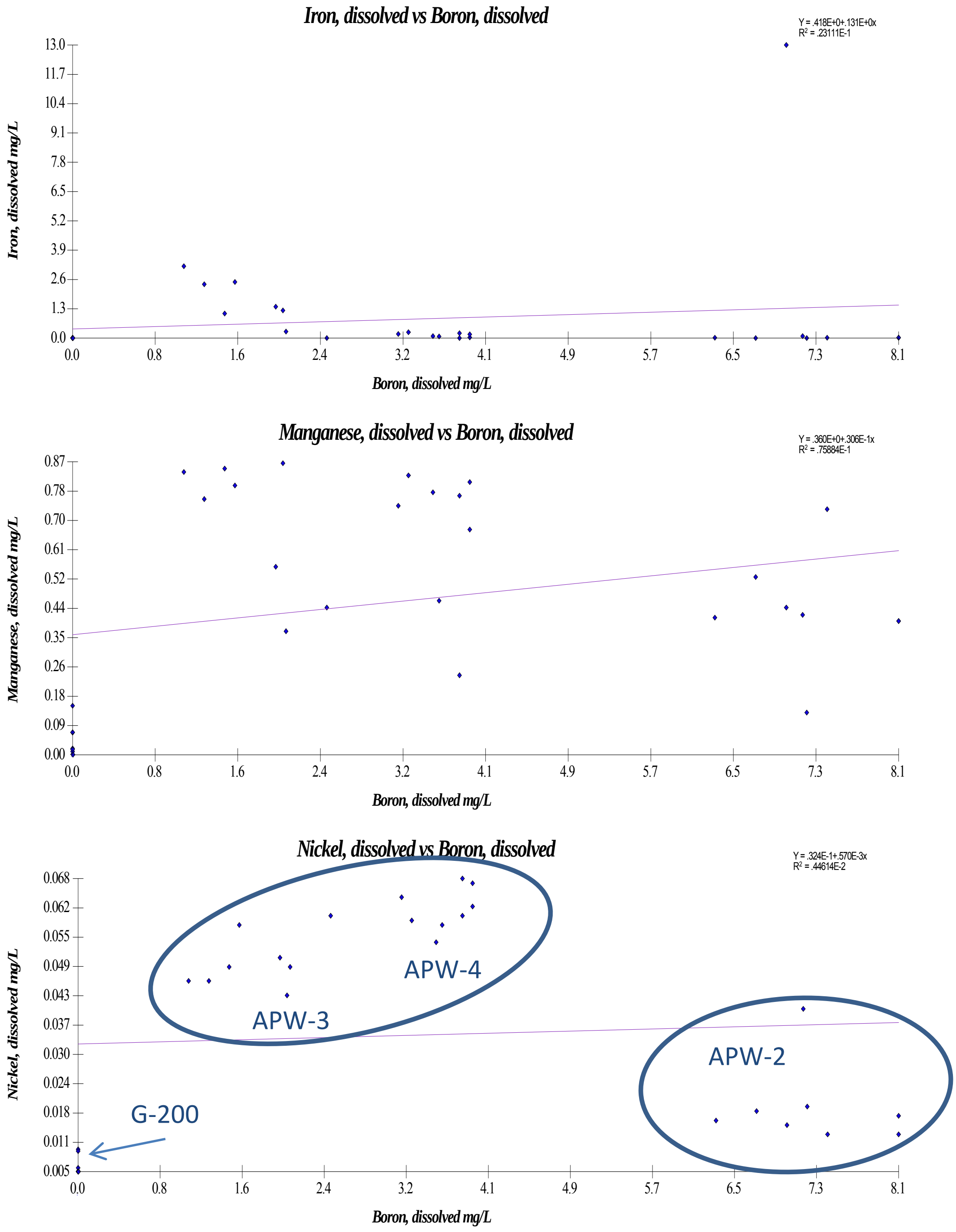


Figure 7. Scatter plot showing no of correlation between boron and manganese, and boron and iron; and two possible correlations between boron and nickel, in APW-2, APW-3, APW-4 and G-200.

Natural
Resource
Technology

TABLES

Table 1. Monitoring Well Construction Details

Phase 1 Hydrogeologic Assessment
Coffeen Energy Center; Montgomery County, IL

Monitoring Well Number	Installation Date[1,2]	Top of Well Riser Elevation	Ground Elevation	Screen Top Depth (BGS)	Screen Bottom Depth (BGS)	Screen Top Elevation	Screen Bottom Elevation	Bottom of Boring Elevation	Slotted Screen Length	Bottom Screen Depth from Ground Surface	Bottom Screen Depth from Top of Casing	Total Boring Depth
APW-2	08/27/10	613.50	610.56	10.00	20.00	600.56	590.56	590.2	10.00	20.00	22.94	20.4
APW-3	08/26/12	621.94	619.10	10.00	20.00	609.10	599.10	598.7	10.00	20.00	22.84	20.4
APW-4	08/26/12	626.84	623.46	10.00	20.00	613.46	603.46	603.1	10.00	20.00	23.38	20.4
G200	02/25/08	625.94	624.20	12.19	16.98	612.01	607.22	606.2	4.79	16.98	18.72	18.0

Monitoring Well Number	Northing[3]	Easting[3]
APW-2	872,502.3	2,546,632.6
APW-3	871,382.5	2,516,641.1
APW-4	871,397.5	2,515,520.2
G200	877,930.6	2,515,650.0

Notes:

All depth and elevation measurements are in feet relative to NAVD 1988.

BGS = below ground surface.

[1] Drilling and well installation for APW-2, APW-3, and APW-4 by Geotechnology, Inc. Drilling and well installation for G200 by Testing Service Corporation.

[2] All wells constructed with 2-inch diametrer, 10-slot, Schedule 40 PVC screens.

[3] Coordinates are referenced to Illinois State Plane Coordinates, East Zone - NAD 1983.

Table 2. Groundwater Levels and Elevations

Phase 1 Hydrogeological Assessment
Coffeen Energy Center; Montgomery County, Illinois

Monitoring Well Number	Ground Surface Elevation[1] (feet)	Measuring Point Elevation[1] (feet)	Groundwater Depth (feet below measuring point)							
			1 12/01/10	2 01/26/11	3 05/04/11	4 07/27/11	5 11/11/11	6 01/25/12	7 05/22/12	8 07/23/12
APW-2	610.56	613.50	10.40	9.18	8.05	9.50	9.98	8.91	9.43	10.60
APW-3	619.10	621.94	5.60	4.25	3.91	4.55	10.95	4.41	5.72	8.98
APW-4	623.46	626.84	4.51	3.43	3.36	3.49	3.61	3.37	4.06	5.04
G200	624.20	625.94	7.32	4.05	2.83	5.68	7.41	2.99	5.01	8.15

Monitoring Well Number	Groundwater Depth (feet below ground surface)							
	1 12/01/10	2 01/26/11	3 05/04/11	4 07/27/11	5 11/11/11	6 01/25/12	7 05/22/12	8 07/23/12
APW-2	7.46	6.24	5.11	6.56	7.04	5.97	6.49	7.66
APW-3	2.76	1.41	1.07	1.71	8.11	1.57	2.88	6.14
APW-4	1.13	0.05	-0.02	0.11	0.23	-0.01	0.68	1.66
G200	5.58	2.31	1.09	3.94	5.67	1.25	3.27	6.41

Monitoring Well Number	Groundwater Elevation (feet)							
	1 12/01/10	2 01/26/11	3 05/04/11	4 07/27/11	5 11/11/11	6 01/25/12	7 05/22/12	8 07/23/12
APW-2	603.10	604.32	605.45	604.00	603.52	604.59	604.07	602.90
APW-3	616.34	617.69	618.03	617.39	610.99	617.53	616.22	612.96
APW-4	622.33	623.41	623.48	623.35	623.23	623.47	622.78	621.80
G200	618.62	621.89	623.11	620.26	618.53	622.95	620.93	617.79

<u>Notes:</u>

[1] All depth and elevation measurements are in feet relative to NAVD 1988.

Table 3. Field and Laboratory Groundwater Monitoring Parameters

Phase 1 Hydrogeologic Assessment
Coffeen Energy Center; Montgomery County, Illinois

Field Parameters			**Analysis Method**
Groundwater Elevation		in-situ	
pH (field)	1	in-situ	SM 21st ed. 4500-H^+
Specific Conductance		in-situ	SM 21st ed. 2520-B
Temperature		in-situ	SM 21st ed. 2550
General Chemistry Parameters[2]			**Analysis Method**
Chloride	1	dissolved	SM21 4500CL C
Total Cyanide	1	total	EPA 335.4
Fluoride	1	dissolved	SM4500 F-B-C
Nitrate as N	1	dissolved	EPA 353.2
Sulfate	1	dissolved	ASTM516-90,02
Total Dissolved Solids	1	dissolved	SM21 2540 C
METALS[2]			**Analysis Method[3]**
Antimony	1,3	dissolved	SW846 6010C
Arsenic	1,3	dissolved	SW846 6010C
Barium	1,3	dissolved	SW846 6010C
Beryllium	1,3	dissolved	SW846 6010C
Boron	1,3	dissolved	SW846 6010C
Cadmium	1,3	dissolved	SW846 6010C
Chromium	1,3	dissolved	SW846 6010C
Cobalt	1,3	dissolved	SW846 6010C
Copper	1,3	dissolved	SW846 6010C
Iron	1,3	dissolved	SW846 6010C
Lead	1,3	dissolved	SW846 6010C
Manganese	1,3	dissolved	SW846 6010C
Mercury	1,3	dissolved	SW846 7470A
Nickel	1,3	dissolved	SW846 6010C
Selenium	1,3	dissolved	SW846 6010C
Silver	1,3	dissolved	SW846 6010C
Thallium	1,3	dissolved	SW846 6010C
Zinc	1,3	dissolved	SW846 6010C

Notes:

[1] Groundwater quality parameters for Class I: Potable Resource Groundwater (IAC 35 Part 620 Section 410).

[2] Samples preserved in field and filtered (except Cyanide) by laboratory.

[3] Sample prep method reference: SW846 3010A.

Parameter, Unit	Class I GW Standard	Monitoring Well APW-2[1]					Monitoring Well APW-3[1]					Monitoring Well APW-4[1]					Background Monitoring Well G200				
		Mean	Median	Maximum	Minimum	% of Non-Detects	Mean	Median	Maximum	Minimum	% of Non-Detects	Mean	Median	Maximum	Minimum	% of Non-Detects	Mean	Median	Maximum	Minimum	% of Non-Detects
Field Parameters	6.5 / 9.0*	6.85	7.00	7.27	**5.86**	N/A	6.71	6.84	7.16	**5.66**	N/A	7.16	7.26	7.71	**6.24**	N/A	7.29	7.25	7.66	7.04	N/A
General Chemistry Parameters (totals)																					
Chloride, mg/L	200	4.0	3.1	10	3.0	0	29	30	32	27	0	29	28	36	21	0	54	51	69	46	0
Cyanide, mg/L	0.2	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Fluoride, mg/L	4	0.45	0.43	0.64	<0.25	12.5	0.30	0.27	0.48	<0.25	25	0.50	0.50	0.66	<0.25	12.5	0.65	0.38	0.51	0.30	12.5
Nitrate, mg/L	10	0.13	0.060	0.57	<0.02	25	0.063	0.047	0.16	<0.02	37.5	0.083	0.030	0.390	<0.02	62.5	4.2	4.2	5.7	2.3	0
Sulfate, mg/L	400	**868**	**840**	**1,100**	**650**	12.5	**906**	**945**	**980**	**761**	12.5	**663**	**675**	**770**	**450**	0	77	73	95	72	0
Total Dissolved Solids, mg/L	1,200	**1,651**	**1,600**	**1,810**	**1,600**	0	**1920**	**1950**	**2100**	**1760**	0	**1,268**	**1,300**	**1,400**	**1,140**	0	525	510	560	500	0
Metals (dissolved)																					
Antimony, mg/L	0.006	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Arsenic, mg/L	0.01**	0.002	0.001	0.002	<0.001	75	0.004	0.004	0.007	<0.001	37.5	0.002	0.001	0.004	<0.001	87.5	0.001	0.001	0.001	<0.001	75
Barium, mg./L	2.0	0.022	0.018	0.020	0.016	12.5	0.024	0.020	0.25	0.017	12.5	0.035	0.026	0.086	0.024	0	0.052	0.058	0.063	<0.001	12.5
Beryllium, mg/L	0.004	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Boron, mg/L	2.0	**7.2**	**7.2**	**8.1**	**6.3**	0	1.8	1.8	**2.5**	1.1	0	**3.6**	**3.7**	**3.9**	**3.2**	0	0.011	0.010	0.014	<0.010	75
Cadmium, mg/L	0.005	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Chromium, mg/L	0.10	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Cobalt, mg/L	1.0	nc	nc	nc	nc	100	0.010	0.005	0.006	<0.002	25	0.008	0.002	0.003	<0.002	50	nc	nc	nc	nc	100
Copper, mg/L	0.65	nc	nc	nc	nc	100	0.006	0.003	0.004	<0.003	62.5	0.006	0.003	0.004	<0.003	50	0.003	0.003	0.003	<0.003	87.5
Iron, mg/L	5.0	1.7	0.030	**13**	<0.010	37.5	1.5	1.3	3.2	<0.010	12.5	0.14	0.14	0.27	<0.01	25	0.016	0.015	0.029	<0.010	37.5
Lead, mg/L	0.0075	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Manganese, mg/L	0.15	**0.43**	**0.41**	**0.73**	0.13	0	**0.69**	**0.78**	**0.87**	**0.37**	0	**0.66**	**0.76**	**0.83**	**0.24**	0	0.046	0.023	0.15	0.006	0
Mercury, mg/L	0.002	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Nickel, mg/L	0.10	0.019	0.017	0.019	0.013	12.5	0.050	0.049	0.060	0.043	0	0.062	0.061	0.068	0.054	0	0.006	0.005	0.010	<0.005	50
Selenium, mg/L	0.050	0.004	0.003	0.007	0.002	12.5	0.005	0.004	0.006	0.002	12.5	0.003	0.002	0.003	<0.001	37.5	0.012	0.012	0.015	0.007	0
Silver, mg/L	0.050	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Thallium, mg/L	0.002	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100	nc	nc	nc	nc	100
Zinc, mg/L	5.0	0.009	0.006	0.027	<0.006	75	0.009	0.006	0.025	<0.006	62.5	0.008	0.006	0.009	<0.006	87.5	0.008	0.006	0.020	<0.006	87.5

Notes:

[1] Eight quarterly samples collected for analysis on 12/1/10 (11/15/10 for G200), 01/26/11 (01/27/12 for G200), 05/04/11, 07/25-28/11, 11/11/12, 01/25/12, 05/22/12, and 07/23/12.

Groundwater quality standards for Class I: Potable Resource Groundwater (IAC 35 Part 620 Section 410).

Statistics calculated with replacement of non-detect concentrations at 1X reported non-detect concentration: nc indicates that statistics were not calculated because all values were below detection limits.

Exceeds Class I Groundwater Quality Standard.   Parameter is 100% Non-Detect in all 4 monitoring wells.

N/A = not applicable.

< = Below method reporting limit.

* Lower and Upper limits for pH is the Class I groundwater quality standard of 6.5 and 9.0 Standard Units.

** Class I standard for arsenic at the time of sampling was 0.05 mg/L

APPENDIX A

REGIONAL GEOLOGY

A REGIONAL GEOLOGY

Regional geologic information was previously presented in the site characterization and groundwater monitoring plan developed by Rapps Engineering & Applied Services (November 2009), and is repeated here for completeness.

A.1 Physiography

Illinois is situated in the south-central part of the Central Lowland Province near the confluence of two major lines of drainage, the Mississippi and Ohio Rivers, making it the lowest of the north-central states with a mean elevation of about 600 feet above sea-level and a total relief of only 973 feet (Leighton et al., 1948). The site lies in the center of the Springfield Plain of the Till Plains Section, the largest physiographic division in Illinois, covering approximately four-fifths of the state (Appendix A [Figure 3]). It is characterized by broad till plains in an uneroded or youthful stage of erosion. The Springfield Plain includes the level portion of the Illinoian drift sheet in central and south-central Illinois, distinguished by its flatness and shallowly entrenched drainage.

A.2 Unlithified Geology

The Quaternary deposits in the Coffeen area consist mainly of diamictons and intercalated outwash deposits that were deposited during Illinoian and Pre-Illinoian glaciations (Appendix A [Figure 5]). Along East Fork Shoal Creek valley, east of the site, the glacial deposits are overlain by modern day channel and floodplain deposits belonging to the Cahokia Formation (Berg and Kempton, 1987; Lineback, 1979). A hydrogeologic investigation was conducted in 1996 by RAPPS Engineering & Applied Science to characterize the site geology as part of an application for a landfill permit. The following geologic descriptions are based largely on the findings of that investigation. The major Quaternary formations present at the site include, from oldest to youngest:

Pre-Illinoian Stage: Pre-Illinoian deposits at the site consist of undifferentiated diamictons belonging to the Banner Formation which generally rest directly on bedrock and consist mostly of glacial tills and intercalated sand and gravel outwash. At the site the Banner Formation consists of a green-gray silty clay with numerous calcite filled fractures, and a compact, brown to gray silty clay with traces of sand and gravel. It exhibits little to no secondary porosity and has a thickness of approximately 35 feet.

Illinoian Stage: The Glasford Formation is the most widespread formation of glacial origin in Illinois and is largely the deposit of Illinoian glaciers of the Lake Michigan Lobe. It includes diamictons, intercalated outwash deposits, and overlying accretion-gley deposits. The three members of the Glasford Formation encountered at the site are, from oldest to youngest, the Smithboro Till Member, the Mulberry Grove Member, and the Vandalia Till Member. The Hagarstown Member of the Pearl Formation was also encountered at the site. Teneriffe Silt locally overlies the Illinoian Age diamicton deposits. Each Illinoian Stage member is described below.

The *Smithboro Member* is the lowest till member of the Glasford Formation in south-central Illinois. It is characterized as a gray, compact diamicton that is softer, more silty, and less friable than the overlying Vandalia Member, and was deposited by ice sheets moving northwest to southeast across the region (Jacobs and Lineback, 1969). At the site, the Smithboro Till Member is represented by a gray, compact, silty diamicton with a variable thickness between 5 and 25 feet.

The *Mulberry Grove Member* typically consists of a thin, lenticular unit of gray sandy silt (Willman and Frye, 1970). It represents the interval between the retreat of the glacier that deposited the Smithboro Member and the advance of the glacier that deposited the Vandalia Member. At the site, the Mulberry Grove Member is represented by one foot of gray sandy silt, which is not laterally continuous.

The *Vandalia Member*, named for Vandalia, Fayette County, near the type locality, is a relatively sandy, gray, compacted diamicton commonly 25 to 50 feet thick with varying amounts of sand and gravel (Lineback, 1979; Willman and Frye, 1970). At the site, the Vandalia Member is represented by a moderately compact, gray, silty to sandy clay diamicton with traces of sand and gravel. It ranges in thickness from 10 to 20 feet and is not laterally continuous throughout the area.

The *Hagarstown Member of the Pearl Formation* consists of gravel, sand, and gravelly diamicton occurring as ice-contact deposits. It commonly occurs as ridged drift in a distinctive belt of linear to curved ridges and knolls. Outwash plains of poorly-sorted to well-sorted sand and gravel are present between the ridges in many places (Killey and Lineback, 1983). The site is located in an unsorted drift plain between such sand and gravel ridges. The Hagarstown Member sediments at the site vary in thickness from 20 to 30 feet, and consist of poorly compacted, brown to gray silty clay with some thin, poorly – sorted sand and gravel layers.

Monican Substage: The Teneriffe Silt is generally a massive, fine to coarse silt, with some beds of sand and gravel (Willman et al., 1975). It locally overlies the Glasford Formation diamicton at the site and consists of gray to brown clayey, sandy silt approximately 15 to 20 feet in thickness.

Sangamonian Stage: The Sangamon Soil formed during the interglacial period between the Illinoian and Wisconsinan Stages. It formed as a result of weathering of the upper portion of the Illinoian drift. The Sangamon Soil occurs locally at the site and consists of approximately one-half to two feet of mottled brown silty clay with pervasive dark organic inclusions.

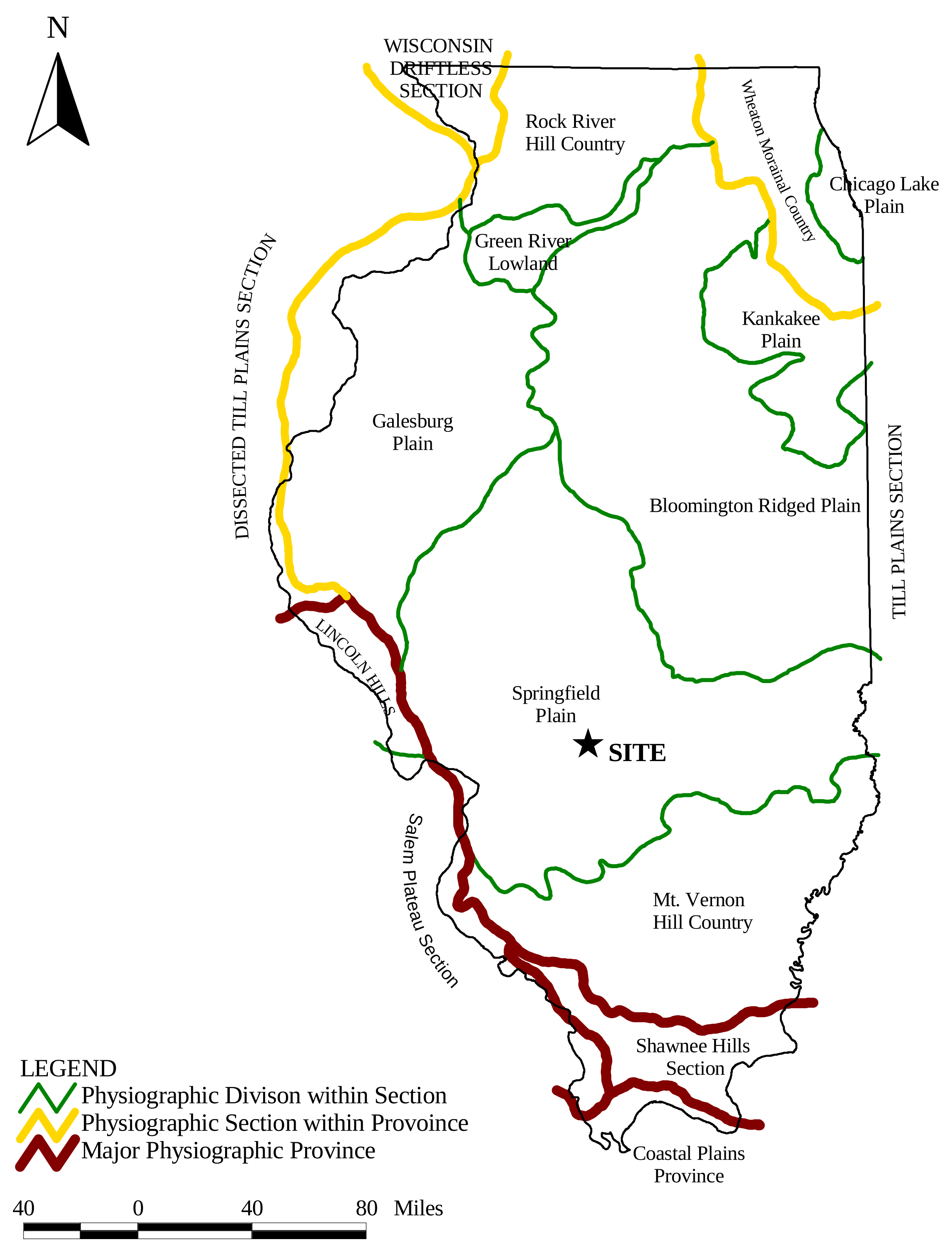
Wisconsinan Stage: Deposits belonging to the Wisconsinan Age Peoria Silt commonly occur in upland areas and along valley walls in Illinois. They generally grade from sandy silt in the bluffs of major source river valleys (e.g., the Mississippi River Valley) to clayey silt away from the bluffs, where it is commonly thinner and relatively weathered (Hansel and Johnson, 1996). They are typically massive and consist predominantly of windblown silt from the valley floor, with local lenses of well-sorted, fine- to medium-grained sand (Willman and Frye, 1970). The Peoria Silt at the site consists of 2 to 7 feet of light brown to light gray clayey silt.

Holocene Stage: The *Cahokia Formation* consists of deposits in the floodplains and channels of modern rivers and streams, and is comprised of mostly poorly sorted sand, silt, and clay with wood and shell fragments, and local deposits of sandy gravel (Lineback, 1979). The upper part consists of overbank silts and clays, while the coarser-textured lower portion is mainly sandy channel and lateral accretion deposits. The Cahokia is present along all Illinois streams, although locally absent where active stream erosion is occurring (Willman and Frye, 1970). The Cahokia Formation is reported along the East Fork Shoal Creek valley to the east of the site (Berg and Kempton, 1987).

A.3 Bedrock

The site and surrounding areas are underlain by rocks belonging to the Pennsylvanian Bond Formation (Appendix A [Figure 4]) (Kolata, 2005; Willman et al., 1967). Detailed descriptions of the Pennsylvanian strata of Illinois were published by Willman et al. (1975). The following geologic description is based on that report. The Bond Formation, named for Bond County where exposures are prominent, includes all strata from the base of the Shoal Creek Limestone Member or the LaSalle Limestone Member to the top of the Millersville Limestone Member or the Livingstone Limestone Member. It is overlain by the Mattoon Formation and underlain by the Modesto Formation. It varies from less than 150 feet thick in eastern Illinois to over 300 feet thick in southeastern Illinois, averaging about 250 feet. The Bond Formation is characterized by a high percentage of limestone and calcareous clays and shales. It is bound by thick limestone members (up to 50 feet), the thickest and purest limestones in the Pennsylvanian System of Illinois. Gray shales constitute the greatest part of the formation, although thick channel sandstones are developed locally.

The elevation of the bedrock surface in the area ranges from 450 to 500 feet above mean sea level (Herzog et al., 1994). The bedrock surface slopes gently towards the west into a minor bedrock valley that runs north-south. Well logs indicate that the lithology of the uppermost bedrock is predominantly shale (Zeizel, 1959).



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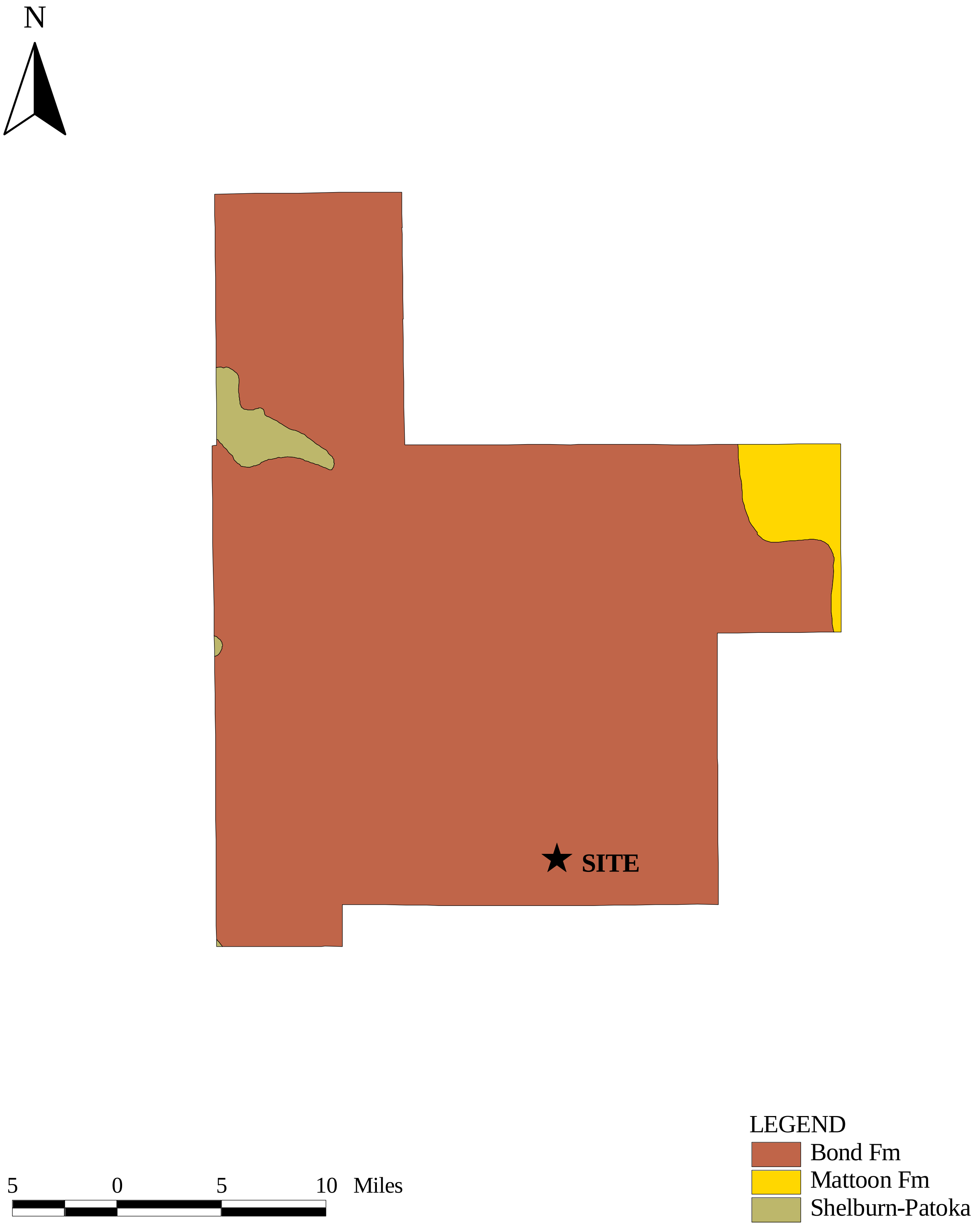
821 S. DURKIN DR. SPRINGFIELD, IL 62704 (217) 787-2118
P.O. BOX 925 CARBONDALE, IL 62903 (618) 521-0574

ILLINOIS PROFESSIONAL DESIGN FIRM No. 184-001130

FIGURE 3
PHYSIOGRAPHIC DIVISIONS OF ILLINOIS (LEIGHTON ET AL, 1948)

AMERENENERGY GENERATING COMPANY
COFFEEN POWER STATION
MONTGOMERY COUNTY, ILLINOIS

PROJECT: SA09035 DRAWING: Physio DATE: 11/09



RAPPS

Engineering & Applied Science, Inc.

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P.O. BOX 925 CARBONDALE, IL 62903 (618) 521-0574

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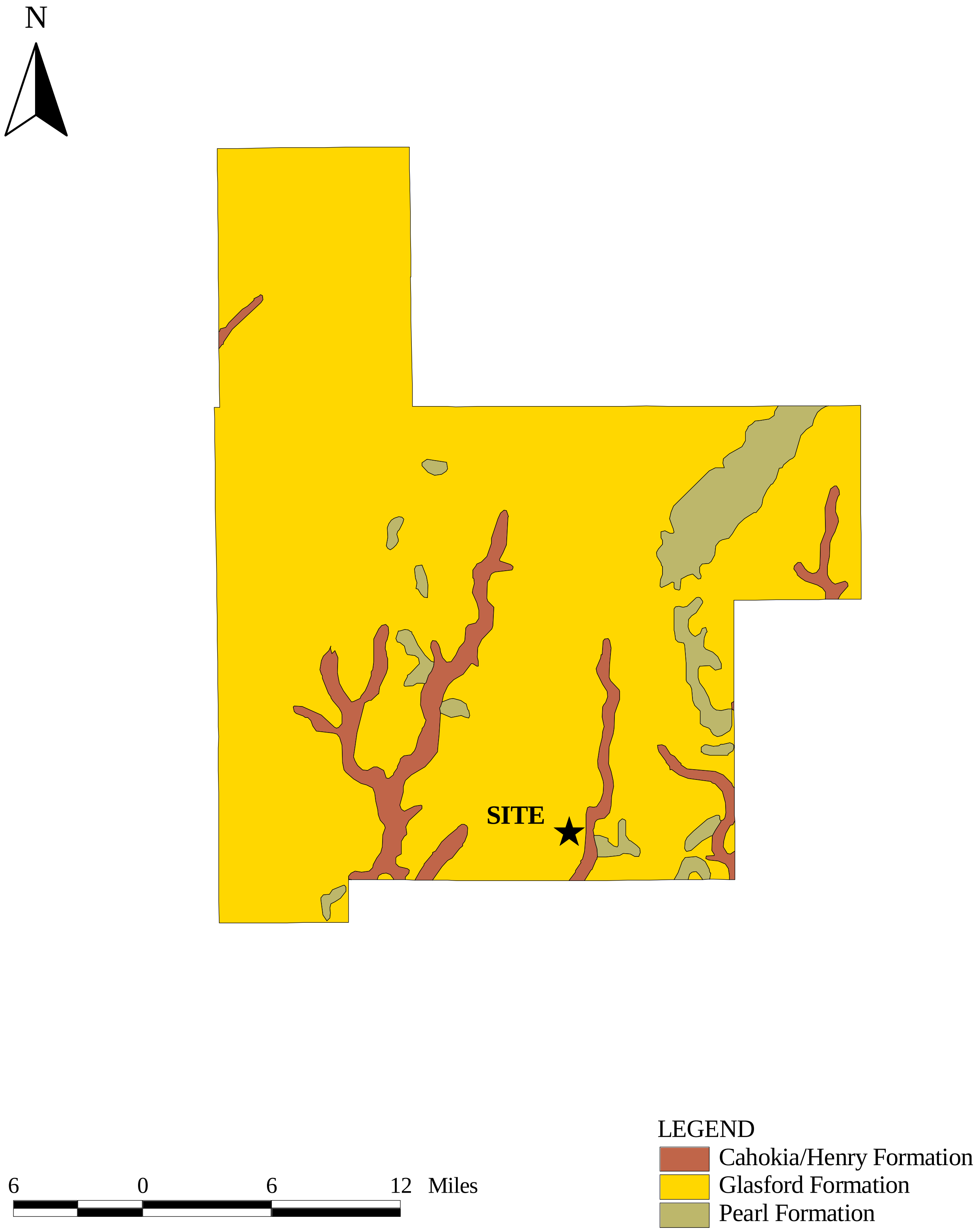
FIGURE 4

BEDROCK GEOLOGY
(HORBERG, 1950)

AMERENENERGY GENERATING COMPANY
COFFEEN POWER STATION
MONTGOMERY COUNTY, ILLINOIS

PROJECT: SA09035 DRAWING: Bedgeo DATE: 11/09



RAPPS
Engineering & Applied Science, Inc.

821 S. DURKIN DR. SPRINGFIELD, IL 62704 (217) 787-2118
P.O. BOX 925 CARBONDALE, IL 62903 (618) 521-0574

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FIGURE 5

QUATERNARY GEOLOGY
(HANSEL AND JOHNSON, 1996)

AMERENENERGY GENERATING COMPANY
COFFEEN POWER STATION
MONTGOMERY COUNTY, ILLINOIS

PROJECT: SA09035 DRAWING: Quat DATE: 11/09

APPENDIX B

WELL SURVEY RESULTS

B WELL SEARCH

B.1 Well Search Overview

The following sources of information were utilized in order to determine community water source and water well locations:

- Illinois State Geological Survey's Illinois Water Well (ILWATER) Internet Map Service
- Illinois State Water Survey Domestic Well Database
- Illinois EPA web-based Geographic Information System (GIS) files
- Illinois Department of Public Health
- Montgomery County Health Department

B.2 Illinois State Geological Survey (ISGS)

The ISGS website provided an ArcIMS View Map as well as a database query for water wells. ISGS database information including any boring logs and well construction information is provided in this Appendix.

B.3 Illinois State Water Survey (ISWS)

All of the wells found on-line through the ISWS Domestic Well Database were previously identified on the ISGS website. Hard copy records contained within the ISWS database, consisting of public, industrial, and commercial water wells, were not all received as of the date of this report. Since the ISWS database generally contains the same well information as the ISGS and Illinois EPA databases, some ISWS well entries on the Appendix B-1 Table were marked as pending. Should any new information be acquired from the ISWS including additional water wells not previously identified from the on-line sources of well information, it will be provided as an addendum to this report. Table B-2 lists wells located by RAPPS (2009) that were not located and identified in the on-line search for this report.

B.4 Illinois Environmental Protection Agency (IEPA)

The Illinois EPA database website provided ArcIMS Viewer Maps showing information on community, non-community, and public water supply wells as defined on the Illinois EPA website:

- Community Water Supply: a public water supply that serves or is intended to serve at least 15 service connections used by residents or regularly serves at least 25 residents.

- Non-Community Water Supply: a public water supply that is not a community water supply.
- Public Water Supply: all mains, pipes and structures through which water is obtained and distributed to the public, including wells and well structures, intakes and cribs, pumping stations, treatment plants, reservoirs, storage tanks and appurtenances, collectively or severally, actually used or intended for use for the purpose of furnishing water for drinking or general domestic use and which serve at least 15 service connections or which regularly serve at least 25 persons at least 60 days per year. A public water supply is either a community water supply or a non-community water supply.

Based on the IEPA maps, two non-CWS wells are located within Sections 10 and 15. Both non-CWS were identified in the ISGS records.

B.5 Montgomery County Health Department

Personnel from the Montgomery County Health Department confirmed the two non-CWS well systems were present within the area and noted that they were used at a campground and wildlife preserve. No additional information was provided about the area.

Table B-1. Well Search Results

Phase I Hydrogeologic Assessment

Coffeen Energy Center

Map	Source of Well Information				Location Name at Time of Well Completion	Well		Location				Year	Aquifer		Well
Well #	ISGS	ISWS***	IEPA	Other		Depth	County	Township	Range	Section	Subsection	Drilled	Type	Formation	Use*
1	121352182400	115230	21824	--	Hueitt, Bill	32	Montgomery	7N	3W	14	NE,NE,NE	1974	Unconsolidated	clay	FD
2	121352182500	115229	21825	--	Stahl, Louis	32	Montgomery	7N	3W	14	NE,NE,NE	1974	Unconsolidated	clay	FD
3	121350164400	115213	1644	--	Flori, Eugene	20	Montgomery	7N	3W	10	--	1969	Unconsolidated	sand	FD
4	121350171700	115228	1717	--	Marfield, Mac	29	Montgomery	7N	3W	14	NE,NW,NE	1970	Unconsolidated	clay	FD
5	121350172600	115224	1726	--	Schuler, Paul	32	Montgomery	7N	3W	14	NW,NE,NE	1971	Unconsolidated	sand	FD
6	121352300600	115226	23006	--	Jump, James	41	Montgomery	7N	3W	14	SE,SE,SE	1986	Unconsolidated	ground-clay	FD
7	121352310800	***	23108	--	Dept. of Conservation	70	Montgomery	7N	3W	15	NE,NW,NW	1987	Unconsolidated	sandy clay	IC
8	121352221300	115222	22213	--	Gadshlen, Clarence	156	Montgomery	7N	3W	14	SE,NE,NE	1977	Bedrock	sandstone	FD
9	121352221400	115223	22214	--	Warfield, William	151	Montgomery	7N	3W	14	NE	1978	Bedrock	sandstone	FD
10	121352334900	243174	23349	--	Monk, Lawrence & Anita	382	Montgomery	7N	3W	14	SE,SE,NE	1993	Bedrock	gray sandstone	FD
11	121352361400	***	23614	--	White & Brewer	40	Montgomery	7N	3W	11	SE,NE,NE	1993	Unconsolidated	silt	MW
12	121352361500	***	23615	--	White & Brewer	35	Montgomery	7N	3W	11	NE	1993	Unconsolidated	silt	MW
13	121352361600	***	23616	--	White & Brewer	17	Montgomery	7N	3W	11	--	--	Unconsolidated	silt	MW
14	121352361700	***	23617	--	White & Brewer	25	Montgomery	7N	3W	11	--	--	Unconsolidated	silty clay	MW
15	121352361800	***	23618	--	White & Brewer	23	Montgomery	7N	3W	11	--	--	Unconsolidated	silty clay	MW
16	121352361900	***	23619	--	White & Brewer	40	Montgomery	7N	3W	11	--	--	Unconsolidated	sandy silt	MW
17	121352362000	***	23620	--	White & Brewer	20	Montgomery	7N	3W	11	--	--	Unconsolidated	sandy silt	MW
18	121352362100	***	23621	--	White & Brewer	33	Montgomery	7N	3W	11	--	--	Unconsolidated	sandy silt	MW
19	121352362300	***	23623	--	White & Brewer	48	Montgomery	7N	3W	12	--	--	Unconsolidated	clay and silt	MW
20	121352362400	***		--	White & Brewer	24	Montgomery	7N	3W	12	--	--	Unconsolidated	sandy silt	MW
21	121352283100	115350	22831	--	Sidner, Joe	50	Montgomery	7N	3W	10	NW,SW,SW	1984	Unconsolidated	gravel	FD
22	121352283200	115215	22832	--	Wibel, William	39	Montgomery	7N	3W	11	SE,SE,NW (A)	1981	Unconsolidated	sand and gravel	FD
23	121352380200	290232	23802	--	O'Dell, Kenneth & Chong	363	Montgomery	7N	3W	11	NW,SE,SE	1996	Bedrock	light gray sandstone	FD
24	121352380300	290231	23803	--	Childers, Joe	401	Montgomery	7N	3W	14	SW,NE,NE	1996	Bedrock	light gray sandstone	FD
25	121352396900	***	13500061	--	Coffeen Lake Fish & Wildlife	--	Montgomery	7N	3W	15	NW,NW,SE	--	--	--	NCWS
26	121352400700	***	13500012	--	Indian Grove Campground	--	Montgomery	7N	3W	10	SW,SW,SW	--	--	--	NCWS

Sources of Information

IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey (Private Well Database)
SWA	IEPA Source Water Assessment

*Well Use

FD	Farm and/or Domestic Water Well
IC	Industrial/Commercial Water Well
CWS	Community Water Supply
NCWS	Non-Community Water Supply
MW	Monitoring well

Notes

- -	Not applicable or no information available
***	ISWS data pending
(A)	Well is mislocated in ISGS and/or IEPA databases

Table B-2. Other Water Wells, Precise Location Not Available

Phase I Hydrogeologic Assessment

Coffeen Energy Center

Well ID	Depth	Location Township	Range	Section	Well Use	Driller	Date Drilled
400397		7N	3W	10	IC		//
43308	16	7N	3W	10	IC	DAN KOHNEN	//
433123	20	7N	3W	10	IC	DAN KOHNEN	//
115214	500	7N	3W	11	IC		7/14/1996
250603	40	7N	3W	11	MO	FOX DRILLING INC.	11/17/1993
250604	35	7N	3W	11	MO	FOX DRILLING INC.	11/18/1993
250605	17	7N	3W	11	MO	FOX DRILLING INC.	1/28/1994
250610	25	7N	3W	11	MO	FOX DRILLING INC.	1/28/1994
250611	23	7N	3W	11	MO	FOX DRILLING INC.	1/28/1994
250612	40	7N	3W	11	MO	FOX DRILLING INC.	1/28/1994
250613	20	7N	3W	11	MO	FOX DRILLING INC.	1/28/1994
250614	33	7N	3W	11	MO	FOX DRILLING INC.	2/3/1994
433009	15	7N	3W	11	MO	DAN KOHNEN	//
290231	401	7N	3W	14	IC	KOHEN CONCR.	8/5/1996
377373	483	7N	3W	14	IC	SCWHARTZ	1997
377374	504	7N	3W	14	IC	SCWHARTZ	1997
377375	490	7N	3W	14	IC	SCWHARTZ	1997
377376	408	7N	3W	14	IC	SCWHARTZ	1997
377377	417	7N	3W	14	IC	SCWHARTZ	1997
377378	418	7N	3W	14	IC	SCWHARTZ	1997
377380	416	7N	3W	14	IC	SCWHARTZ	1997
403162		7N	3W	14			//
403163		7N	3W	14			//
115231	70	7N	3W	15	ST	H LINK	6/23/1987

Well Use

DO	Domestic
MO	not specified
IC	not specified
ST	not specified

These wells are listed in RAPPS (2009). NRT has ordered but not yet received these records from the ISWS Domestic Wells Database.

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ILLINOIS STATE GEOLOGICAL SURVEY

Noncommunity - Public Water Well	**Top**	**Bottom**
no record	0	0
Total Depth		

Permit Date: **Permit #:**

COMPANY

FARM Indian Grove Campground

DATE DRILLED **NO.**

ELEVATION 0 **COUNTY NO.** 24007

LOCATION SW SW SW

LATITUDE 39.057742 **LONGITUDE** -89.416636

COUNTY **Montgomery** **API** **121352400700** **10 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Water Well for Business	**Top**	**Bottom**
no record	0	0
Total Depth		

Permit Date: **Permit #:**

COMPANY

FARM Coffeen Lake Fish & Wildlife

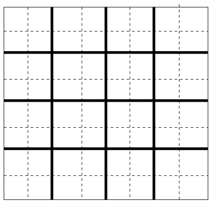
DATE DRILLED **NO.**

ELEVATION 0 **COUNTY NO.** 23969

LOCATION NW NW SE

LATITUDE 39.048688 **LONGITUDE** -89.407144

COUNTY Montgomery **API** 121352396900



15 - 7N - 3W

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
brown clay firm sticky	0	15
brown clay sandy & pebble firm	15	27
brn gvl coarse clean loose water bearing	27	29
gray clay hard sandy & pebble	29	65
greenish brown clay sandy firm	65	82
brown shale very sandy S-M	82	84
gray-brown sandstone clean-dirty	84	93
brown shale soft & sandy	93	99
gray & brown shale in layers soft	99	123
gry brn sandstone loose clean wtr bearin	123	153
gray shale sandy	153	178
dark gray shale	178	197
gray & dull gray & dark gray lime	197	204
dark gray & black shale	204	208
gray shale	208	218
coal	218	219
lt gray shale w/pieces brown lime & coal	219	240
shale & gray sandstone in fine sheets	240	250
gray shale sandy & sticky	250	257
gry sandy & sticky shale w/strk brn lime	257	262
dark gray & black shale sticky	262	267
gry-lt gry shale sticky w/fine strk lime	267	281
gray sandstone clean semi loose	281	300
gray shale sticky (M) chips	300	302

Permit Date: May 15, 1996 **Permit #:**

COMPANY Kohnen, Clarence

FARM Childers, Joe

DATE DRILLED August 5, 1996 **NO.**

ELEVATION 0 **COUNTY NO.** 23803

LOCATION SW NE NE

LATITUDE 39.054141 **LONGITUDE** -89.383921

COUNTY **Montgomery** **API** **121352380300** **14 - 7N - 3W**

ILLINOIS STATE GEOLOGICAL SURVEY

gray sandstone loose clean	302	306
gray sandy shale chips & sticky chips	306	324
gray sandstone loose clean w/pieces lime	324	398
off white lime H & tan soft	398	399
dark gray shale sticky chips	399	401
Total Depth		**401**

Casing: 6" PVC SDR 21 from -1' to 86'
4.5" PV SDR 17 from 41' to 401'
4.5" SLOTTED from 361' to 401'

Grout: BENTONITE SLRY from 0 to 86.

Water from gry-lt gry sandstone at 341' to 398'.
Static level 295' below casing top which is 0' above GL
Pumping level 401' when pumping at 10 gpm for 0 hours

Remarks: TDS 550, shale trap @ 86' & 341' & 339'

Location source: Location from permit

Kohnen, Clarence
Childers, Joe

COUNTY Montgomery **API 121352380300** **14 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
brown sandy clay	0	7
orangish brown clay sandy & pebble hard	7	9
brown clay very sandy & pebble hard	9	40
gray clay very sandy & pebble hard	40	43
greenish gray clay tacky	43	50
brn sandy clay pebble hard & cobblestone	50	72
gray clay sandy pebble hard	72	85
brown clay tacky stiff	85	101
grn-gry shale w/f strk dk red/brn rock	101	107
gray shale sandy (H)	107	115
gray sandstone clean tight	115	117
gray shale very sandy	117	135
gray sandstone clean cemented (H)	135	157
gray shale sticky	157	177
gray shale very soft (cavey)	177	180
gray shale sticky little sandy	180	187
lime gray & dull gray (H-M)	187	196
gray & black shale sandy firm	196	201
gray shale sandy & sticky	201	263
gray & dk gry shale w/f pieces brn lime	263	274
gray & lt gray shale & sticky	274	288
gray sandstone loose (dirty)	288	290
gray sandstone w/streak of gry sandstone	290	297
gray sandstone clean loose semi loose	297	301

Permit Date: June 21, 1996 **Permit #:**

COMPANY Kohnen, Clarence
FARM O'Dell, Kenneth & Chong
DATE DRILLED August 6, 1996 **NO.**
ELEVATION 0 **COUNTY NO.** 23802
LOCATION NW SE SE
LATITUDE 39.05958 **LONGITUDE** -89.383966
COUNTY **Montgomery** **API 121352380200** **11 - 7N - 3W**

ILLINOIS STATE GEOLOGICAL SURVEY

gray shale very sandy	301	307
gray sandstone clean loose fine cuttings	307	315
gray sandstone w/streak of gray shale	315	317
gray sandstone clean semi loose	317	325
gray sandstone clean loose water bearing	325	363
Total Depth		**363**

Casing: 6" PVC SDR 21 from 0' to 116'
4.5" PVC SDR 17 from 102' to 362'
4.5" SLOTTED @ 321'-322'& from 342' to 362'

Grout: BENTONITE SLRY from 0 to 116.

Water from light gray sandstone at 322' to 362'.
Static level 300' below casing top which is 1' above GL
Pumping level 362' when pumping at 15 gpm for 0 hours

Remarks: TDS 800,shale trap @ 116'-302'-322'-330'

Location source: Location from permit

Kohnen, Clarence O'Dell, Kenneth & Chong

COUNTY Montgomery **API 121352380200** **11 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
silt	0	14
sandy silt	14	24
Total Depth		**24**

Casing: 2" SCH 40 PVC from 0' to 14'

Grout: CEMENT/BENT 5% from 0 to 8.

Water from at 0' to 15'.

Additional location info: Lot: Subdivision:
875281N,2519953E state pl

Location source: Location from the driller

Permit Date:

Permit #: none

COMPANY Fox Drilling

FARM White & Brewer

DATE DRILLED January 28, 1994

NO. PZ-5

ELEVATION 0

COUNTY NO. 23624

LOCATION 1340'N line, 190'W line of section

LATITUDE 39.067664

LONGITUDE -89.379894

COUNTY **Montgomery**

API **121352362400**

12 - 7N - 3W

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
clay	0	4
silty clay	4	10
sandy clay	10	27
silt	27	44
clay	44	48
Total Depth		**48**

Casing: 2" SCH 40 PVC from 0' to 36'

Screen: 10' of 2" diameter .01 slot

Grout: CEMENT/BENT 5% from 0 to 30.

Size hole below casing: 7.87"

Water from at 0' to 26'.
Static level 29' below casing top which is 3' above GL

Additional location info: Lot: Subdivision:
875339N,2519836E state pl

Location source: Location from the driller

Permit Date:

Permit #: none

COMPANY Fox Drilling

FARM White & Brewer

DATE DRILLED January 28, 1994

NO. PZ-4

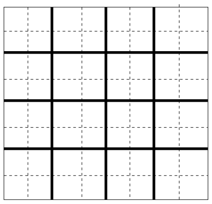
ELEVATION 620GL

COUNTY NO. 23623

LOCATION 1280'N line, 70'W line of section

LATITUDE 39.067833

LONGITUDE -89.380319



COUNTY Montgomery **API** 121352362300 **12 - 7N - 3W**

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ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
clayey silt	0	4
silty clay	4	18
sandy silt	18	25
sand	25	31
clayey silt	31	33
Total Depth		**33**

Casing: 2" SCH 5 STAINLESS STL from 0' to 21'

Screen: 10' of 2" diameter .01 slot

Grout: CEMENT/BENT 5% from 0 to 16.

Size hole below casing: 7.87"

Water from at 0' to 2'.
Static level 4' below casing top which is 2' above GL

Location source: Location from the driller

Permit Date: **Permit #:** none

COMPANY Fox Drilling
FARM White & Brewer
DATE DRILLED **NO.** G-120A
ELEVATION 623GL **COUNTY NO.** 23621
LOCATION 1990'N line, 730'E line of section
LATITUDE 39.065884 **LONGITUDE** -89.38313
COUNTY Montgomery **API** 121352362100 **11 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
clayey silt	0	1
silty clay	1	10
silty sand	10	14
sandy silt	14	20
Total Depth		**20**

Casing: 2" SCH 40 PVC from 0' to 9'

Screen: 10' of 2" diameter .01 slot

Grout: CEMENT/BENT 5% from 0 to 4.

Size hole below casing: 7.87"

Water from at 0' to 3'.
Static level 9' below casing top which is 2' above GL

Location source: Location from the driller

Permit Date: **Permit #:** none

COMPANY Fox Drilling
FARM White & Brewer
DATE DRILLED **NO.** G119B
ELEVATION 622GL **COUNTY NO.** 23620
LOCATION 1080'N line, 750'E line of section
LATITUDE 39.068397 **LONGITUDE** -89.383229
COUNTY **Montgomery** **API** **121352362000** **11 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
silty clay	0	10
silty sand	10	14
sandy silt	14	29
silty clay	29	33
clayey silt	33	40
Total Depth		**40**

Casing: 2" SCH 5 STAINLESS STL from 0' to 30'

Screen: 10' of 2" diameter .01 slot

Grout: CEMENT/BENT 5% from 0 to 27.

Size hole below casing: 7.87"

Water from at 0' to 5'.
Static level 7' below casing top which is 2' above GL

Location source: Location from the driller

Permit Date: **Permit #:** none

COMPANY Fox Drilling
FARM White & Brewer
DATE DRILLED **NO.** G-119A
ELEVATION 623GL **COUNTY NO.** 23619
LOCATION 1060'N line, 730'E line of section
LATITUDE 39.068452 **LONGITUDE** -89.383158
COUNTY **Montgomery** **API** **121352361900** **11 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
sandy clay	0	3
silty lcay	3	22
sandy, silty clay	22	23
Total Depth		**23**

Casing: 2" SCH 40 PVC from 0' to 12'

Screen: 10' of 2" diameter .01 slot

Grout: CEMENT/BENT 5% from 0 to 12.

Size hole below casing: 7.87"

Water from at 0' to 8'.
Static level 10' below casing top which is 2' above GL

Location source: Location from the driller

Permit Date: **Permit #:** none

COMPANY Fox Drilling
FARM White & Brewer
DATE DRILLED **NO.** PZ-12
ELEVATION 624GL **COUNTY NO.** 23618
LOCATION 910'N line, 530'E line of section
LATITUDE 39.068862 **LONGITUDE** -89.382456
COUNTY **Montgomery** **API** **121352361800** **11 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
silty clay	0	25
Total Depth		**25**

Casing: 2" SCH 40 PVC from 0' to 15'

Screen: 10' of 2" diameter .01 slot

Grout: CEMENT/BENT 5% from 0 to 11.

Size hole below casing: 7.87"

Water from at 0' to 6'.
Static level 9' below casing top which is 3' above GL

Location source: Location from the driller

Permit Date:

Permit #: none

COMPANY Fox Drilling

FARM White & Brewer

DATE DRILLED

NO. PZ-11

ELEVATION 624GL

COUNTY NO. 23617

LOCATION 1770'N line, 500'E line of section

LATITUDE 39.066488

LONGITUDE -89.382322

COUNTY **Montgomery**

API **121352361700**

11 - 7N - 3W

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
clay	0	3
silt	3	16
clay	16	17
Total Depth		**17**

Casing: 2" SSCH 40 PVC from 0' to 6'
Screen: 10' of 2" diameter .01 slot
Grout: CEMENT/BENT 5% from 0 to 3.

Size hole below casing: 7.87"

Water from at 0' to 11'.
Static level 13' below casing top which is 2' above GL

Location source: Location from the driller

Permit Date:

Permit #: none

COMPANY Fox Drilling
FARM White & Brewer
DATE DRILLED
NO. PZ-3
ELEVATION 621GL
COUNTY NO. 23616
LOCATION 1620'N line, 200'E line of section
LATITUDE 39.066898
LONGITUDE -89.381266
COUNTY **Montgomery**
API **121352361600**
11 - 7N - 3W

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
clay	0	3
silt	3	33
clay	33	35
Total Depth		**35**

Casing: 2" SCH 40 PVC from 0' to 23'
Screen: 10' of 2" diameter .01 slot
Grout: CEMENT/BENT from 0 to 19.

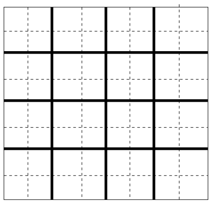
Size hole below casing: 7.87"

Water from at 0' to 10'.
Static level 12' below casing top which is 2' above GL

Location source: Location from the driller

Permit Date: **Permit #:** none

COMPANY Fox Drilling
FARM White & Brewer
DATE DRILLED November 18, 1993 **NO.** PZ-2
ELEVATION 621GL **COUNTY NO.** 23615
LOCATION 1470'S line, 300'W line of NE
LATITUDE 39.068212 **LONGITUDE** -89.388821
COUNTY **Montgomery** **API** **121352361500** **11 - 7N - 3W**



Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Monitoring	**Top**	**Bottom**
clay	0	3
silt	3	35
sand	35	38
clay	38	40
Total Depth		**40**

Casing: 2" SCH 40 PVC from 0' to 28'

Screen: 10' of 2" diameter .01 slot

Grout: CEMENT/BENT from 0 to 23.

Size hole below casing: 7.87"

Water from at 0' to 27'.
Static level 27' below casing top which is 2' above GL

Location source: Location from the driller

Permit Date: **Permit #:** none

COMPANY Fox Drilling
FARM White & Brewer
DATE DRILLED November 17, 1993 **NO.** PZ-1
ELEVATION 623GL **COUNTY NO.** 23614
LOCATION 0'N line, 0'E line of SE NE NE
LATITUDE 39.069551 **LONGITUDE** -89.380585
COUNTY **Montgomery** **API** **121352361400** **11 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
brown-gray firm sandy clay	0	60
brown-gray very sandy shale	60	78
brown-gray cemented sandstone	78	114
off white hard lime	114	116
gray hard sandstone	116	118
dark gray shale in layers	118	154
gray & white hard lime	154	161
gray & dark gray sandy shale	161	255
gray clean sandstone	255	261
hard shale & sandy chips	261	266
gray sandstone, some shale	266	297
gray ss, tight & fine grained cuttings	297	299
gray ss, brown lime in fine clean sheets	299	301
gray ss, few cuttings, tight clean	301	319
gray ss w/bits of brown ss fine grained	319	323
gray coarse sandstone, few cuttings	323	335
gray sandstone w/bits of brown lime	335	340
gray sandstone w/bits of black shale	340	348
gray fine grained ss w/decomposed matter	348	354
gray ss w/st of tan lime clean few ctgs	354	373
gray shale	373	374
gray ss w/fine st of gray shale	374	376
gray sandstone cement looking	376	378
tan lime w/st of coal	378	379

Permit Date: August 12, 1993 **Permit #:**

COMPANY Kohnen, Clarence
FARM Monk, Lawrence & Anita
DATE DRILLED October 7, 1993 **NO.**
ELEVATION 0 **COUNTY NO.** 23349
LOCATION SE SE NE
LATITUDE 39.050503 **LONGITUDE** -89.38159
COUNTY Montgomery **API** 121352334900 **14 - 7N - 3W**

ILLINOIS STATE GEOLOGICAL SURVEY

cemented sandstone	379	380
gray shale	380	382
Total Depth		**382**

Casing: 6" PVC SDR 21 from -1' to 115'
5" PVC SDR 21 SOLID from 101' to 341'
5" PVC SDR 17 SLOTTED from 341' to 381'

Grout: CLAY SLURRY from 0 to 65.

Grout: HOLE PLUG from 65 to 80.

Grout: BENTONITE SLRY from 80 to 115.

Grout: SHALE TRAP from 115 to 0.

Size hole below casing: 5.62"

Water from gray sandstone at 290' to 379'.
Static level 290' below casing top which is 1' above GL

Remarks: See files for lengthy driller's log.

Address of well: Red Ball Trail, Co. Rd.#9
Coffeen, IL

Location source: Location from permit

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Noncommunity - Public Water Well	**Top**	**Bottom**
SS.#66054 (5'-70')	0	0
yellow clay	0	20
sandy wet clay	20	35
gray clay	35	50
gray peat mix	50	58
gray sandy clay	58	60
gray clay	60	68
gray wet sand	68	70
Total Depth		**70**

Casing: 6" PLASTIC from 0' to 12'
36" CONCRETE from 0' to 70'

Size hole below casing: 0"

Water from sandy clay at 22' to 70'.

Remarks: drilled for Lost Creek Constr.

Sample set # 66054 (5' - 70') Received: July 2, 1987

Location source: Location from permit

Permit Date: June 16, 1987 **Permit #:** 132664

COMPANY Link, Harold F.
FARM Dept. of Conservation
DATE DRILLED June 23, 1987 **NO.**
ELEVATION 0 **COUNTY NO.** 23108
LOCATION NE NW NW
LATITUDE 39.055951 **LONGITUDE** -89.414273
COUNTY Montgomery **API** 121352310800 **15 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
brown top soil	0	1
yellow clay	1	8
yellow clay-sand	8	16
gray clay-sand	16	22
yellow gravel	22	24
gray clay-sand	24	36
yellow sand rock	36	41
Total Depth		**41**

Casing: 36" CONCRETE from -1' to 41'

Grout: CONCRETE from 0 to 10.
Grout: GRAVEL from 10 to 41.

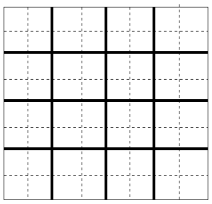
Size hole below casing: 0"

Water from ground-clay at 23' to 24'.

Location source: Location from permit

Permit Date: November 25, 1986 **Permit #:** 128294

COMPANY Kohnen, Clarence
FARM Jump, James
DATE DRILLED December 3, 1986 **NO.**
ELEVATION 0 **COUNTY NO.** 23006
LOCATION 150'N line, 150'E line of SE SE SE
LATITUDE 39.043761 **LONGITUDE** -89.380946



COUNTY Montgomery **API 121352300600** **14 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
brown top soil	0	1
yellow clay	1	8
yellow clay & sand	8	18
yellow gravel & sand	18	30
yellow sand & gravel	30	39
Total Depth		**39**

Casing: 36" CONCRETE from -1' to 39'
" from 0' to 0'

Grout: CONCRETE from 0 to 10.

Grout: GRAVEL from 10 to 39.

Size hole below casing: 0"

Water from at 22' to 39'.
Permanent pump installed at 38' on December 1, 1981, with a capacity of 10 gpm

Location source: Location from permit

Permit Date: November 13, 1981 **Permit #:** 102105

COMPANY Kohnen, Clarence
FARM Wibel, William
DATE DRILLED November 30, 1981 **NO.**
ELEVATION 0 **COUNTY NO.** 22832
LOCATION 115'S line, 102'W line of SE SE NW
LATITUDE 39.064493 **LONGITUDE** -89.391801
COUNTY Montgomery **API** 121352283200 **11 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
clay	0	14
gravel & clay mix	14	16
yellow clay	16	31
gray clay	31	36
gry clay & gvl-mix	36	38
gray clay	38	50
Total Depth		**50**

Casing: 6" PLASTIC from 0' to 10'
36" CONCRETE from 0' to 50'

Size hole below casing: 0"

Water from gravel at 14' to 38'.

Location source: Location from permit

Permit Date: May 15, 1984 **Permit #:** 112378

COMPANY Link, Harold F.
FARM Sidner, Joe
DATE DRILLED June 6, 1984 **NO.**
ELEVATION 0 **COUNTY NO.** 22831
LOCATION NW SW SW
LATITUDE 39.059539 **LONGITUDE** -89.416652
COUNTY **Montaomerv** **API** **121352283100** **10 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
tan clay	0	37
gray clay	37	106
limestone	106	110
gray shale	110	136
sandstone	136	151
Total Depth		**151**

Casing: 5" VALLEY STEEL from -1' to 112'

Size hole below casing: 4.75"

Water from sandstone at 136' to 151'.
Static level 47' below casing top which is 1' above GL
Pumping level 92' when pumping at 5 gpm for 2 hours

Driller's Log filed
Location source: Location from permit

Permit Date: April 28, 1977 **Permit #:** 59626

COMPANY Courson, Richard C.
FARM Warfield, William
DATE DRILLED May 10, 1977 **NO.** 1
ELEVATION 630GL **COUNTY NO.** 22214
LOCATION 200'N line, 1100'E line of NE
LATITUDE 39.056309 **LONGITUDE** -89.384343
COUNTY **Montgomery** **API** **121352221400** **14 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
tan clay	0	38
gray clay	38	108
gray shale	108	112
limestone	112	115
gray shale	115	142
sandstone	142	156
Total Depth		**156**

Casing: 5" VALLEY STEEL from -1' to 116'

Size hole below casing: 4.75"

Water from sandstone at 142' to 156'.
Static level 45' below casing top which is 1' above GL
Pumping level 95' when pumping at 5 gpm for 2 hours

Driller's Log filed
Location source: Location from permit

Permit Date: April 28, 1977 **Permit #:** 59627

COMPANY owner
FARM Gadshlen, Clarence
DATE DRILLED May 12, 1977 **NO.** 1
ELEVATION 0 **COUNTY NO.** 22213
LOCATION 100'S line, 125'E line of SE NE NE
LATITUDE 39.053487 **LONGITUDE** -89.380881
COUNTY **Montgomery** **API** **121352221300** **14 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
clay	0	32
Total Depth		**32**

Casing: 30" CONCRETE from 0' to 33'

Water from clay at 0' to 0'.

Location source: Location from permit

Permit Date:

Permit #: 28887

COMPANY Bekemeyer, Gust

FARM Stahl, Louis

DATE DRILLED May 5, 1974

NO.

ELEVATION 0

COUNTY NO. 21825

LOCATION NE NE NE

LATITUDE 39.055928

LONGITUDE -89.381606

COUNTY Montgomery

API 121352182500

14 - 7N - 3W

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
clay	0	32
Total Depth		**32**

Casing: 30" CONCRETE from 0' to 33'

Water from clay at 0' to 0'.

Location source: Location from permit

Permit Date: **Permit #:** 28886

COMPANY Bekemeyer, Gust

FARM Hueitt, Bill

DATE DRILLED May 5, 1974 **NO.**

ELEVATION 0 **COUNTY NO.** 21824

LOCATION NE NE NE

LATITUDE 39.055928 **LONGITUDE** -89.381606

COUNTY **Montgomery** **API** **121352182400** **14 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
clay	0	25
sand	25	32
Total Depth		**32**

Casing: 36" CONCRETE from 1' to 32'

Size hole below casing: 36"

Water from sand at 0' to 0'.

Driller's Log filed

Location source: Location from permit

Permit Date: **Permit #:**

COMPANY Bekemeyer, Gust

FARM Schuler, Paul

DATE DRILLED February 4, 1971 **NO.**

ELEVATION 0 **COUNTY NO.** 01726

LOCATION NW NE NE

LATITUDE 39.055952 **LONGITUDE** -89.383929

COUNTY **Montgomery** **API** **121350172600** **14 - 7N - 3W**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
clay	0	29
Total Depth		**29**

Casing: 36" CONCRETE from 1' to 29'

Water from clay at 0' to 0'.

Location source: Location from permit

Permit Date: **Permit #:**

COMPANY Bekemeyer, Gust

FARM Marfield, Mac

DATE DRILLED September 15, 1970 **NO.**

ELEVATION 0 **COUNTY NO.** 01717

LOCATION NE NW NE

LATITUDE 39.055977 **LONGITUDE** -89.386252

COUNTY **Montgomery** **API** **121350171700** **14 - 7N - 3W**

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	**Top**	**Bottom**
s.s. #56274	0	0
top soil	0	3
clay & sand	3	12
sand	12	15
sand clay & shale	15	20
Total Depth		**20**

Casing: 3" CONCRETE from 0' to 20'

Water from sand at 12' to 15'.

Driller's Log filed

Sample set # 56274 (0' - 20') Received: June 20, 1969

Location source: Location from permit

Permit Date: January 1, 1969 **Permit #:** NF 6054

COMPANY owner

FARM Flori, Eugene

DATE DRILLED May 19, 1969 **NO.** 1

ELEVATION 0 **COUNTY NO.** 01644

LOCATION 210'S line, 300'W line of SW

LATITUDE 39.057424 **LONGITUDE** -89.416746

COUNTY **Montgomery** **API** **121350164400** **10 - 7N - 3W**

APPENDIX C

BORING LOGS WITH WELL DIAGRAMS

Surface Elevation: 610.56

Datum msl

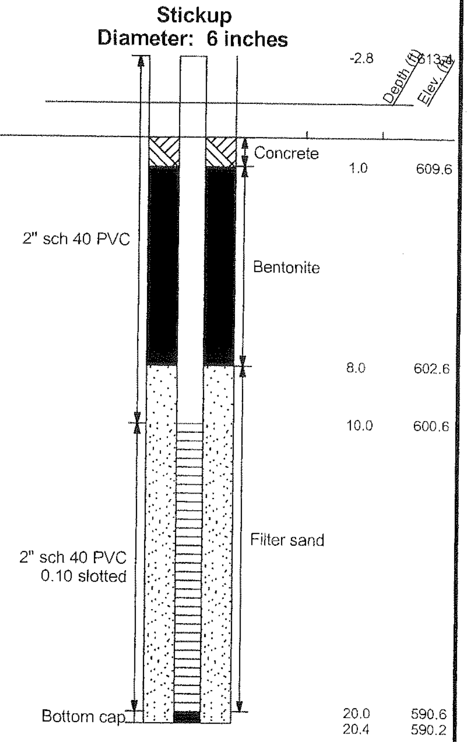
Completion Date: 8/27/10

Northing: 872502.26

Easting: 2516632.59

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Medium stiff, brown, silty CLAY - CL		
		6-3-3	SS1
		1-2-4	SS2
5	Medium stiff, gray, silty CLAY, trace sand - CL		
	∇	1-2-5	SS3
	Hard to stiff, brown to gray, silty CLAY, trace sand seams - CL (TILL)		
		9-22-28	SS4
10			
		1-6-12	SS5
15			
		3-4-9	SS6
20	Boring terminated at 20 feet.		
25			
30			
35			

WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 7 FEET ∇

DRILLING DATA

__ AUGER 4 1/4" HOLLOW STEM

WASHBORING FROM __ FEET

MVU DRILLER SWG LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: KBB
Date: 9/10/10	Date: 1-4-11	Date: 1/4/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren-Coffeen Ash Pond Evaluation

LOG OF BORING: APW-2

Project No. J017150.01

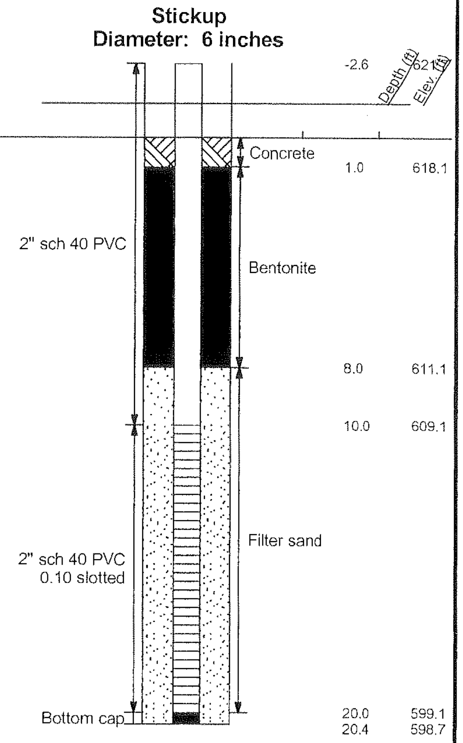
Surface Elevation: 619.10
Datum msl

Completion Date: 8/26/10
Northing: 871382.45
Easting: 2516641.06

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL: brown, silty clay	1-2-3	SS1
	Medium stiff, grayish-brown, silty CLAY with lignite - CL		
5		1-3-3	SS2
		1-3-4	SS3
	Soft, brown, silty CLAY - CL ∇	2-3-3	SS4
10	Stiff to hard, brown to grayish-brown, silty CLAY - CL (TILL)		
15		27-44 -50/1"	SS5
		44-50/2"	SS6
20	Boring terminated at 20 feet.		
25			
30			
35			

GRAPHIC LOG

WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 9 FEET ∇

DRILLING DATA

__ AUGER 4 1/4" HOLLOW STEM
WASHBORING FROM __ FEET
MVU DRILLER SWG LOGGER
CME 55TRK DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: KBG
Date: 9/10/10	Date: 1-4-11	Date: 1/4/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren-Coffeen Ash Pond Evaluation

LOG OF BORING: APW-3

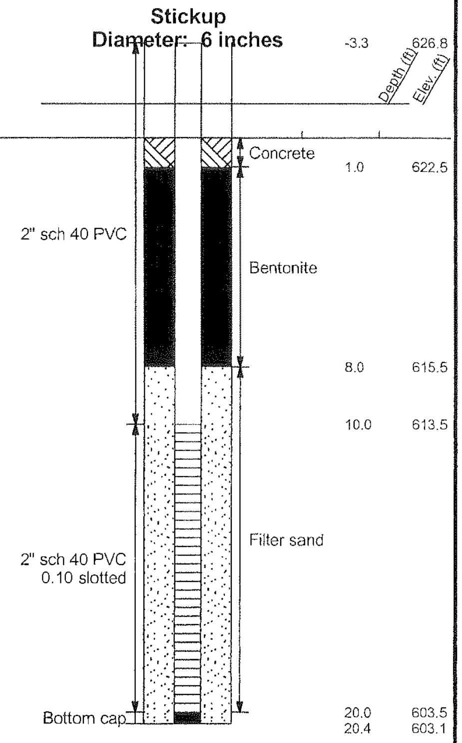
Project No. J017150.01

LOG OF BORING 2002 WL J017150.01- COFFEEN.GPJ GTINC 0638301.GPJ 12/13/10

Surface Elevation: 623.46
Datum msl
Completion Date: 8/26/10
Northing: 871397.48
Easting: 2515520.23

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Medium stiff, grayish-brown, silty CLAY - CL	▨		
		▨	0-1-1	SS1
5		▨	1-2-5	SS2
		▨	1-3-4	SS3
10		▨	1-2-3	SS4
	Medium to fine SAND - SP ∇	░	1-2-1	SS5
15	Hard, gray, silty CLAY - CL (TILL)	▩		
		▩	14-47	SS6
20	Boring terminated at 20 feet.			
25				
30				
35				

WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 14 FEET ∇

DRILLING DATA

__ AUGER 4 1/4" HOLLOW STEM
WASHBORING FROM __ FEET
MVU DRILLER SWG LOGGER
CME 55TRK DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: RSP
Date: 9/10/10	Date: 1-4-11	Date: 1/5/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren-Coffeen Ash Pond Evaluation

LOG OF BORING: APW-4

Project No. J017150.01

LOG OF BORING 2002 WL J017150.01- COFFEEN.GPJ GTINC 0638301.GPJ 12/13/10

Illinois Environmental Protection Agency **Well Completion Report**

Site #: ______ County: Montgomery Well #: G200

Site Name: AEG Coffeen Power Station CCB Management Facility Borehole #: G200

~~State Plane~~ Plant Coordinate: X 877,930.6 Y 2,515,650.0 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Jeffrey D. Emrick IL Registration #: 035-003507

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): ______

Logged By: Suzanna L Simpson Date Started: 2/25/2008 Date Finished: 2/25/2008

Report Form Completed By: Suzanna L Simpson Date: 2/29/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hr.

Type of Bentonite Seal -- [✓ Granular] Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hr.

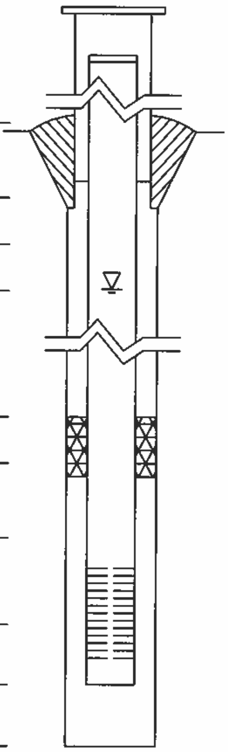
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Formation Sand (if applicable)

Installation Method: Slough



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
626.54	-2.34	Top of Protective Casing
625.94	-1.74	Top of Riser Pipe
624.20	0.00	Ground Surface
620.70	3.50	Top of Annular Sealant
621.45	2.75	Static Water Level (After Completion) 3/12/2008
620.70	3.50	Top of Seal
614.20	10.00	Top of Sand Pack
612.01	12.19	Top of Screen
607.22	16.98	Bottom of Screen
606.84	17.36	Bottom of Well
606.20	18.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	13.93
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	19.10
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: [✓ Steel]
Riser Pipe Above W.T.	SS304	SS316	PTFE	[✓ PVC]	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	[✓ PVC]	OTHER:
Screen	SS304	SS316	PTFE	[✓ PVC]	OTHER:

Well Completion Form (revised 02/06/02)

APPENDIX D

GROUNDWATER QUALITY DATA SUMMARY

Coffeen Energy Center
Water Quality Data: December 2010 through September 2012

Date Range: 10/01/2010 to 07/23/2012

Well Id	Date Sampled	Lab Id	Ag, diss, mg/L	As, diss, mg/L	B, diss, mg/L	Ba, diss, mg/L	Be, diss, mg/L	Cd, diss, mg/L
APW-2	12/01/2010		<0.005	<0.004	7.160	<0.050	<0.004	<0.004
	01/26/2011	11013614-1	<0.005	<0.001	7.200	0.020	<0.001	<0.001
	05/04/2011	1050500-01	<0.005	<0.001	6.700	0.017	<0.001	<0.001
	07/27/2011	1073185-01	<0.005	<0.001	6.300	0.018	<0.001	<0.001
	11/11/2011	1111715-01	<0.005	<0.001	8.100	0.018	<0.001	<0.001
	01/25/2012	2013026-01	<0.005	0.001	7.400	0.019	<0.001	<0.001
	05/22/2012	2052940-01	<0.005	0.002	7.000	0.016	<0.001	<0.001
	07/23/2012	2073210-01	<0.005	<0.001	8.100	0.017	<0.001	<0.001
APW-3	12/01/2010		<0.005	<0.004	2.070	<0.050	<0.004	<0.004
	01/26/2011	11013614-2	<0.005	<0.001	2.500	0.025	<0.001	<0.001
	05/04/2011	1050500-02	<0.005	<0.001	1.500	0.021	<0.001	<0.001
	07/28/2011	1073185-02	<0.005	0.005	1.100	0.020	<0.001	<0.001
	11/11/2011	1111715-02	<0.005	0.005	1.600	0.019	<0.001	<0.001
	01/25/2012	2013026-02	<0.005	0.002	2.100	0.020	<0.001	<0.001
	05/22/2012	2052940-02	<0.005	0.007	1.300	0.019	<0.001	<0.001
	07/23/2012	2073210-02	<0.005	0.004	2.000	0.017	<0.001	<0.001
APW-4	12/01/2010		<0.005	<0.004	3.540	0.086	<0.004	<0.004
	01/26/2011	11013614-3	<0.005	<0.001	3.800	0.044	<0.001	<0.001
	05/04/2011	1050500-03	<0.005	<0.001	3.900	0.027	<0.001	<0.001
	07/28/2011	1073185-03	<0.005	<0.001	3.200	0.026	<0.001	<0.001
	11/11/2011	1111715-03	<0.005	<0.001	3.900	0.025	<0.001	<0.001
	01/25/2012	2013026-03	<0.005	<0.001	3.600	0.026	<0.001	<0.001
	05/22/2012	2052940-03	<0.005	0.002	3.300	0.024	<0.001	<0.001
	07/23/2012	2073210-03	<0.005	<0.001	3.800	0.025	<0.001	<0.001
G200	11/15/2010	10112850-1	<0.005	<0.001	<0.010	<0.001	<0.001	<0.001
	01/27/2011	11013836-1	<0.005	<0.001	<0.010	0.063	<0.001	<0.001
	05/04/2011	1050693-01	<0.005	<0.001	0.011	0.057	<0.001	<0.001
	07/25/2011	1072922-01	<0.005	<0.001	<0.010	0.055	<0.001	<0.001
	11/11/2011	1111718-14	<0.005	0.001	<0.010	0.063	<0.001	<0.001
	01/30/2012	2013252-03	<0.005	<0.001	<0.010	0.060	<0.001	<0.001
	05/22/2012	2052942-01	<0.005	0.001	<0.010	0.057	<0.001	<0.001
	07/23/2012	2073209-09	<0.005	<0.001	0.014	0.058	<0.001	<0.001

Coffeen Energy Center
Water Quality Data: December 2010 through September 2012

Date Range: 10/01/2010 to 07/23/2012

Well Id	Date Sampled	Lab Id	Cl, diss, mg/L	CN, total, mg/L	Co, diss, mg/L	Cr, diss, mg/L	Cu, diss, mg/L	F, diss, mg/L
APW-2	12/01/2010		10.000	<0.010	<0.050	<0.010	<0.025	0.640
	01/26/2011	11013614-1	3.100	<0.005	<0.002	<0.004	<0.003	0.330
	05/04/2011	1050500-01	2.900	<0.005	<0.002	<0.004	<0.003	<0.250
	07/27/2011	1073185-01	3.000	<0.005	<0.002	<0.004	<0.003	0.440
	11/11/2011	1111715-01	3.300	<0.005	<0.002	<0.004	<0.003	0.510
	01/25/2012	2013026-01	3.300	<0.005	<0.002	<0.004	<0.003	0.410
	05/22/2012	2052940-01	3.000	<0.005	<0.002	<0.004	<0.003	0.410
	07/23/2012	2073210-01	3.000	<0.005	<0.002	<0.004	<0.003	0.600
APW-3	12/01/2010		27.000	<0.010	<0.050	<0.010	<0.025	0.340
	01/26/2011	11013614-2	32.000	<0.005	<0.002	<0.004	0.004	<0.250
	05/04/2011	1050500-02	31.000	<0.005	0.005	<0.004	0.004	<0.250
	07/28/2011	1073185-02	27.000	<0.005	0.006	<0.004	0.004	0.270
	11/11/2011	1111715-02	28.000	<0.005	0.005	<0.004	<0.003	0.480
	01/25/2012	2013026-02	31.000	<0.005	0.003	<0.004	<0.003	0.270
	05/22/2012	2052940-02	27.000	<0.005	0.006	<0.004	<0.003	0.260
	07/23/2012	2073210-02	31.000	<0.005	0.004	<0.004	<0.003	0.250
APW-4	12/01/2010		28.500	<0.010	<0.050	<0.010	<0.025	0.660
	01/26/2011	11013614-3	36.000	<0.005	<0.002	<0.004	0.003	0.550
	05/04/2011	1050500-03	33.000	<0.005	0.003	<0.004	0.004	<0.250
	07/28/2011	1073185-03	31.000	<0.005	0.002	<0.004	0.004	0.490
	11/11/2011	1111715-03	21.000	<0.005	<0.002	<0.004	<0.003	0.620
	01/25/2012	2013026-03	27.000	<0.005	0.003	<0.004	<0.003	0.510
	05/22/2012	2052940-03	25.000	<0.005	0.003	<0.004	0.003	0.470
	07/23/2012	2073210-03	26.000	<0.005	<0.002	<0.004	<0.003	0.410
G200	11/15/2010	10112850-1	46.000	<0.005	<0.002	<0.004	<0.003	<2.500
	01/27/2011	11013836-1	47.000	<0.005	<0.002	<0.004	<0.003	0.350
	05/04/2011	1050693-01	49.000	<0.005	<0.002	<0.004	<0.003	0.340
	07/25/2011	1072922-01	51.000	<0.005	<0.002	<0.004	<0.003	0.340
	11/11/2011	1111718-14	51.000	<0.005	<0.002	<0.004	0.003	0.510
	01/30/2012	2013252-03	54.000	<0.005	<0.002	<0.004	<0.003	0.400
	05/22/2012	2052942-01	69.000	<0.005	<0.002	<0.004	<0.003	0.300
	07/23/2012	2073209-09	68.000	<0.005	<0.002	<0.004	<0.003	0.440

Coffeen Energy Center
Water Quality Data: December 2010 through September 2012

Date Range: 10/01/2010 to 07/23/2012

Well Id	Date Sampled	Lab Id	Fe, diss, mg/L	GW Depth (TOC), ft	GW Elv, ft	Hg, diss, mg/L	Mn, diss, mg/L	Ni, diss, mg/L
APW-2	12/01/2010		<0.100	10.400	603.100	<0.000	0.418	<0.040
	01/26/2011	11013614-1	<0.010	9.180	604.320	<0.000	0.130	0.019
	05/04/2011	1050500-01	<0.010	8.050	605.450	<0.000	0.530	0.018
	07/27/2011	1073185-01	0.029	9.500	604.000	<0.000	0.410	0.016
	11/11/2011	1111715-01	0.030	9.980	603.520	<0.000	0.400	0.013
	01/25/2012	2013026-01	0.024	8.910	604.590	<0.000	0.730	0.013
	05/22/2012	2052940-01	13.000	9.430	604.070	<0.000	0.440	0.015
	07/23/2012	2073210-01	0.035	10.600	602.900	<0.000	0.400	0.017
APW-3	12/01/2010		1.240	5.600	616.340	<0.000	0.866	0.043
	01/26/2011	11013614-2	<0.010	4.250	617.690	<0.000	0.440	0.060
	05/04/2011	1050500-02	1.100	3.910	618.030	<0.000	0.850	0.049
	07/28/2011	1073185-02	3.200	4.550	617.390	<0.000	0.840	0.046
	11/11/2011	1111715-02	2.500	10.950	610.990	<0.000	0.800	0.058
	01/25/2012	2013026-02	0.300	4.410	617.530	<0.000	0.370	0.049
	05/22/2012	2052940-02	2.400	5.720	616.220	<0.000	0.760	0.046
	07/23/2012	2073210-02	1.400	8.980	612.960	<0.000	0.560	0.051
APW-4	12/01/2010		<0.100	4.510	622.330	<0.000	0.780	0.054
	01/26/2011	11013614-3	<0.010	3.430	623.410	<0.000	0.240	0.068
	05/04/2011	1050500-03	0.041	3.360	623.480	<0.000	0.810	0.067
	07/28/2011	1073185-03	0.190	3.490	623.350	<0.000	0.740	0.064
	11/11/2011	1111715-03	0.180	3.610	623.230	<0.000	0.670	0.062
	01/25/2012	2013026-03	0.088	3.370	623.470	<0.000	0.460	0.058
	05/22/2012	2052940-03	0.270	4.060	622.780	<0.000	0.830	0.059
	07/23/2012	2073210-03	0.230	5.040	621.800	<0.000	0.770	0.060
G200	11/15/2010	10112850-1	<0.010	7.320	618.620	<0.000	0.024	0.010
	01/27/2011	11013836-1	0.023	4.050	621.890	<0.000	0.071	0.009
	05/04/2011	1050693-01	0.020	2.830	623.110	<0.000	0.007	0.005
	07/25/2011	1072922-01	<0.010	5.680	620.260	<0.000	0.015	0.006
	11/11/2011	1111718-14	0.029	7.410	618.530	<0.000	0.150	<0.005
	01/30/2012	2013252-03	0.016	2.990	622.950	<0.000	0.072	<0.005
	05/22/2012	2052942-01	0.013	5.010	620.930	<0.000	0.021	<0.005
	07/23/2012	2073209-09	<0.010	8.150	617.790	<0.000	0.006	<0.005

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Coffeen Energy Center
Water Quality Data: December 2010 through September 2012

Date Range: 10/01/2010 to 07/23/2012

Well Id	Date Sampled	Lab Id	NO3, diss, mg/L	Pb, diss, mg/L	pH (field), std	Sb, diss, mg/L	Se, diss, mg/L	SO4, diss, mg/L
APW-2	12/01/2010		<0.110	<0.005	5.860	<0.006	<0.010	833.000
	01/26/2011	11013614-1	0.063	<0.001	7.180	<0.003	0.002	840.000
	05/04/2011	1050500-01	<0.020	<0.001	6.950	<0.003	0.007	840.000
	07/27/2011	1073185-01	0.050	<0.001	6.860	<0.003	0.004	<1,000.000
	11/11/2011	1111715-01	0.040	<0.001	7.270	<0.003	0.003	650.000
	01/25/2012	2013026-01	0.570	<0.001	7.100	<0.003	0.003	840.000
	05/22/2012	2052940-01	0.130	<0.001	7.040	<0.003	0.004	1,100.000
	07/23/2012	2073210-01	0.060	<0.001	6.530	<0.003	0.003	840.000
APW-3	12/01/2010		0.160	<0.005	5.660	<0.006	<0.010	761.000
	01/26/2011	11013614-2	0.054	<0.001	7.040	<0.003	0.002	810.000
	05/04/2011	1050500-02	<0.020	<0.001	6.950	<0.003	0.004	940.000
	07/28/2011	1073185-02	<0.020	<0.001	6.730	<0.003	0.006	<1,000.000
	11/11/2011	1111715-02	<0.020	<0.001	7.160	<0.003	0.005	980.000
	01/25/2012	2013026-02	0.070	<0.001	6.990	<0.003	0.004	830.000
	05/22/2012	2052940-02	0.040	<0.001	6.700	<0.003	0.005	980.000
	07/23/2012	2073210-02	0.120	<0.001	6.450	<0.003	0.004	950.000
APW-4	12/01/2010		<0.110	<0.005	6.240	<0.006	<0.010	600.000
	01/26/2011	11013614-3	0.046	<0.001	7.510	<0.003	0.003	670.000
	05/04/2011	1050500-03	<0.020	<0.001	7.240	<0.003	0.002	650.000
	07/28/2011	1073185-03	<0.020	<0.001	7.050	<0.003	0.001	750.000
	11/11/2011	1111715-03	0.040	<0.001	7.710	<0.003	<0.001	450.000
	01/25/2012	2013026-03	0.390	<0.001	7.420	<0.003	0.001	680.000
	05/22/2012	2052940-03	<0.020	<0.001	7.280	<0.003	0.002	730.000
	07/23/2012	2073210-03	<0.020	<0.001	6.850	<0.003	<0.001	770.000
G200	11/15/2010	10112850-1	3.700	<0.001	7.660	<0.003	0.011	74.000
	01/27/2011	11013836-1	3.400	<0.001	7.300	<0.003	0.011	73.000
	05/04/2011	1050693-01	4.100	<0.001	7.040	<0.003	0.013	73.000
	07/25/2011	1072922-01	4.800	<0.001	7.070	<0.003	0.014	72.000
	11/11/2011	1111718-14	2.300	<0.001	7.480	<0.003	0.007	72.000
	01/30/2012	2013252-03	4.300	<0.001	7.520	<0.003	0.013	73.000
	05/22/2012	2052942-01	5.700	<0.001	7.200	<0.003	0.015	87.000
	07/23/2012	2073209-09	5.600	<0.001	7.050	<0.003	0.009	95.000

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Coffeen Energy Center
Water Quality Data: December 2010 through September 2012

Date Range: 10/01/2010 to 07/23/2012

Well Id	Date Sampled	Lab Id	TDS, mg/L	Tl, diss, mg/L	Zn, diss, mg/L
APW-2	12/01/2010		1,810.000	<0.002	0.027
	01/26/2011	11013614-1	1,600.000	<0.001	<0.006
	05/04/2011	1050500-01	1,700.000	<0.001	<0.006
	07/27/2011	1073185-01	1,600.000	<0.001	<0.006
	11/11/2011	1111715-01	1,600.000	<0.001	<0.006
	01/25/2012	2013026-01	1,600.000	<0.001	0.008
	05/22/2012	2052940-01	1,600.000	<0.001	<0.006
	07/23/2012	2073210-01	1,700.000	<0.001	<0.006
APW-3	12/01/2010		1,760.000	<0.002	0.025
	01/26/2011	11013614-2	1,800.000	<0.001	<0.006
	05/04/2011	1050500-02	1,800.000	<0.001	<0.006
	07/28/2011	1073185-02	2,100.000	<0.001	0.008
	11/11/2011	1111715-02	2,000.000	<0.001	<0.006
	01/25/2012	2013026-02	1,900.000	<0.001	0.008
	05/22/2012	2052940-02	2,000.000	<0.001	<0.006
	07/23/2012	2073210-02	2,000.000	<0.001	<0.006
APW-4	12/01/2010		1,140.000	<0.002	<0.020
	01/26/2011	11013614-3	1,200.000	<0.001	<0.006
	05/04/2011	1050500-03	1,300.000	<0.001	<0.006
	07/28/2011	1073185-03	1,300.000	<0.001	<0.006
	11/11/2011	1111715-03	1,300.000	<0.001	<0.006
	01/25/2012	2013026-03	1,200.000	<0.001	<0.006
	05/22/2012	2052940-03	1,300.000	<0.001	0.009
	07/23/2012	2073210-03	1,400.000	<0.001	<0.006
G200	11/15/2010	10112850-1	550.000	<0.001	<0.006
	01/27/2011	11013836-1	510.000	<0.001	<0.006
	05/04/2011	1050693-01	510.000	<0.001	<0.006
	07/25/2011	1072922-01	550.000	<0.001	0.020
	11/11/2011	1111718-14	500.000	<0.001	<0.006
	01/30/2012	2013252-03	510.000	<0.001	<0.006
	05/22/2012	2052942-01	510.000	<0.001	<0.006
	07/23/2012	2073209-09	560.000	<0.001	<0.006

APPENDIX E

EXCEEDANCES OF CLASS I GROUNDWATER STANDARDS

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Coffeen Energy Center
Exceedances of Class I Groundwater Standards: December 2010 - September 2012

Date Range: 10/01/2010 to 07/23/2012

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
State Std	B, diss	01020	mg/L	APW-2	12/01/2010	7.160		2.000
					01/26/2011	7.200		2.000
					05/04/2011	6.700		2.000
					07/27/2011	6.300		2.000
					11/11/2011	8.100		2.000
					01/25/2012	7.400		2.000
					05/22/2012	7.000		2.000
					07/23/2012	8.100		2.000
				APW-3	12/01/2010	2.070		2.000
					01/26/2011	2.500		2.000
					01/25/2012	2.100		2.000
				APW-4	12/01/2010	3.540		2.000
					01/26/2011	3.800		2.000
					05/04/2011	3.900		2.000
					07/28/2011	3.200		2.000
					11/11/2011	3.900		2.000
					01/25/2012	3.600		2.000
					05/22/2012	3.300		2.000
					07/23/2012	3.800		2.000
	Fe, diss	01046		APW-2	05/22/2012	13.000		5.000
	Mn, diss	01056			12/01/2010	0.418		0.150
					05/04/2011	0.530		0.150
					07/27/2011	0.410		0.150
					11/11/2011	0.400		0.150
					01/25/2012	0.730		0.150
					05/22/2012	0.440		0.150
					07/23/2012	0.400		0.150
				APW-3	12/01/2010	0.866		0.150
					01/26/2011	0.440		0.150
					05/04/2011	0.850		0.150
					07/28/2011	0.840		0.150
					11/11/2011	0.800		0.150
					01/25/2012	0.370		0.150
					05/22/2012	0.760		0.150
					07/23/2012	0.560		0.150
				APW-4	12/01/2010	0.780		0.150
					01/26/2011	0.240		0.150
					05/04/2011	0.810		0.150

Coffeen Energy Center
Exceedances of Class I Groundwater Standards: December 2010 - September 2012

Date Range: 10/01/2010 to 07/23/2012

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
State Std	Mn, diss	01056	mg/L	APW-4	07/28/2011	0.740		0.150
					11/11/2011	0.670		0.150
					01/25/2012	0.460		0.150
					05/22/2012	0.830		0.150
					07/23/2012	0.770		0.150
	pH (field)	00400	std	APW-2	12/01/2010	5.860	6.500	
				APW-3	12/01/2010	5.660	6.500	
					07/23/2012	6.450	6.500	
				APW-4	12/01/2010	6.240	6.500	
	SO4, diss	00946	mg/L	APW-2	12/01/2010	833.000		400.000
					01/26/2011	840.000		400.000
					05/04/2011	840.000		400.000
					11/11/2011	650.000		400.000
					01/25/2012	840.000		400.000
					05/22/2012	1,100.000		400.000
					07/23/2012	840.000		400.000
				APW-3	12/01/2010	761.000		400.000
					01/26/2011	810.000		400.000
					05/04/2011	940.000		400.000
					11/11/2011	980.000		400.000
					01/25/2012	830.000		400.000
					05/22/2012	980.000		400.000
					07/23/2012	950.000		400.000
				APW-4	12/01/2010	600.000		400.000
					01/26/2011	670.000		400.000
					05/04/2011	650.000		400.000
					07/28/2011	750.000		400.000
					11/11/2011	450.000		400.000
					01/25/2012	680.000		400.000
					05/22/2012	730.000		400.000
					07/23/2012	770.000		400.000
	TDS	00515		APW-2	12/01/2010	1,810.000		1,200.000
					01/26/2011	1,600.000		1,200.000
					05/04/2011	1,700.000		1,200.000
					07/27/2011	1,600.000		1,200.000
					11/11/2011	1,600.000		1,200.000
					01/25/2012	1,600.000		1,200.000
					05/22/2012	1,600.000		1,200.000

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Coffeen Energy Center
Exceedances of Class I Groundwater Standards: December 2010 - September 2012

Date Range: 10/01/2010 to 07/23/2012

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
State Std	TDS	00515	mg/L	APW-2	07/23/2012	1,700.000		1,200.000
				APW-3	12/01/2010	1,760.000		1,200.000
					01/26/2011	1,800.000		1,200.000
					05/04/2011	1,800.000		1,200.000
					07/28/2011	2,100.000		1,200.000
					11/11/2011	2,000.000		1,200.000
					01/25/2012	1,900.000		1,200.000
					05/22/2012	2,000.000		1,200.000
					07/23/2012	2,000.000		1,200.000
				APW-4	05/04/2011	1,300.000		1,200.000
					07/28/2011	1,300.000		1,200.000
					11/11/2011	1,300.000		1,200.000
					05/22/2012	1,300.000		1,200.000
					07/23/2012	1,400.000		1,200.000

ENVIRONMENTAL CONSULTANTS

PHASE 1 HYDROGEOLOGICAL ASSESSMENT REPORT

COAL COMBUSTION PRODUCT IMPOUNDMENT
E.D. EDWARDS ENERGY CENTER
PEORIA COUNTY, ILLINOIS

Project No. 2122

Prepared For:

AMEREN ENERGY RESOURCES GENERATING COMPANY

Prepared By:

Natural Resource Technology, Inc.
23713 West Paul Road, Suite D
Pewaukee, WI 53072

March 19, 2013

Bruce R. Hensel, PG
Principal Hydrogeologist

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TECHNOLOGY

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APPENDICES

1 INTRODUCTION

1.1 Purpose

Ameren Energy Resources Generating Company owns and operates the E.D. Edwards Energy Center in Peoria County, Illinois (Figure 1). The coal-fired plant currently operates one impoundment for coal combustion product (CCP) management purposes. To assess the potential for constituent migration from this impoundment as requested by the Agency in their correspondence dated April 10, 2009, Ameren commissioned a hydrogeologic study, water well survey, development of a groundwater monitoring plan, and an initial groundwater quality assessment.

The objectives of this report are to:

- Summarize hydrogeologic information pertinent to the site.
- Evaluate groundwater quality data to determine whether or not operation of the impoundment has adversely affected groundwater.
- Determine the potential for off-site migration and whether or not there are potential groundwater receptors in the event of a release.

2 SETTING

Portions of the information in this section were previously presented and modified from in the site characterization and groundwater monitoring plan developed by Rapps Engineering & Applied Services (November 2009).

2.1 Power Plant and CCP Impoundment

The E.D. Edwards Energy Center (Plant) is located in Peoria County between Mapleton and Bartonville in Section 11, Township 7 North, Range 7 East (Figure 2). The plant is located on the floodplain of the Illinois River adjacent to a levee and has one CCP impoundment encompassing approximately 89 surface acres. The CCP impoundment is located in the south half of Section 11 and the north half of Section 14, Township 7 North, Range 7 East.

The CCP impoundment has a volume of approximately 1,800 acre-feet. The impoundment formerly accepted bottom ash, fly ash, and low volume wastewater (LVW) from the Plant's three coal-fired boilers, but currently only bottom ash is sluiced to the pond along with the LVW. All fly ash is now transported to Ameren's Duck Creek CCP Landfill for disposal. The impoundment is configured with an internal berm to promote settlement and compliance with NPDES Permit IL00019710. CCPs are periodically reclaimed from the impoundment for beneficial uses.

Other features in the vicinity of the Plant that are not owned by Ameren include a large salt pile just north of the Plant property, and the Mosaic Company, which produces fertilizers, located between Ameren's property and the Illinois River. The Mosaic Company property lies directly east of the settling pond at the south end of the CCP impoundment.

2.2 Regional Geology

The Plant is located in the Illinois Valley where the sequence of unlithified Quaternary deposits, from land surface down is:

- Poorly sorted sand, silt, and clay of the Cahokia Formation. Fine-grained deposits are predominant near the land surface, and coarse-grained deposits typically occur near the base of this formation, which is more than 20 feet thick in the area.
- Glacial outwash belonging to the Henry and Banner Formations. The sands of the Henry and Banner Formations fill the deepest part of the Illinois Valley, and are 75 to 150 feet thick in the area.

The unlithified deposits are underlain by Pennsylvanian age bedrock, much of which is shale, of the Carbondale and Modesto Formations (Kolata, 2005; Willman et al., 1967). Additional detail is provided in Appendix A.

2.3 Water Resources

2.3.1 Surface Water

The major surface water body near the Plant is the Illinois River, which flows from northeast to southwest and is located approximately 1000 feet east of the CCP impoundment. Other large surface water bodies in the area include Worley and Pekin Lakes, located approximately one-half mile east of the plant, and Powerton Lake, located approximately 3 miles to the southwest. In addition, many minor streams and drainage channels cut across the valley floor in the study area. These are either engineered structures or intermittent streams that drain into the Illinois River and its tributaries.

2.3.2 Groundwater

Berg, Kempton and Cartwright (1984) classified the area as AX (alluvium, a mixture of gravel, sand, silt, and clay along streams, variable in composition and thickness). Aquifers in the Illinois Valley generally fall into two broad categories: (1) unlithified sediments that are glacial or alluvial in origin and contain mostly sand and gravel deposits interbedded with clay and silt, and (2) bedrock aquifers like sandstone and fractured limestone, which vary widely in permeability. The principal aquifer in the area is the sand and gravel outwash deposits of the Banner and Henry Formations in the Illinois Valley. Well logs indicate that high capacity wells with yields up to 1,000 gallons per minute (gpm) have been developed in this aquifer. Groundwater wells in the adjacent uplands are either shallow wells in thin sand and gravel lenses which occur within the Glasford Formation diamicton or drilled into the underlying bedrock.

2.3.3 Well Search

Public records were searched to identify water wells located within 2,500 feet of the CCP impoundment. The E.D. Edwards Plant property is located in Township 7 North, Range 7 East, and the CCP impoundment is located in the southeast quarter of Section 11 and the northeast quarter of Section 14. The 2,500 foot boundary spans across Sections11, 12, 13, and 14 on the west side of the Illinois River. Sections east of the river were not searched because groundwater from the site will discharge to the river and there is no potential for receptors on the opposite side of the river from the CCP impoundment. All wells identified within Sections 11, 12, 13, and 14 are shown on Figure 3 and tabulated in Appendix B.

The following sources of information were queried to identify water well locations:

- Illinois State Geological Survey's Illinois Water Well (ILWATER) Internet Map Service
- Illinois State Water Survey Domestic Well Database
- Illinois EPA's web-based Geographic Information System (GIS) files
- Illinois Department of Public Health
- Peoria County Health Department

Thirteen water well records were identified within the four sections surrounding the CCP impoundment, and are numbered 1 through 13 on Figure 3. Based on state records, there is one non-community water supply (NCWS) well, nine industrial/commercial wells, and three farm/domestic water wells within the four section search area (Figure 3 and Appendix B). No wells were identified for the Plant. The NCWS well is located southwest of the Plant in the northwest quarter of Section 14. A phase I wellhead protection area (WHPA) of 1,000 feet surround this NCWS. The Peoria County Health Department indicated that this NCWS well is not a potable well, and that the Freedom Gas Station where it is located hauls their potable water to the site.

One well (#12 on Figure 3) plotted within the boundary of the CCP impoundment. Well number 12 was reportedly installed in 2001 and completed in clay at a depth of 20 feet. This is property that Ameren or its predecessor companies owned prior to 2001, which indicates that the location information for well 12 is not accurate, and there is no well at this location.

Eight wells are plotted between the CCP impoundment and the Illinois River (Figure 3). Inspection of the logs for well numbers 4, 6, 7, 8, 9, 10, and 11 indicate that they were engineering borings, rather than water supply wells, drilled in 1971 for a bridge evaluation, while well number 1 is listed as a farm/domestic water supply well completed in gravel at a depth of 33 feet. The property where this well is reportedly located is commercial, rather than farm or domestic as indicated in the database, and the existence of this well as a source of potable water supply has not been confirmed. Well number 3 which is north of the CCP impoundment is listed as a farm/domestic water well completed in bedrock at a depth of 65 feet, and well number 5, also to the north, is identified as an industrial/commercial water supply well completed in bedrock at a depth of 60 feet. The use designations for well numbers 3 and 5 appears consistent with the observed property usage, although usage of these wells for potable water supply has not been confirmed.

Public water supply (PWS) wells within a ten mile radius of the Edwards CCP impoundment were identified via a search of the Illinois State Water Survey's Illinois Water Inventory Program (IWIP) database (not available on-line) by RAPPS (2009). Forty-one wells were located within the ten-mile search radius, including two belonging to Glasford, seven belonging to Illinois American - Peoria, three belonging to Pleasant Valley, three belonging to Creve Coeur, nine belonging to East Peoria, three belonging to Marquette Heights, two belonging to North Pekin, two belonging to South Pekin, eight belonging to Illinois American - Pekin, and two belonging to Groveland Township. The closest PWS wells are the Illinois American – Pekin wells, located approximately 1.5 miles east of the ash pond, on the opposite side of the Illinois River, where there is no potential for groundwater migration from the CCP impoundment.

3 MONITORING WELL INSTALLATION, DEVELOPMENT, AND SAMPLING

3.1 Monitoring Well Installation and Development

Four monitoring wells (APW-1, APW-2, APW-3, and APW-4) were installed between July 19 and July 27, 2010 (Figure 1) by Geotechnology, Inc. At each well location, subsurface borings were advanced with a rotary drill rig equipped with hollow-stem augers to facilitate soil classification. Soil was continuously sampled through the center of the hollow stem auger. Monitoring wells, constructed of 2" inside diameter schedule 40 PVC riser and screen, with steel above-ground well covers, were installed at each location to monitor groundwater within the uppermost water-bearing unit adjacent to the impoundment. The wells were constructed consistent with monitoring well construction standards per IAC Title 35, Section 811.318. Drilling and sampling equipment was decontaminated before sampling and between sample locations to prevent cross contamination. The monitoring wells were surveyed by a licensed surveyor.

Monitoring well construction and survey data are summarized in Table 1. Boring logs and well diagrams are included in Appendix C. Boring depths were between 18 and 50 feet bgs. A cross-sectional view of the four monitoring wells showing ground surface and well screen elevations is provided in Figure 4.

Monitoring wells were developed on November 16, 2010, by surging and pumping a minimum of five well volumes and until specific conductivity stabilized or the wells were pumped dry. The depth to groundwater was measured in each monitoring well using an electronic water level indicator. Groundwater levels ranged from approximately 6.25 feet to 10.7 feet below ground surface (bgs) at the time of well installation.

3.2 Groundwater Sampling and Chemical Analysis

The monitoring wells were sampled during eight consecutive quarterly monitoring events from December 2010 through September 2012 in order to establish a statistical baseline for groundwater quality. The monitoring wells were purged and sampled for the first quarterly sampling event on December 14, 2010 using disposable bailers. Each monitoring well was purged until three well volumes were removed. Water quality parameters including pH, specific conductivity, and temperature were monitored in the field. Groundwater levels ranged from 6.11 feet to 11.12 feet bgs in the four wells. Table 2 presents the groundwater levels and elevations.

Water samples were preserved in the field and samples for all parameters (both general chemistry and metals), with the exception of cyanide, were filtered at the laboratory for analysis. Sample containers were labeled, placed in an ice-filled cooler, and transported using standard chain-of-custody procedures. The first round of groundwater sampling was conducted by Geotechnology, Inc. and sample analyses conducted by Accutest Laboratories located in Marlborough, MA . The groundwater sampling information and laboratory analytical reports are provided in the Geotechnology, Inc. monitoring report dated and submitted to the IEPA on February 18, 2011. The seven subsequent quarterly monitoring events were conducted by Ameren, and the samples were analyzed by PDC, Inc. All eight rounds of groundwater samples were analyzed for the inorganic constituents listed under Title 35, 620.410 with the exception of radium 226 and 228. Table 3 lists the field, general chemistry, and metal parameters monitored during the eight quarters of baseline sampling along with the analytical methods.

4 SITE HYDROGEOLOGY

4.1 Lithology

The information used to describe site hydrogeology is based on the local geology obtained from published sources as presented in Section 2 and Appendix A, supplemented with the boring data collected at the four monitoring well locations APW-1 through APW-4. The four borings ranged from 18.5 to 50 feet bgs and were advanced through 1.5 feet to 12.5 feet of fill material consisting of heterogeneous soils, clay, gravel, coal, or coal ash. The northernmost boring, and the closest to the western bluffs of the Illinois River, was for monitoring well APW-1. The geology at this location consisted of 7.5 feet of fill material underlain by 13 feet of brown silty clay. Bedrock consisting of shaley limestone was intercepted at 18.5 feet bgs. The boring logs for the other three monitoring well locations (APW-2, APW-3, and APW-4) were all constructed through fill material underlain by brown and/or gray silty clay. The thickest extent of silty clay, exceeding 45 feet, was encountered at well location APW-2.

The uppermost water-bearing unit encountered at the north end of the Plant and along the east (downgradient) side of the impoundment appears to be the fine grained upper part of the Cahokia Formation. This upper portion of the Cahokia is the uppermost hydrostratigraphic unit in the vicinity of the impoundment and would serve as an upper semi-confining layer to any underlying coarse-grained sand and gravel deposits, if present, belonging to the lower portion of the Cahokia or deeper sand and gravel deposits of the Henry Formation. The fine-grained deposits in which the monitoring wells are installed are part of a thick sequence of brown and gray silty clay observed close to the Illinois River at wells APW-2, APW-3, and APW-4. The silty clay appears to pinch out as the limestone bluffs are approached to the north and west, as exhibited by the 5.5 feet of silty clay at well APW-1 at the north side of the Plant property, with bedrock at 18.5 feet bgs.

The Illinois River penetrates into the upper silty clay confining layer and may be in direct contact with the more permeable sand and gravel deposits, if present, of either the Lower Cahokia and/or Henry Formation.

4.2 Groundwater Flow

Groundwater elevation data (potentiometric levels) were collected for the four monitoring wells installed within the uppermost water-bearing unit at the Plant. Groundwater depths and elevations for the eight quarterly monitoring events are provided on Table 2 and graphically illustrated in time-series plots on

Figure 5. Groundwater levels were the closest to ground surface at the northernmost monitoring well APW-1, with water levels ranging from 1.5 to 4.3 feet bgs from December 2010 through September 2012. However, the groundwater elevations at this upriver location were the lowest observed at the Plant in five of the eight quarters. The lowest observed groundwater elevations (i.e., deepest) at well APW-1 were observed in June 2012 and the highest elevations (i.e., shallowest) were observed in September 2012. Overall the groundwater levels in this well had a range of 2.84 feet.

Monitoring wells APW-2 through APW-4, located south of APW-1 and along the east side of the impoundment, had groundwater levels ranging from 2.65 to 8.28 feet bgs, although there were two deeper groundwater levels of 11.94 feet bgs at well APW-3 that appear to be potential outliers. These two deeper water levels do not fit with the trends (Figure 5) observed in the four monitoring wells over the two years of measurement. Groundwater elevations in these three southern monitoring wells are deepest at well APW-3, second deepest at APW-2, and shallowest at APW-4. This appears to be counter-intuitive given that well APW-4 is furthest south and would conceivably be downgradient from the rest of the wells. However, this well is located at the highest topographic elevation and has the highest screened elevation of the four monitoring wells.

Considering that there is a 35 foot difference in groundwater elevation between the four wells, a 35 foot difference in ground surface elevation between the four wells, and only a 5 foot difference in groundwater elevation for most measurements, and given that the wells are all screened in a clay that likely has low hydraulic conductivity, it is apparent that the measured groundwater elevations are a reflection of land surface elevation rather than groundwater flow patterns. Therefore, a potentiometric surface map was not prepared. Ultimately, groundwater flow is expected to be southwestward towards the Illinois River, with baseflow discharge from the unlithified deposits to the river during most of the year, as conceptualized in Figure 6. This conceptual flow model suggests that, in the event of a release, there is potential for off-site migration toward the east and south.

4.3 Potential For Groundwater Receptors

A potential groundwater receptor is a water supply well located in a position that can be interpreted as downgradient from the CCP impoundment, and screened within a geologic formation that can reasonably be expected to be a groundwater migration pathway in the event of a release.

Figure 3 shows water wells located within the vicinity of the CCP impoundment. As described in Section 2.3.3, three of these points (well numbers 1, 3, and 5) represent relatively shallow water supply wells.

As noted in Section 4.2, there is potential for off-site migration to the east and south of the CCP impoundment. Based on this assessment, well number 1 on Figure 3, which is listed as a farm/domestic (although land use suggests industrial/commercial) water supply well completed in gravel at a depth of 33 feet, is a potential receptor in the event of a release and off-site migration from the CCP impoundment. Well numbers 3 and 5 are not likely potential receptors because they are in positions conceptually upgradient of the CCP impoundment.

There are no public water supply wells in a position that could be considered a potential receptor. The closest PWS wells are more than a mile away and on the east (opposite) side of the Illinois River, and the closest PWS wells on the west side of the river are 5 miles to the north.

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5 GROUNDWATER CHEMISTRY

5.1 Overview

The purpose of the sampling and inorganic analysis of groundwater from monitoring wells at the Plant was to assess background and downgradient groundwater quality; to evaluate elevated concentrations and those exceeding groundwater standards; and to identify primary factors potentially influencing groundwater quality changes spatially and temporally.

All of the groundwater quality data collected and analyzed for both field and laboratory parameters, including the full list of inorganic constituents listed in IAC 35 Part 620 Section 410 except for Radium 224/226, are provided in Appendix D for the eight quarters of monitoring conducted from December 2010 through September 2012. A statistical summary of all of the water quality data at each monitoring well is provided in Table 4, including the mean, median, maximum, minimum, standard deviation, and percent non-detects. Although shallow groundwater in the uppermost water-bearing unit may meet the classification criteria of a Class II (General Resource) groundwater, for the purposes of this report only the Class I groundwater standards are shown on Table 4 and only those constituent concentrations exceeding Class I groundwater standards are highlighted on the table.

5.2 Comparison of Groundwater Quality to Class I Standards

A listing of all exceedances of Class I groundwater quality standards, sorted by constituent, well location, and sample date, is provided in Appendix E. Those constituents with exceedances are also highlighted on Table 4. Constituents with Class I groundwater quality exceedances were:

- pH: APW-1 (2 of 8 samples), APW-2 (1 of 8), APW-3 (1 of 8), APW-4 (3 of 8)
- Chloride: APW-1 (1 of 8)
- Iron: APW-1 (7 of 8), APW-2 (3 of 8), APW-3 (6 of 8), APW-4 (2 of 8)
- Manganese: APW-1 (8 of 8), APW-2 (8 of 8), APW-3 (8 of 8), APW-4 (8 of 8)
- TDS: APW-1 (2 of 8)
- Sulfate: APW-3 (1 of 8)

All wells had pH values lower than the 6.5 SU standard in the first quarter monitoring event that were most likely caused by systematic error due to instrument calibration or non-stabilized groundwater geochemistry at the time of sampling. Subsequent values lower than the standard at APW-1 (background well) and APW-4 are not associated with coal ash leachate, which tends to be alkaline.

The chloride and TDS exceedances observed in groundwater at well APW-1 are most likely related to runoff or leachate from the salt pile located to the north of the Plant. This property is not associated with the Plant. Iron and manganese exceedances of the Class I standard are from naturally occurring geochemical conditions. These two constituents are elevated in all four of the monitoring wells and exhibit no spatial distribution related to the CCP impoundment. There is no correlation of either iron or manganese to the coal ash indicator constituents of boron or sulfate.

The only constituent exceedance in groundwater *potentially* related to the CCP impoundment is sulfate. Sulfate had one exceedance at well APW-3 during the first quarterly monitoring event, with a concentration of 401 mg/L versus a Class I standard of 400 mg/L. However, the boron concentration in this sample was low (0.25 mg/L), and as shown in Section 5.3.1, sulfate concentrations have steadily decreased since the well was installed. The lack of elevated boron suggests that the sulfate exceedance at APW-3 was not due to CCP impoundment operation, and the steadily decreasing concentration suggests that it may have been due to disequilibrium conditions imposed during monitoring well installation.

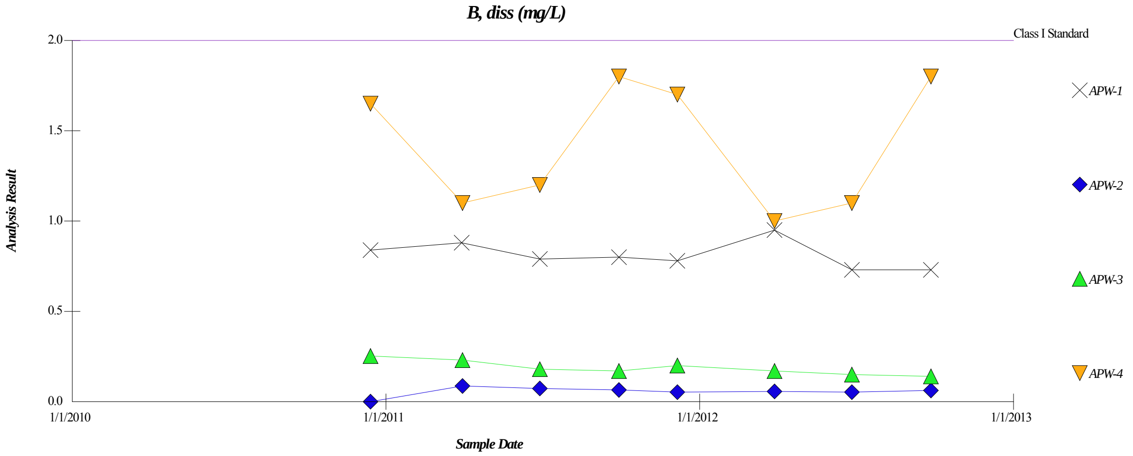
5.3 Groundwater Quality Analysis

5.3.1 Primary Coal Ash Leachate Indicators

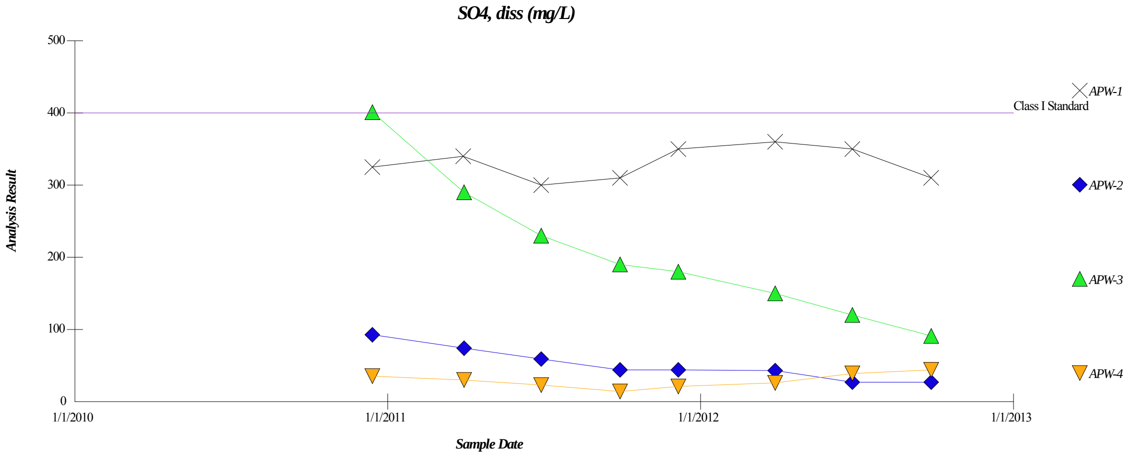
Boron and sulfate are the primary indicator constituents for coal ash leachate. Median boron concentrations in groundwater at the Plant range from 0.064 mg/L at well APW-2 to 1.4 mg/L at well APW-4. Median sulfate concentrations range from 28 mg/L at well APW-4 at the southwest corner of the impoundment to 333 mg/L at well APW-1, located at the north end of the Plant property and furthest from the impoundment.

Well No.	Median Concentration	
	Boron mg/L	**Sulfate mg/L**
APW-1	0.80	333
APW-2	0.064	44
APW-3	0.18	185
APW-4	1.4	28
IL Class I Standard	*2.0*	*400*

There is no correlation between boron and sulfate concentrations, suggesting that these concentrations are not related to coal ash leachate, which typically has high concentrations of both boron and sulfate. The highest median boron concentration occurs at APW-4, which has the lowest median sulfate concentration. While APW-3, which had the highest single sulfate concentration and highest median concentration of the three wells close to the impoundment had a relatively low median boron concentration of 0.18 mg/L. Boron concentrations were stable or decreasing during the monitoring period.



Graph showing boron concentration versus time.



Graph showing sulfate concentration versus time.

5.3.2 Other Constituents Potentially Impacted by Coal Ash Leachate

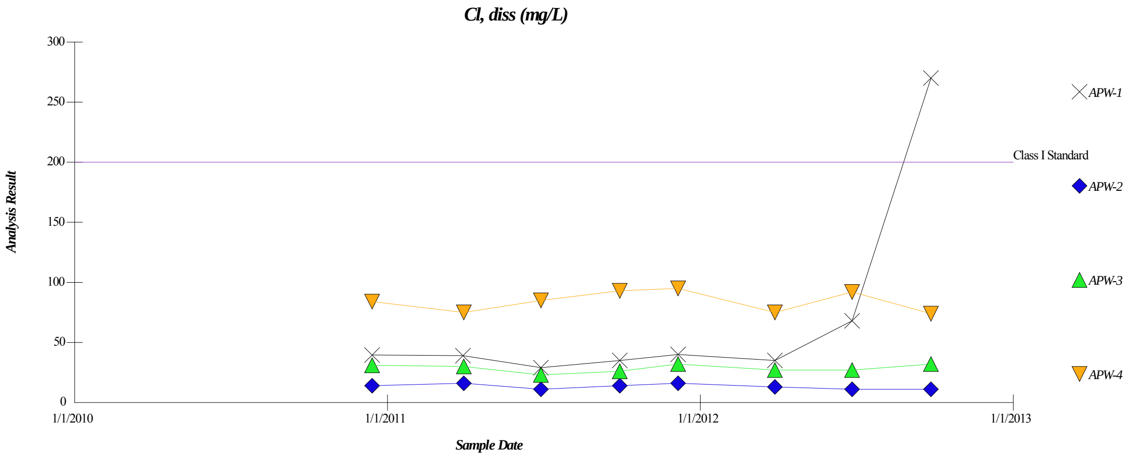
There is no evidence of any other constituents potentially impacted by coal ash leachate.

5.3.3 Constituents with Elevated Concentrations Due to Causes Other than Coal Ash Leachate

Chloride, iron, manganese, and TDS had Class I groundwater quality standard exceedances that were unrelated to coal ash leachate. Median concentrations are listed below.

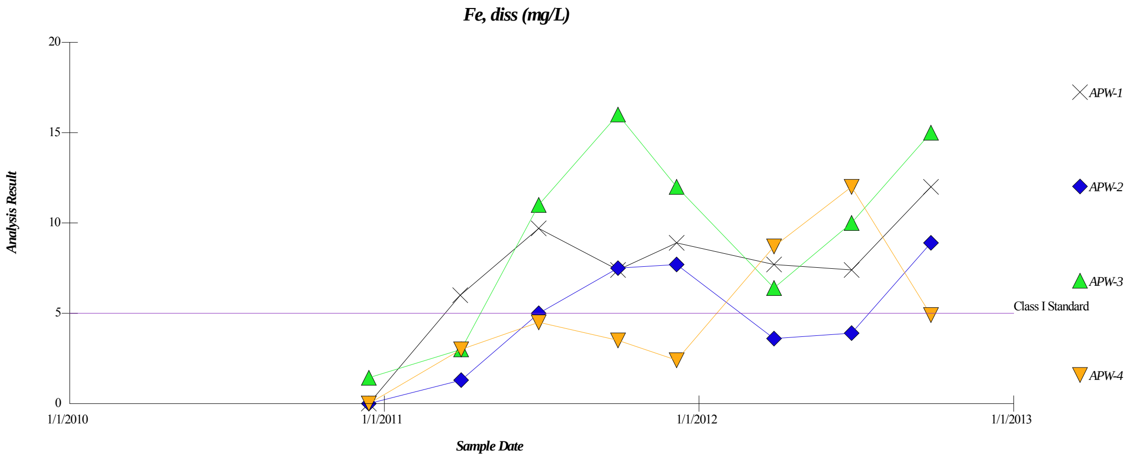
Well No.	Median Concentration			
	Chloride mg/L	**Iron mg/L**	**Manganese mg/L**	**TDS mg/L**
APW-1	39	7.6	1.7	905
APW-2	14	4.5	0.74	620
APW-3	29	11	0.56	1100
APW-4	85	4.0	1.6	675
IL Class I Std.	*200*	*5.0*	*0.15*	*1200*

Background well APW-1 had a large range of chloride concentrations, with minimum and maximum concentrations of 29 and 270 mg/L, respectively. Well APW-4 had a narrower range of concentrations, from 74 to 95 mg/L, and a higher median concentration than APW-1. The high chloride concentrations observed in groundwater at well APW-1 are believed to be associated with the salt pile located adjacent to the Plant's north property boundary. Based on the very low sulfate concentrations at APW-4 (median of 28 mg/L), chloride concentrations in this well cannot be attributed to CCP impoundment leachate.

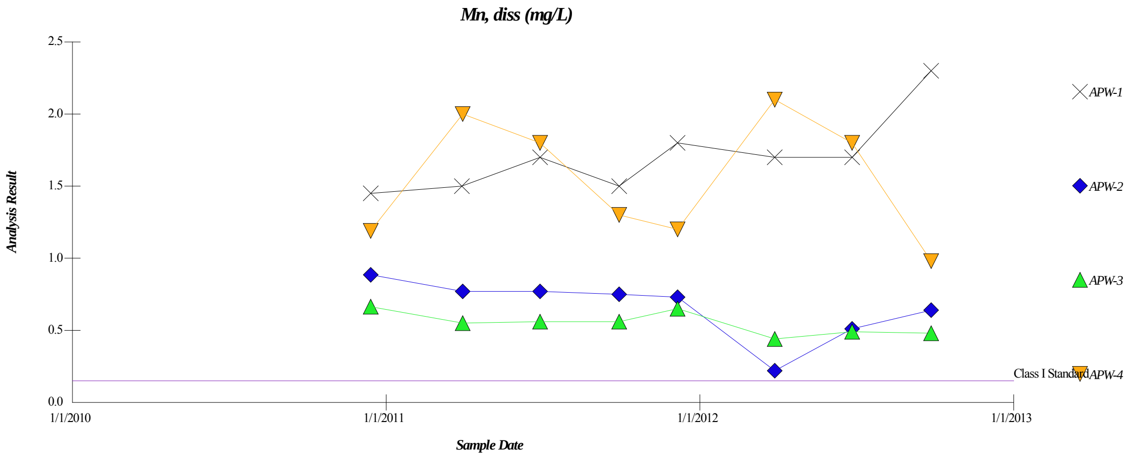


Graph showing chloride concentration versus time.

Iron and manganese both occur at elevated concentrations relative to the Class I standard in all four monitoring wells. Groundwater at all four wells exhibits a wide range in iron concentrations with high standard deviations. Median iron concentrations range from 4.0 to 10.5 mg/L, with maximum concentrations ranging from 8.9 to 16 mg/L. Manganese concentrations were higher than the Class I standard in all samples from all wells, with medians ranging from 0.56 to 1.7 mg/L and maximums ranging from 0.66 to 2.3 mg/L. The background well (APW-1) has the highest median manganese and second highest median iron concentrations. Iron and manganese are both highly redox sensitive, and the observed concentrations are indicative of a reduced geochemical environment. The site-wide distribution and redox sensitivity of these constituents indicates that the observed concentrations are naturally occurring.

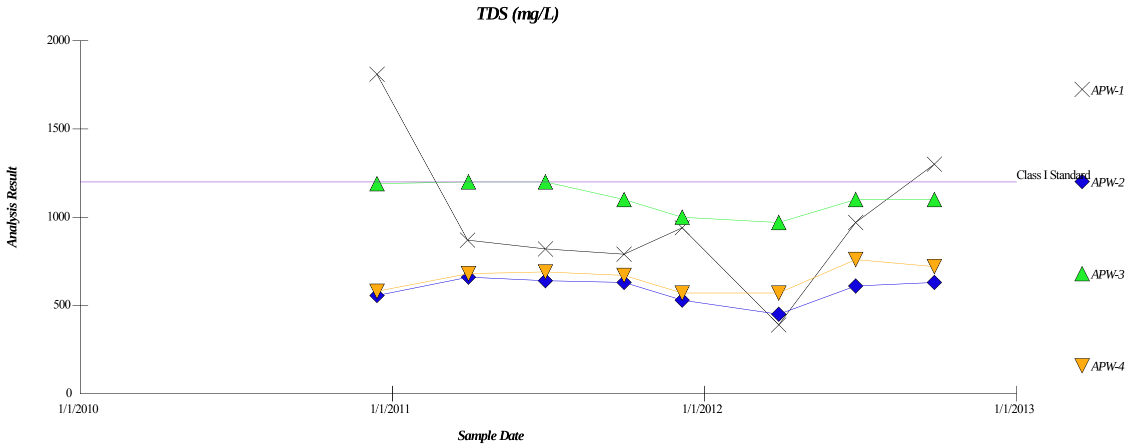


Graph showing iron concentration versus time.

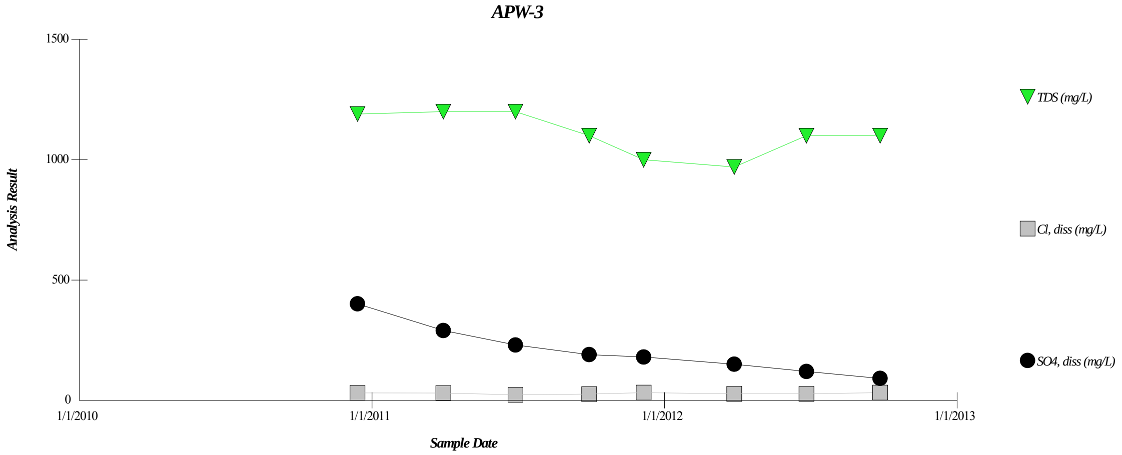


Graph showing manganese concentration versus time.

TDS has relatively high concentrations in the background monitoring well (APW-1) and at APW-3. The concentrations at APW-1 are attributed to the nearby salt pile. TDS concentrations at APW-3 do not correlate with any other monitored constituent at this well (see second chart below), although sulfate concentrations (which are attributed to geochemical conditions imposed on the groundwater when the monitoring well was installed) contribute to the observed TDS value. TDS largely reflects major constituent concentrations in groundwater, and the lack of correlation at APW-3 suggests that another major constituent is also affecting TDS. Possible constituents that may be contributing to observed concentrations are alkalinity, calcium, magnesium, and sodium.



Graph showing total dissolved solids concentration versus time.



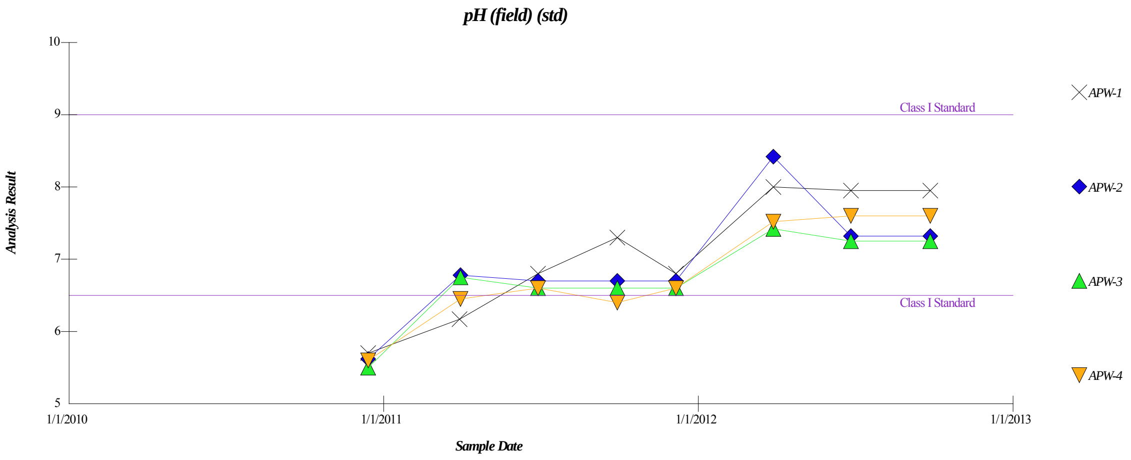
Graph comparing showing TDS, sulfate, and chloride concentrations versus time at APW-3.

5.3.4 Constituents with Concentrations Near or Below Background

The following constituents were detected in some samples, but at low concentrations relative to background well APW-1: arsenic, barium, fluoride, nickel, nitrate, pH and selenium.

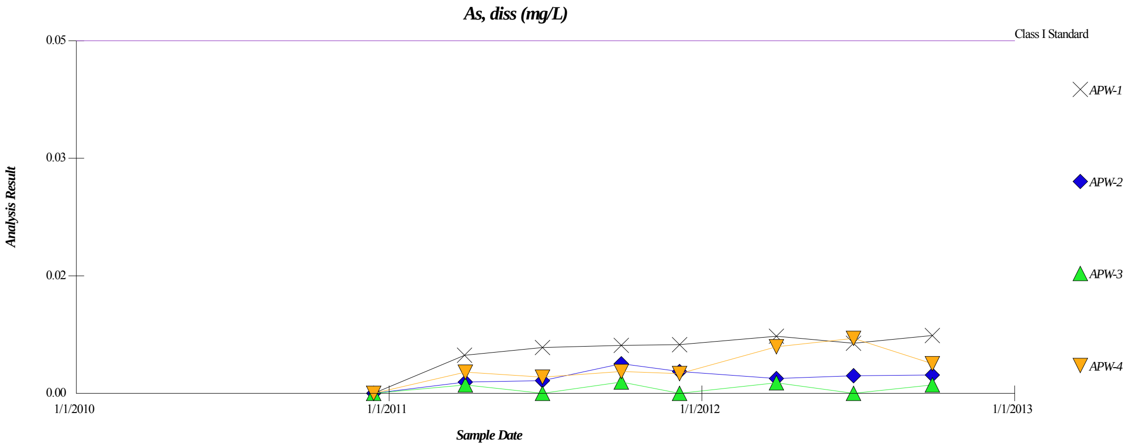
	Median Concentration						
Well No.	**Arsenic mg/L**	**Barium mg/L**	**Fluoride mg/L**	**Nickel mg/L**	**Nitrate mg/L**	**pH SU**	**Selenium mg/L**
APW-1	0.007	0.068	0.27	0.012	0.030	7.05	<0.001
APW-2	0.003	0.15	0.27	0.009	0.035	6.74	<0.001
APW-3	0.001	0.28	0.25	0.016	0.13	6.68	0.002
APW-4	0.004	0.20	0.34	0.011	0.12	6.60	0.002
IL Class I Standard	*0.01*	*2.0*	*4.0*	*0.1*	*10*	*6.5-9.0*	*0.05*

Minimum values for pH at the four monitoring ranged from 5.5 to 5.7 SU, and maximum values ranged from 7.4 to 8.4 SU. The values below 6.0 SU at all four wells occurred only in the first quarter sampling event. No similarly low pH readings were observed in the subsequent seven quarters of monitoring. One explanation for this observation is that the field instrumentation used to measure pH was not calibrated accurately, leading to a systematic error of low pH readings in all of the groundwater samples in December 2010. An alternative explanation to account for the low pH readings is that the groundwater was not stabilized from the drilling and well installation. Values for pH increased over the two years of groundwater monitoring, even if the first sample event is excluded. Median pH was slightly higher at APW-1 than the other three monitoring wells. Coal ash leachate is usually alkaline, so the lower pH values around the ash pond are not indicative of a release.



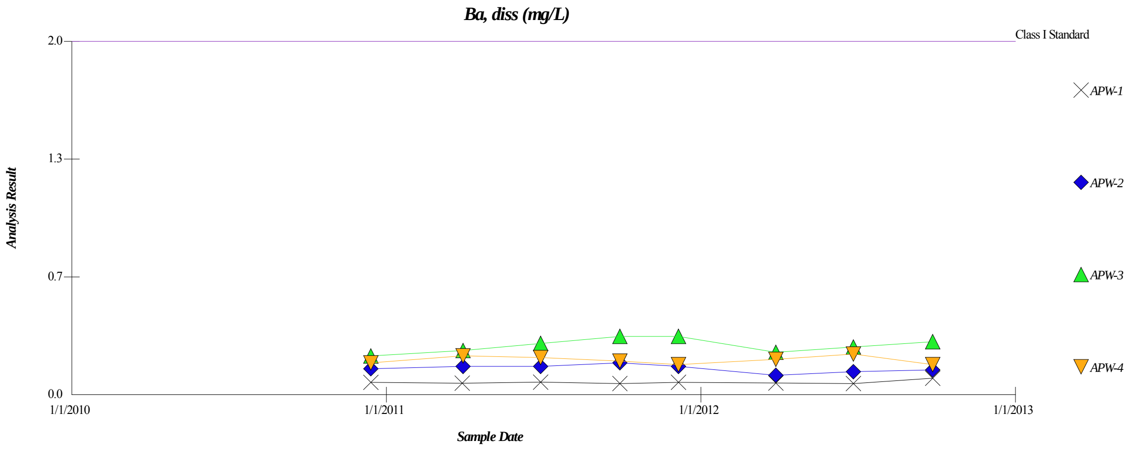
Graph showing pH versus time.

Arsenic concentrations ranged from below the detection limits of 0.001 and 0.004 mg/L to a maximum concentration of 0.008 mg/L at APW-1 and APW-4. Median concentrations ranged from 0.001 to 0.007 mg/L, with the highest concentrations observed in groundwater at background well APW-1.



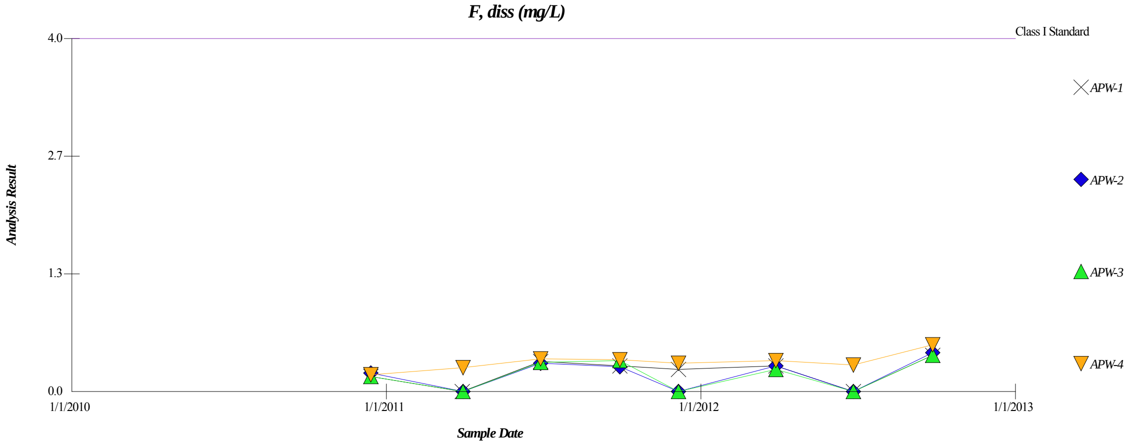
Graph showing arsenic concentration versus time. Non-detects are plotted as zero.

Barium concentrations ranged from 0.063 at APW-1 to 0.33 mg/L at APW-3. Concentrations were slightly higher at the three wells near the CCP impoundment than in the background well. Barium exists in groundwater as a cation, and cation solubility in groundwater increases as pH decreases. The pH in the three wells near the ash impoundment was lower than at the background location and appears to explain this slight difference in barium concentrations.



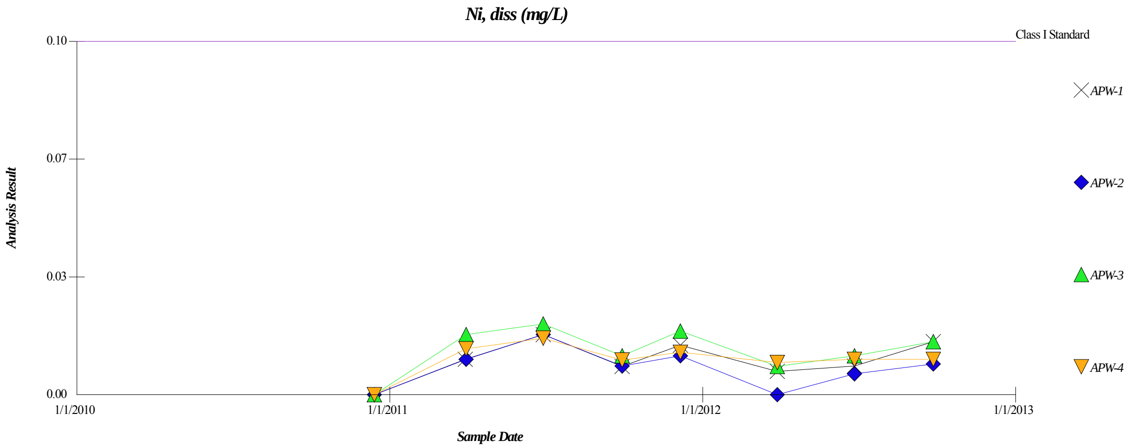
Graph showing barium concentration versus time.

Fluoride concentrations were similar in all wells, with medians ranging from 0.25 to 0.34 mg/L and maximum concentrations ranging from 0.41 at APW-1 and APW-3 to 0.53 mg/L at APW-4. No temporal or spatial pattern of concentrations was observed.



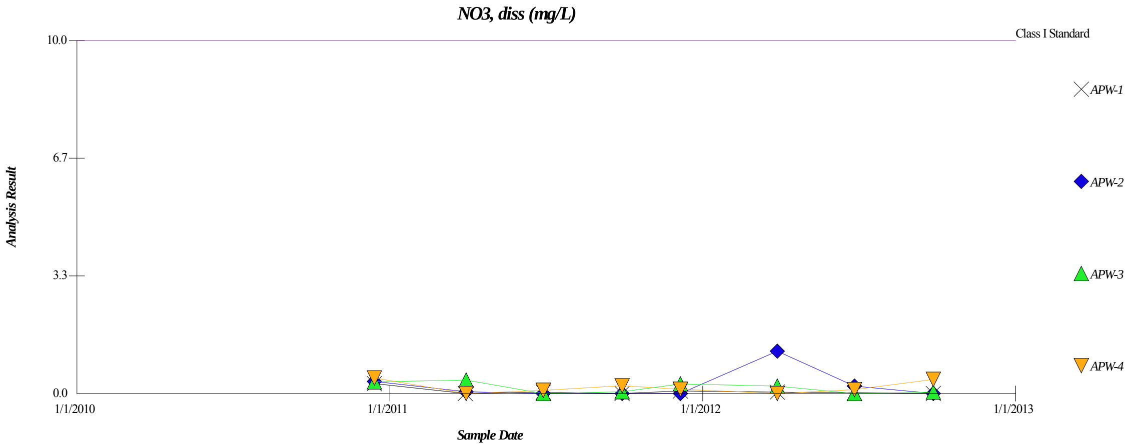
Graph showing fluoride concentration versus time. Non-detects are plotted as zero.

Nickel concentrations ranged from below the detection limit of 0.005 in one sample to a maximum concentration of 0.02 mg/L at APW-3. Median concentrations at the four wells ranged from 0.009 to 0.016 mg/L. No temporal or spatial pattern of concentrations was observed.



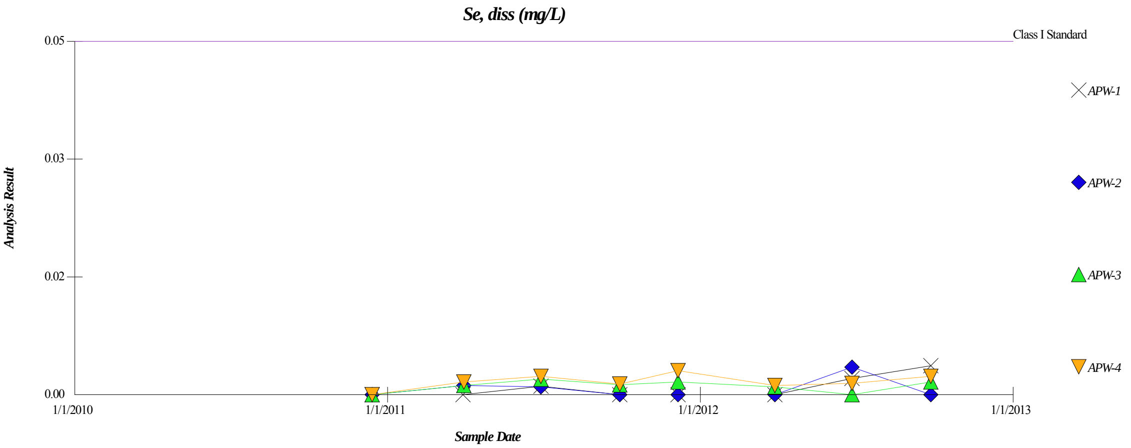
Graph showing nickel concentration versus time. Non-detects are plotted as zero.

Nitrate concentrations were also similar in all wells, with medians ranging from 0.03 to 0.13 mg/L and a maximum concentration of 1.2 mg/L at APW-2. No temporal or spatial pattern of concentrations was observed.



Graph showing nitrate concentration versus time. Non-detects are plotted as zero.

Selenium concentrations ranged from below the detection limits of 0.001 mg/L to a maximum concentration of 0.004 mg/L at APW-1 and APW-2. No temporal or spatial pattern of concentrations was observed.



Graph showing selenium concentration versus time. Non-detects are plotted as zero.

5.3.5 Constituents That Were Infrequently or Not Detected

Beryllium, cadmium, cobalt, cyanide, mercury, silver, and thallium were below their respective detection limits in all monitoring wells during all eight sample events.

Antimony, chromium, copper, lead, and zinc were typically not detected, and when detected concentrations were low relative to the Class I standard.

		Antimony, mg/L	Chromium, mg/L	Copper, mg/L	Lead, mg/L	Zinc, mg/L
APW-1	Max	n/a	0.011	n/a	0.001	0.011
	% BDL	100%	87.5%	100%	87.5%	87.5%
APW-2	Max	n/a	n/a	0.003	n/a	n/a
	% BDL	100%	100%	87.5%	100%	100%
APW-3	Max	n/a	0.004	0.005	n/a	n/a
	% BDL	100%	75%	75%	100%	100%
APW-4	Max	0.003	0.004	0.047	n/a	n/a
	% BDL	87.5%	62.5%	87.5%	100%	100%
Illinois Class I Standard		*0.006*	*0.10*	*0.65*	*0.0075*	*5*

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The primary conclusion from voluntary monitoring of groundwater at the E.D. Edwards CCP impoundment is that the operation of the impoundment has not caused exceedances of Class I groundwater quality standards. Furthermore:

- In the event of a release, there is potential for off-site migration from the CCP impoundment to the east and south. Furthermore, there is one record for a water supply well on the commercial property immediately east of the CCP impoundment, and if this well is used for potable use it represents a potential receptor.
- The impoundment is underlain by clay deposits that are 12 to 45 feet or more thick. These clays potentially restrict migration of leachate from the impoundment to surrounding groundwater.
- Groundwater elevations at the site mimic land surface topography and do not provide an indication of horizontal groundwater flow direction.
- The only coal ash indicator constituent with an exceedance of a Class I groundwater quality standard was sulfate at APW-3. This exceedance occurred in only the first sample and sulfate concentrations at APW-3 decreased throughout the remainder of the monitoring period, suggesting that the initial concentration was due to a geochemical disequilibrium condition created when the monitoring well was drilled.
- Class I groundwater quality exceedances of other constituents are either due to natural conditions (pH, iron, manganese), or off-site anthropogenic effects (chloride and TDS at APW-1).
- The CCP impoundment monitoring wells are screened in clay-rich soil that may have hydraulic conductivity lower than 1×10^{-4} cm/s. If low hydraulic conductivity is confirmed, then groundwater monitored by these wells may be most-appropriately categorized as Class II groundwater. If classified as Class II, manganese concentrations do not exceed the groundwater quality standard. The Class II standards for chloride, sulfate, TDS, and iron are the same as Class I, so exceedances of these constituents are not affected by the groundwater class.

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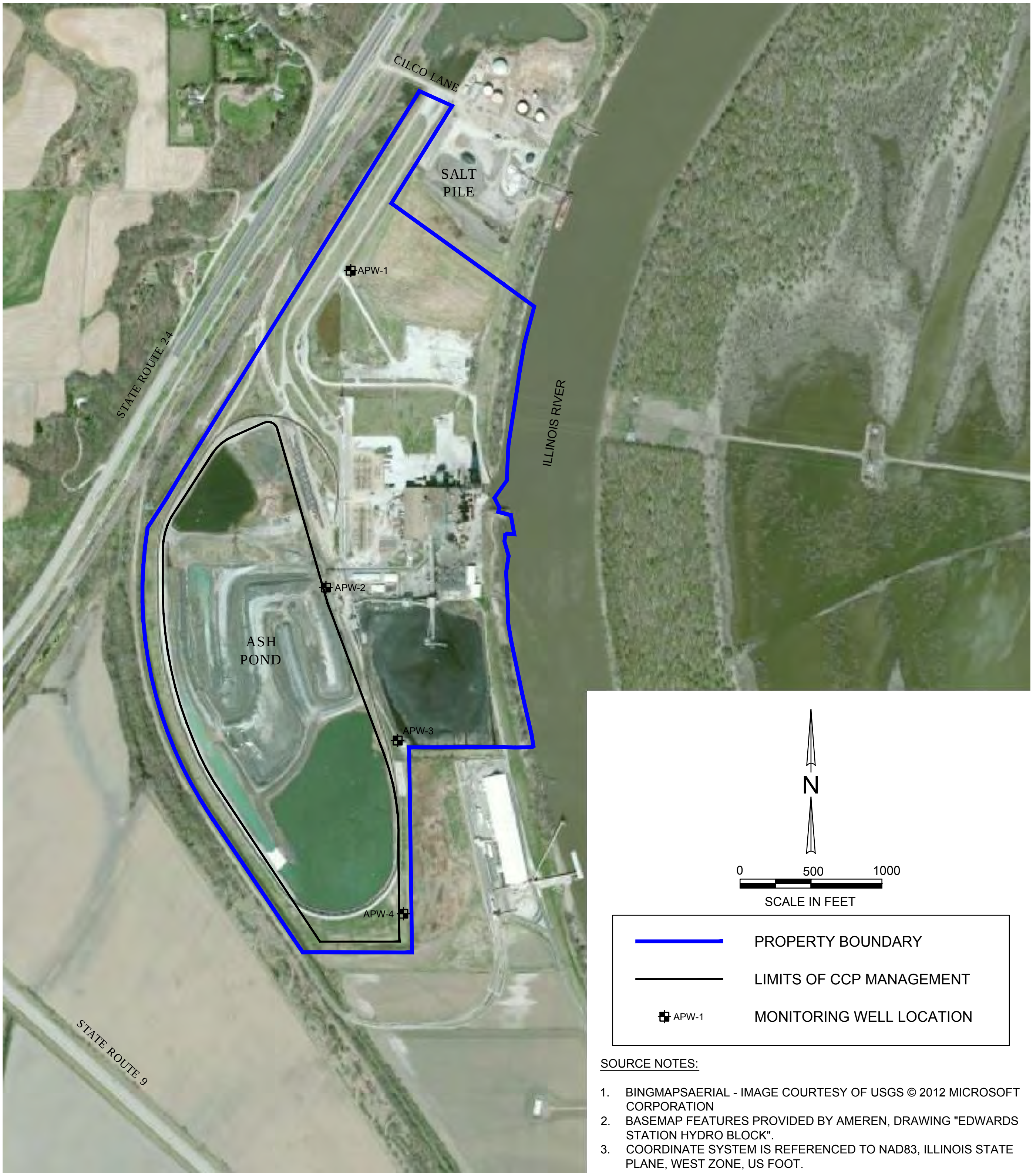
FIGURES



▬	PROPERTY BOUNDARY
▬	LIMITS OF CCP MANAGEMENT
⌖ APW-1	MONITORING WELL LOCATION

SOURCE NOTES:

1. BINGMAPSAERIAL - IMAGE COURTESY OF USGS © 2012 MICROSOFT CORPORATION
2. BASEMAP FEATURES PROVIDED BY AMEREN, DRAWING "EDWARDS STATION HYDRO BLOCK".
3. COORDINATE SYSTEM IS REFERENCED TO NAD83, ILLINOIS STATE PLANE, WEST ZONE, US FOOT.

Mar 05, 2013 11:16am PLOTTED BY: ndraskovich SAVED BY: ndraskovich
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SITE OVERVIEW MAP

NATURAL
RESOURCE
TECHNOLOGY

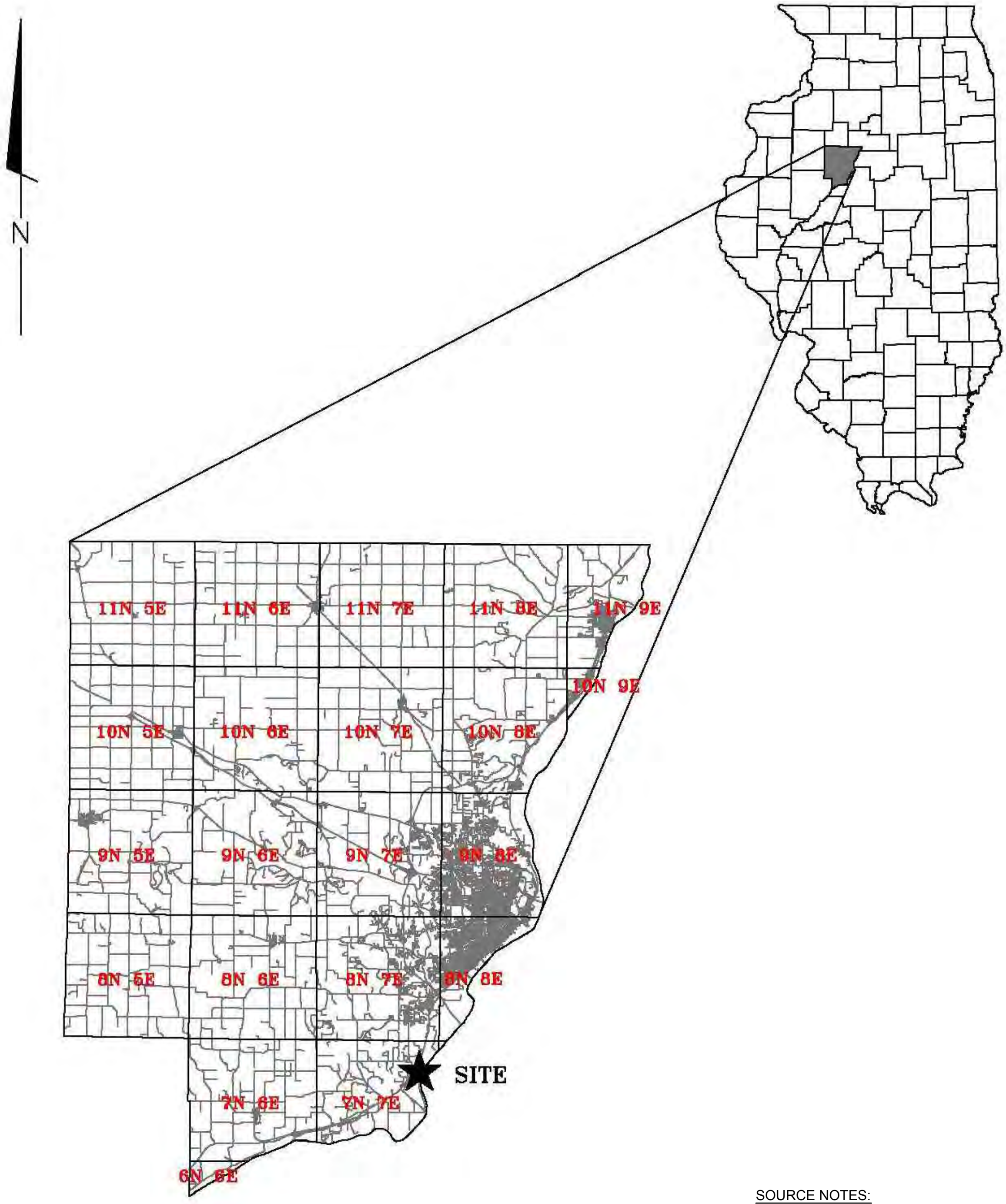
PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY RESOURCES GENERATING
E.D. EDWARDS ENERGY CENTER
PEORIA COUNTY, ILLINOIS

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

PROJECT NO.
2122/2.0

DRAWING NO.
2122-2-A01C-SITE OVER

FIGURE NO.
1



SOURCE NOTES:

1. FIGURE CONTENTS TAKEN FROM RAPPS ENGINEERING & APPLIED SCIENCE, INC. SITE LOCATION MAP, FIGURE 1 FROM PROJECT: SA09035, DRAWING: LOCMAP, DATED 11/09.

SITE LOCATION MAP

PROJECT NO.
2122/2.0

NATURAL
RESOURCE
TECHNOLOGY

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY RESOURCES GENERATING
E.D. EDWARDS ENERGY CENTER
PEORIA COUNTY, ILLINOIS

DRAWING NO.
2122-2-A02C-SITE LOC

FIGURE NO.
2

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

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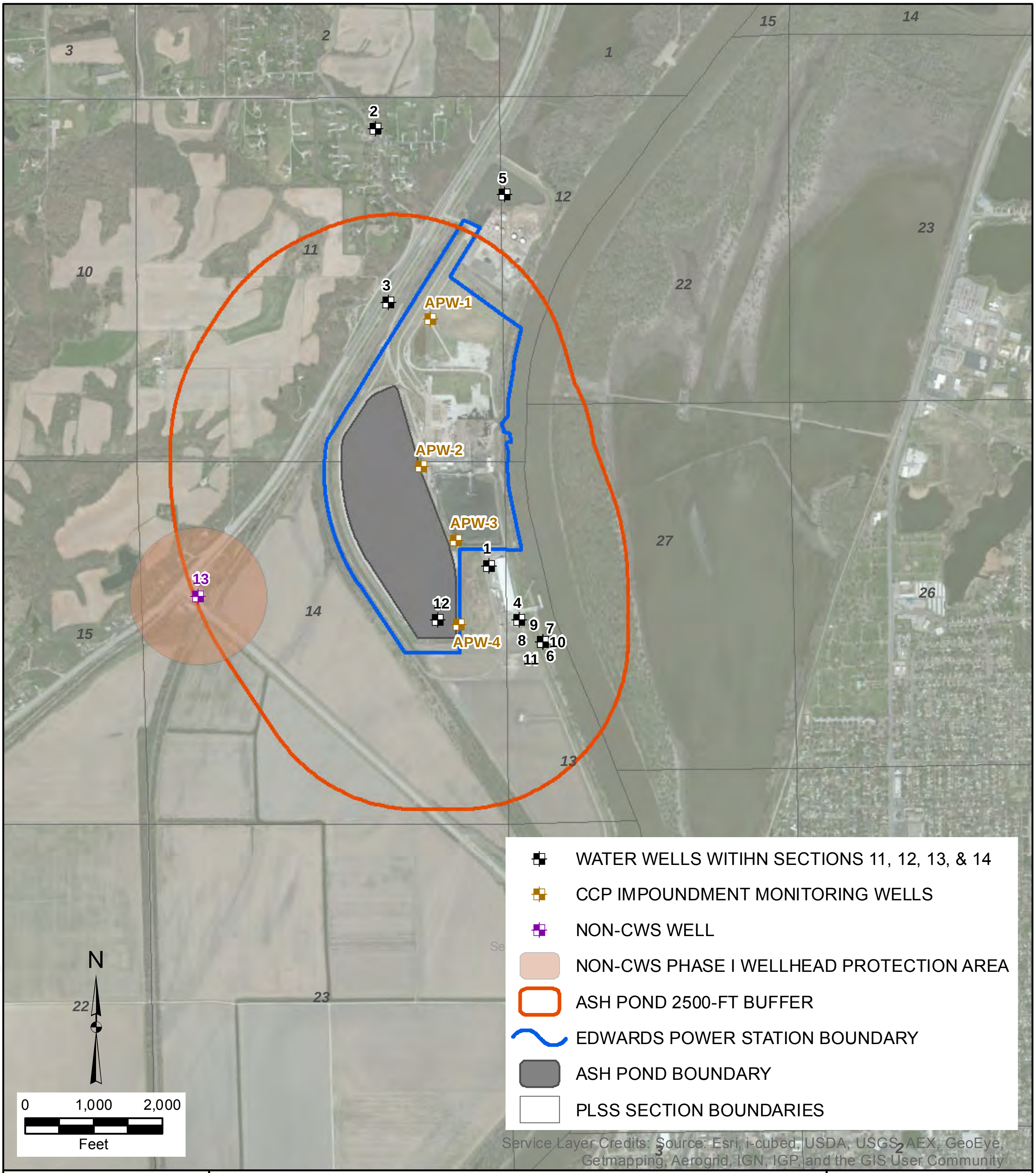

Y:\Mapping\Projects\21\2122\MXD\Fig 3. Potable Well Search Results-Edwards_2.mxd Author: nkron; Date/Time: 2/28/2013, 8:47:07 AM

DRAWN BY/DATE:
NDK 2/12/13
REVIEWED BY/DATE:
TDC 2/12/13
APPROVED BY/DATE:
BRH 2/14/13

WELL SEARCH RESULTS

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY RESOURCES GENERATING
E.D. EDWARDS PLANT
PEORIA COUNTY, ILLINOIS

PROJECT NO: 2122

FIGURE NO: 3

NATURAL RESOURCE TECHNOLOGY

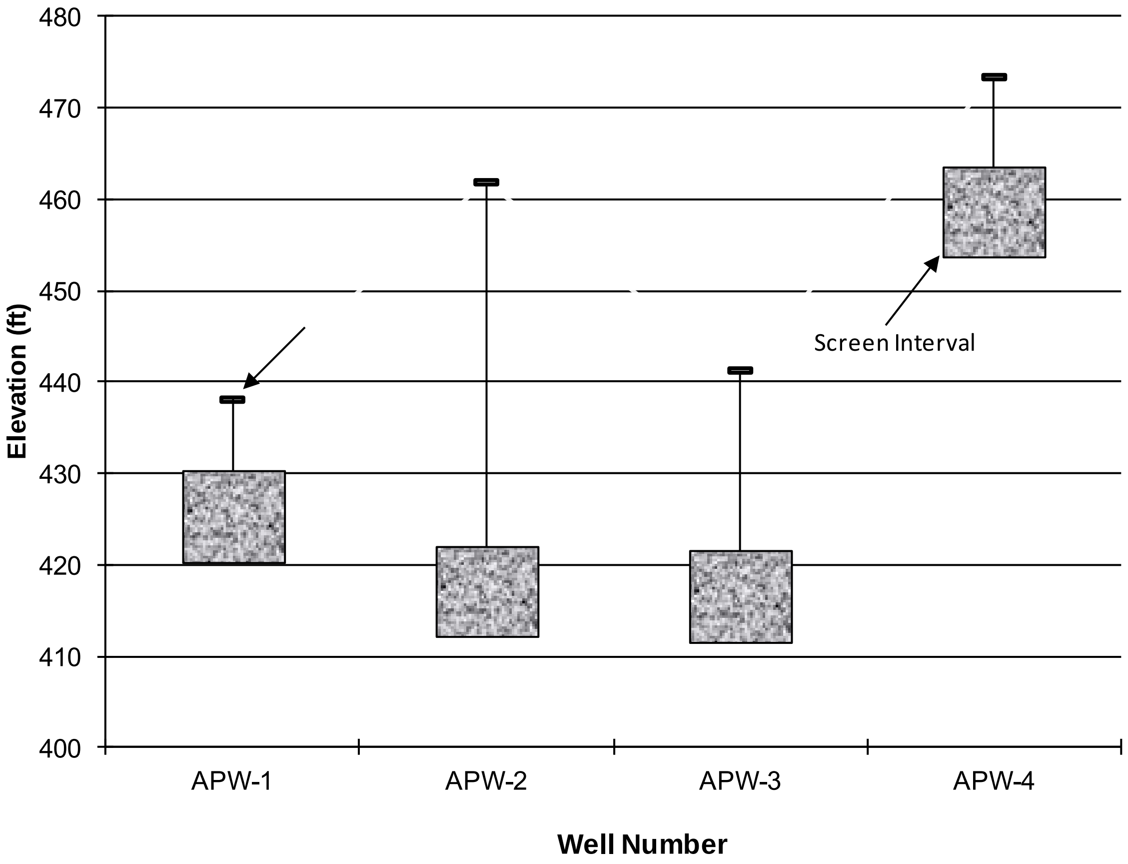

Figure 4. Monitoring Well Screen Elevations.

Natural Resource Technology

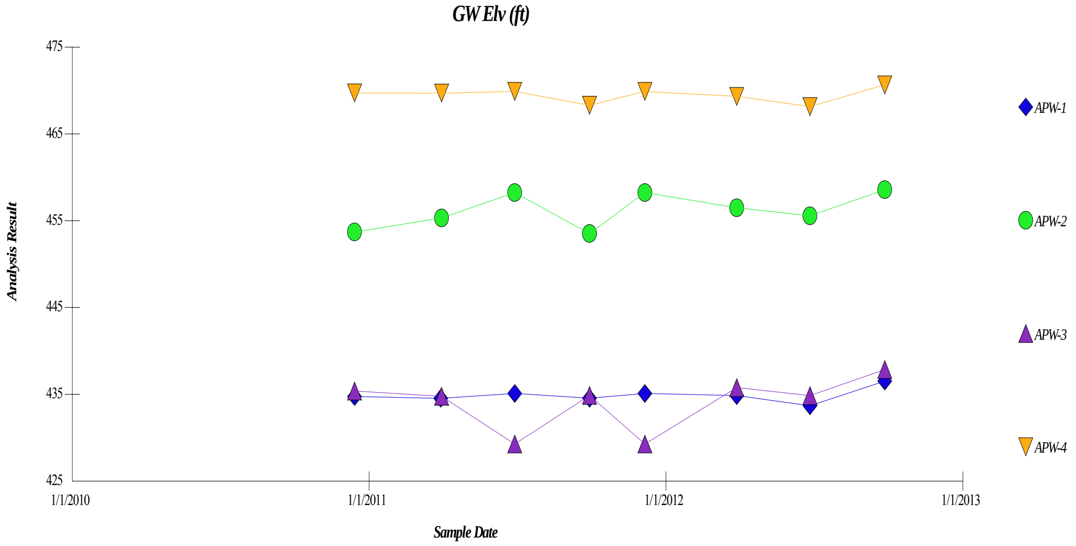

Figure 5. Groundwater Elevation Time Series.

Natural Resource Technology

SOURCE NOTES:

1. FIGURE CONTENTS TAKEN FROM RAPPS ENGINEERING & APPLIED SCIENCE, INC. FLOW SYSTEM (CONCEPTUAL), FIGURE 7 FROM PROJECT: SA09035, DRAWING: FLOWSYS, DATED 11/09.

FLOW SYSTEM
(CONCEPTUAL)

NATURAL
RESOURCE
TECHNOLOGY

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY RESOURCES GENERATING
E.D. EDWARDS ENERGY CENTER
PEORIA COUNTY, ILLINOIS

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

PROJECT NO.
2122/2.0

DRAWING NO.
2122-2-A06C-FLOW SYS

FIGURE NO.
6

Mar 05, 2013 11:16am PLOTTED BY: ndraskovich SAVED BY: ndraskovich Layout1
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XREFS:

TABLES

Monitoring Well Number	Installation Date[1,2]	Top of Well Riser Elevation	Ground Elevation	Screen Top Depth (BGS)	Screen Bottom Depth (BGS)	Screen Top Elevation	Screen Bottom Elevation	Bottom of Boring Elevation	Slotted Screen Length	Bottom Screen Depth from Ground Surface	Bottom Screen Depth from Top of Casing	Total Boring Depth
APW-1	07/27/10	440.85	438.02	7.66	17.66	430.36	420.36	420.0	10.00	17.66	20.49	18.0
APW-2	07/20/12	464.82	461.80	39.66	49.66	422.14	412.14	411.8	10.00	49.66	52.68	50.0
APW-3	07/19/12	444.27	441.21	19.66	29.66	421.55	411.55	411.2	10.00	29.66	32.72	30.0
APW-4	07/27/12	475.90	473.30	9.66	19.66	463.64	453.64	453.3	10.00	19.66	22.26	20.0

Monitoring Well Number	Northing[3]	Easting[3]
APW-1	1,432,880.8	2,435,852.4
APW-2	1,730,732.1	2,435,719.3
APW-3	1,429,652.7	2,436,225.5
APW-4	1,428,432.4	2,436,265.5

Notes:

All depth and elevation measurements are in feet relative to NAVD 1988.

BGS = below ground surface.

[1] Drilling and well installation by Geotechnology, Inc.

[2] All wells constructed with 2-inch diametrer, 10-slot, Schedule 40 PVC screens.

[3] Coordinates are referenced to Illinois State Plane Coordinates, East Zone - NAD 1983.

Monitoring Well Number	Ground Surface Elevation[1] (feet)	Measuring Point Elevation[1] (feet)	Groundwater Depth (feet below measuring point)							
			1 12/14/10	2 03/30/11	3 06/29/11	4 09/29/11	5 12/06/11	6 03/28/12	7 06/26/12	8 09/26/12
APW-1	438.02	440.85	6.11	6.31	5.75	6.30	5.75	6.00	7.17	4.33
APW-2	461.80	464.82	11.12	9.50	6.58	11.30	6.58	8.33	9.25	6.25
APW-3	441.21	444.27	8.89	9.50	15.00	9.40	15.00	8.50	9.42	6.42
APW-4	473.30	475.90	6.18	6.20	6.00	7.60	6.00	6.58	7.75	5.25

Monitoring Well Number	Groundwater Depth (feet below ground surface)							
	1 12/14/10	2 03/30/11	3 06/29/11	4 09/29/11	5 12/06/11	6 03/28/12	7 06/26/12	8 09/26/12
APW-1	3.28	3.48	2.92	3.47	2.92	3.17	4.34	1.50
APW-2	8.10	6.48	3.56	8.28	3.56	5.31	6.23	3.23
APW-3	5.83	6.44	11.94	6.34	11.94	5.44	6.36	3.36
APW-4	3.58	3.60	3.40	5.00	3.40	3.98	5.15	2.65

Monitoring Well Number	Groundwater Elevation (feet)							
	1 12/14/10	2 03/30/11	3 06/29/11	4 09/29/11	5 12/06/11	6 03/28/12	7 06/26/12	8 09/26/12
APW-1	434.74	434.54	435.10	434.55	435.10	434.85	433.68	436.52
APW-2	453.70	455.32	458.24	453.52	458.24	456.49	455.57	458.57
APW-3	435.38	434.77	429.27	434.87	429.27	435.77	434.85	437.85
APW-4	469.72	469.70	469.90	468.30	469.90	469.32	468.15	470.65

Notes:

[1] All depth and elevation measurements are in feet relative to NAVD 1988.

Field Parameters			**Analysis Method**
Groundwater Elevation		in-situ	
pH (field)	[1]	in-situ	SM 21st ed. 4500-H^+
Specific Conductance		in-situ	SM 21st ed. 2520-B
Temperature		in-situ	SM 21st ed. 2550
General Chemistry Parameters[2]			**Analysis Method**
Chloride	[1]	dissolved	SM21 4500CL C
Total Cyanide	[1]	total	EPA 335.4
Fluoride	[1]	dissolved	SM4500 F-B-C
Nitrate as N	[1]	dissolved	EPA 353.2
Sulfate	[1]	dissolved	ASTM516-90,02
Total Dissolved Solids	[1]	dissolved	SM21 2540 C
METALS[2]			**Analysis Method[3]**
Antimony	[1,3]	dissolved	SW846 6010C
Arsenic	[1,3]	dissolved	SW846 6010C
Barium	[1,3]	dissolved	SW846 6010C
Beryllium	[1,3]	dissolved	SW846 6010C
Boron	[1,3]	dissolved	SW846 6010C
Cadmium	[1,3]	dissolved	SW846 6010C
Chromium	[1,3]	dissolved	SW846 6010C
Cobalt	[1,3]	dissolved	SW846 6010C
Copper	[1,3]	dissolved	SW846 6010C
Iron	[1,3]	dissolved	SW846 6010C
Lead	[1,3]	dissolved	SW846 6010C
Manganese	[1,3]	dissolved	SW846 6010C
Mercury	[1,3]	dissolved	SW846 7470A
Nickel	[1,3]	dissolved	SW846 6010C
Selenium	[1,3]	dissolved	SW846 6010C
Silver	[1,3]	dissolved	SW846 6010C
Thallium	[1,3]	dissolved	SW846 6010C
Zinc	[1,3]	dissolved	SW846 6010C

Notes:

[1] Groundwater quality parameters for Class I: Potable Resource Groundwater (IAC 35 Part 620 Section 410).

[2] Samples preserved in field and filtered (except Cyanide) by laboratory.

[3] Sample prep method reference: SW846 3010A.

		Monitoring Well APW-1						Monitoring Well APW-2						Monitoring Well APW-3						Monitoring Well APW-4					
Parameter, Unit	Class I GW Standard	Mean	Median	Maximum	Minimum	Std Dev	% of Non-Detects	Mean	Median	Maximum	Minimum	Std Dev	% of Non-Detects	Mean	Median	Maximum	Minimum	Std Dev	% of Non-Detects	Mean	Median	Maximum	Minimum	Std Dev	% of Non-Detects
Field Parameters																									
pH, Std Units	6.5 / 9.0*	7.08	7.05	8.00	**5.70**	0.87	N/A	6.95	6.74	8.42	**5.62**	0.80	N/A	6.75	6.68	7.42	**5.50**	0.61	N/A	6.80	6.60	7.60	**5.60**	0.72	N/A
General Chemistry Parameters (totals)																									
Chloride, mg/L	200	69	39	**270**	29	82	0	13	14	16	11	2.1	0	29	29	32	23	3.3	0	84	85	95	74	8.69	0
Cyanide, mg/L	0.2	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100
Fluoride, mg/L	4	0.28	0.27	0.41	<0.25	0.071	25	0.29	0.27	0.44	<0.25	0.070	37.5	0.28	0.25	0.41	<0.25	0.076	37.5	0.34	0.34	0.53	0.19	0.10	0
Nitrate, mg/L	10	0.064	0.030	0.28	<0.02	0.089	37.5	0.24	0.035	1.2	<0.02	0.41	50	0.17	0.13	0.38	<0.02	0.15	25	0.18	0.12	0.44	<0.02	0.16	25
Sulfate, mg/L	400	331	333	360	300	22	0	51	44	93	27	23	0	207	185	**401**	91	100	0	29	28	44	14	10	0
Total Dissolved Solids, mg/L	1,200	986	905	**1,810**	390	416	0	558	620	660	450	71	0	1,107	1,100	1,200	970	88	0	655	675	760	570	73	0
Metals (dissolved)																									
Antimony, mg/L	0.006	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	0.003	0.003	0.003	<0.003	0.001	87.5
Arsenic, mg/L	0.01	0.007	0.007	0.008	<0.004	0.001	12.5	0.003	0.003	0.004	<0.004	0.001	12.5	0.002	0.001	0.002	<0.001	0.001	50	0.004	0.004	0.008	<0.004	0.002	12.5
Barium, mg./L	2	0.070	0.068	0.093	0.063	0.010	0	0.15	0.15	0.18	0.11	0.022	0	0.28	0.28	0.33	0.22	0.041	0	0.20	0.20	0.23	0.17	0.023	0
Beryllium, mg/L	0.004	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100
Boron, mg/L	2	0.81	0.80	0.95	0.73	0.075	0	0.069	0.064	0.087	<0.10	0.017	12.5	0.19	0.18	0.25	0.14	0.039	0	1.4	1.4	1.8	1.0	0.35	0
Cadmium, mg/L	0.005	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100
Chromium, mg/L	0.1	0.006	0.004	0.011	<0.004	0.003	87.5	nc	nc	nc	nc	nc	100	0.005	0.004	0.004	<0.004	0.002	75	0.005	0.004	0.004	<0.004	0.002	62.5
Cobalt, mg/L	1.0	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	0.008	0.002	0.003	<0.002	0.017	50
Copper, mg/L	0.65	nc	nc	nc	nc	nc	100	0.006	0.003	0.003	<0.003	0.008	87.5	0.006	0.003	0.005	<0.003	0.008	75	0.011	0.003	0.047	<0.003	0.016	87.5
Iron, mg/L	5	**7.4**	**7.6**	**12**	<0.1	3.5	12.5	4.8	4.5	**8.9**	<0.1	3.1	12.5	**9.4**	**11**	**16**	1.4	5.3	0	4.9	4.0	**12**	<0.1	3.8	12.5
Lead, mg/L	0.0075	0.002	0.001	0.001	<0.001	0.0014	87.5	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100
Manganese, mg/L	0.15	**1.7**	**1.7**	**2.3**	**1.5**	0.27	0	**0.66**	**0.74**	**0.89**	**0.22**	0.21	0	**0.55**	**0.56**	**0.66**	**0.44**	0.079	0	**1.6**	**1.6**	**2.1**	**0.98**	0.43	0
Mercury, mg/L	0.002	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100
Nickel, mg/L	0.1	0.015	0.012	0.017	<0.005	0.011	12.5	0.013	0.009	0.017	<0.005	0.011	25	0.018	0.016	0.020	<0.04	0.010	12.5	0.015	0.011	0.016	<0.04	0.010	12.5
Selenium, mg/L	0.05	0.003	0.001	0.004	<0.001	0.003	62.5	0.003	0.001	0.004	<0.001	0.003	62.5	0.003	0.002	0.002	<0.001	0.003	25	0.003	0.002	0.003	<0.010	0.003	12.5
Silver, mg/L	0.05	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100
Thallium, mg/L	0.002	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100
Zinc, mg/L	5	0.008	0.006	0.011	<0.006	0.005	87.5	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100	nc	nc	nc	nc	nc	100

Notes:

Eight quarterly samples collected for analysis on 12/14/10, 03/30/11, 06/29/11, 09/29/11, 12/06/12, 03/28/12, 06/26/12, and 09/26/12.

Groundwater quality standards for Class I: Potable Resource Groundwater (IAC 35 Part 620 Section 410).

Statistics calculated with replacement of non-detect concentrations at 1X reported non-detect concentration: nc indicates that statistics were not calculated because all values were below detection limits.

Exceeds Class I Groundwater Quality Standard.

Parameter is 100% Non-Detect in all 4 monitoring wells.

N/A = not applicable.

< = Below method reporting limit.

* Lower and Upper limits for pH is the Class I groundwater quality standard of 6.5 and 9.0 Standard Units.

APPENDIX A

REGIONAL GEOLOGY

A REGIONAL GEOLOGY

Regional geologic information was previously presented in the site characterization and groundwater monitoring plan developed by Rapps Engineering & Applied Services (November 2009), and is repeated here for completeness.

A.1 Physiography

Illinois is situated in the south-central part of the great Central Lowland Province near the confluence of two major lines of drainage, the Mississippi and Ohio Rivers, making it the lowest of the north-central states with a mean elevation of about 600 feet above sea-level and a total relief of only 973 feet (Leighton et al., 1948). The Plant lies at the eastern edge of the Galesburg Plain of the Till Plains section, the largest physiographic division in Illinois, covering approximately four-fifths of the state (Appendix A [Figure 3]). It is characterized by level to undulatory till plains with a few morainic ridges in a late youthful stage of erosion. The Galesburg Plain includes the western portion of the Illinoian drift sheet in western Illinois, with most streams flowing from a central upland region westward into the Mississippi River and eastward and southward into the Illinois River. Drainage systems are well developed and the larger valleys tend to be steep walled, alluviated, and terraced. The district is high above mean sea level so minor valleys tend to be numerous, deep, and youthful.

A.2 Unlithified Geology

The Plant is located in the Illinois Valley, where the Quaternary deposits consist of glacial outwash belonging to the Banner and Henry Formations, overlain by channel and floodplain deposits of the Cahokia Formation (Appendix A [Figure 5]) (Berg and Kempton, 1987; Lineback, 1979). The Sankoty Sand Member of the Banner Formation rests directly on bedrock and fills the deepest part of the Illinois Valley in the area. Its thickness varies greatly from about 50 to 150 feet due to erosion and irregularities on the bedrock surface (Burch and Kelly, 1993). The Sankoty Sand is the most extensive aquifer in the region and is characterized by coarse- to medium-grained sand with an abundance of quartz grains, of which 25 percent or more are pink, rounded, and polished. Gravel is present in some beds but is not common (Willman and Frye, 1970).

The upper part of the Sankoty Sand has been eroded in the Illinois Valley south of Peoria and is buried by glacial outwash deposits belonging to the Henry Formation. The outwash constituting the Henry Formation consists of sorted and stratified water-laid material that is predominantly sand and gravel. These outwash sediments were deposited by debris-laden meltwaters flowing away from the ice fronts during both the advances and retreats of glaciers during the Wisconsinan Age (Ibid.) and were previously classified with the Mackinaw Member sand and gravel outwash deposited as valley trains. The lithogenic Mackinaw Member is now an informal sedimentary facies (Hansel and Johnson, 1996). To the east and south of the site, the sand and gravel occurs along the Bath Terrace, which was developed by erosion along the Illinois River caused by melting of Wisconsinan ice (Walker et al., 1965). Well logs indicate that the combined thickness of the Sankoty Sand and the Henry Formation ranges from approximately 75 to 150 feet in the area.

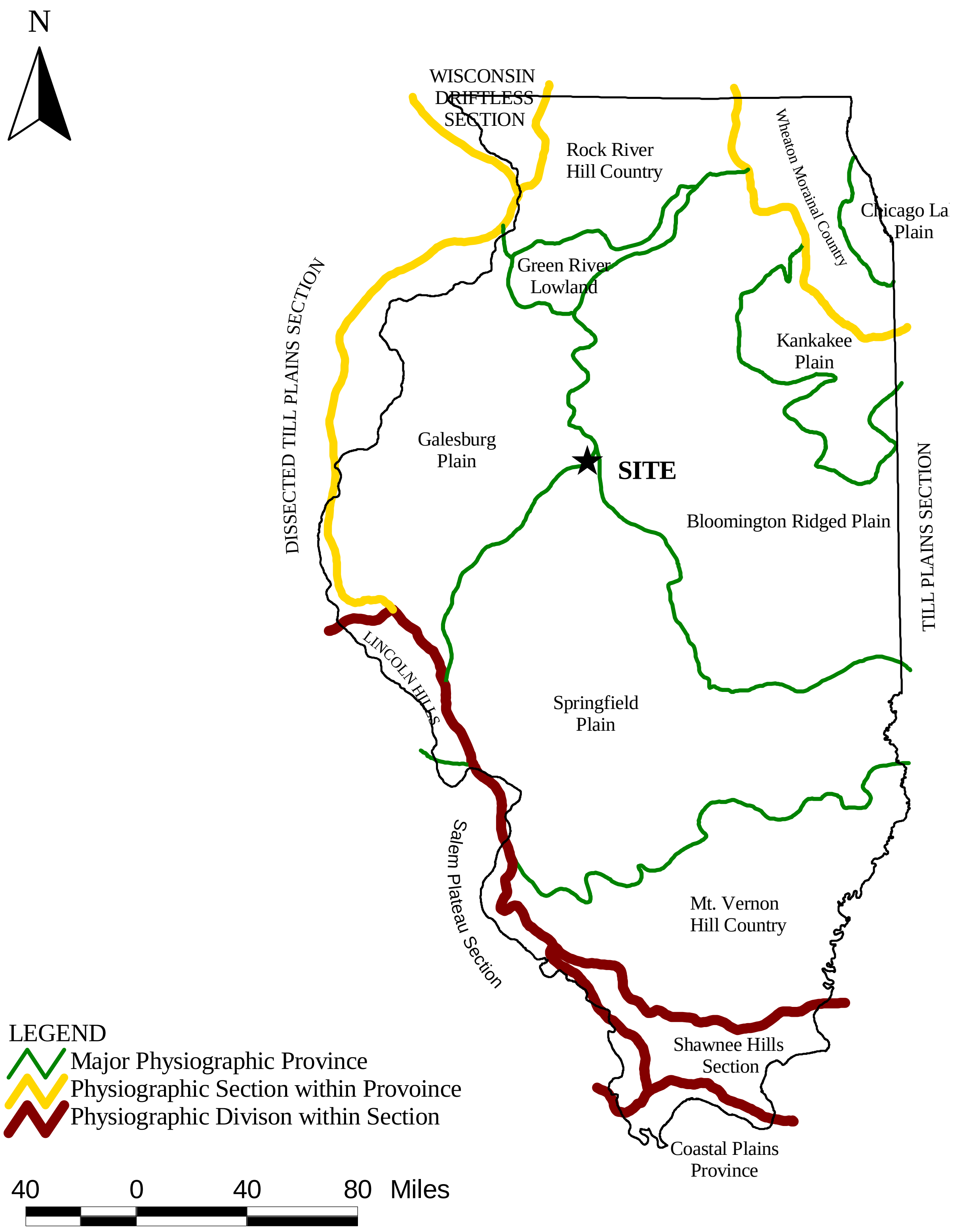
The Cahokia Formation consists of deposits in the floodplains and channels of modern rivers and streams, and is comprised of mostly poorly sorted sand, silt, and clay with wood and shell fragments, and local deposits of sandy gravel (Lineback, 1979). The upper part consists of overbank silts and clays, while the coarser-textured lower portion is mainly sandy channel and lateral accretion deposits. The Cahokia is present along all Illinois streams, although locally absent where active stream erosion is occurring. In major valleys, it commonly overlies the well-sorted deposits of the Henry Formation (Willman and Frye, 1970). The Cahokia Formation is generally greater than 20 feet thick in the area (Berg and Kempton, 1987).

A.3 Bedrock

The Plant and surrounding areas are underlain by rocks of the Pennsylvanian Carbondale and Modesto Formations (Appendix A [Figure 4]) (Kolata, 2005; Willman et al., 1967). Detailed descriptions of the Pennsylvanian strata of Illinois were published by Willman et al. (1975). The following geologic descriptions are based on that report. The Carbondale Formation, named for Carbondale, Jackson County, near the outcrop belt of the formation, includes all strata from the base of the Colchester (No. 2) Coal Member to the top of the Danville (No. 7) Coal Member. It overlies the Spoon Formation and varies in thickness from less than 150 feet in western and northeastern Illinois to more than 400 feet in southern Illinois. The Carbondale Formation consists of sandstones, shales, limestones, and coals. The sandstones occur in elongate, channel facies up to about 100 feet thick, are typically subgraywackes, and are more argillaceous than older Pennsylvanian sandstones in Illinois. Gray shales make up the greatest part of the formation, with the thicker gray shales probably representing delta front or prodelta deposits. Gray to dark-gray, argillaceous limestones are widespread and normally fossiliferous. The coals include the principal economic coals of Illinois, the Danville (No. 7), the Herrin (No. 6), the Springfield-Harrisburg (No. 5), and the Colchester (No. 2).

The Modesto Formation, named for Modesto, Macoupin County, near the type locality, overlies the Carbondale Formation and includes all strata from the top of Danville (No. 7) Coal to the base of the Shoal Creek Limestone Member or the LaSalle Limestone Member. Its thickness varies from less than 125 feet along the LaSalle Anticlinal Belt in east-central Illinois to over 450 feet in southern Illinois, averaging approximately 350 feet. The Modesto consists of sediments similar to those found in the underlying Carbondale Formation, but the coals are thinner and less extensive, the limestones tend to be thicker and less argillaceous, and several red claystones and shales are associated with the open-marine limestones. Gray shales constitute a major part of the Modesto Formation and individual beds tend to be extremely thick.

The elevation of the bedrock surface in the study area ranges from approximately 400 to 450 feet above mean sea level (Herzog et al., 1994). Well logs indicate that the depth to bedrock ranges from more than 50 feet in the Illinois Valley to less than 20 feet in the adjacent uplands, and the lithology of the uppermost bedrock is mainly shale.



RAPPS
Engineering & Applied Science, Inc.

821 S. DURKIN DR. SPRINGFIELD, IL 62704 (217) 787-2118
P.O. BOX 925 CARBONDALE, IL 62903 (618) 521-0574

ILLINOIS PROFESSIONAL DESIGN FIRM No. 184-001130

FIGURE 3

PHYSIOGRAPHIC DIVISIONS OF ILLINOIS
(LEIGHTON ET AL, 1948)

AMERENENERGY RESOURCES GENERATING
E. D. EDWARDS PLANT
PEORIA COUNTY, ILLINOIS

PROJECT: SA09035 DRAWING: Physio DATE: 11/09

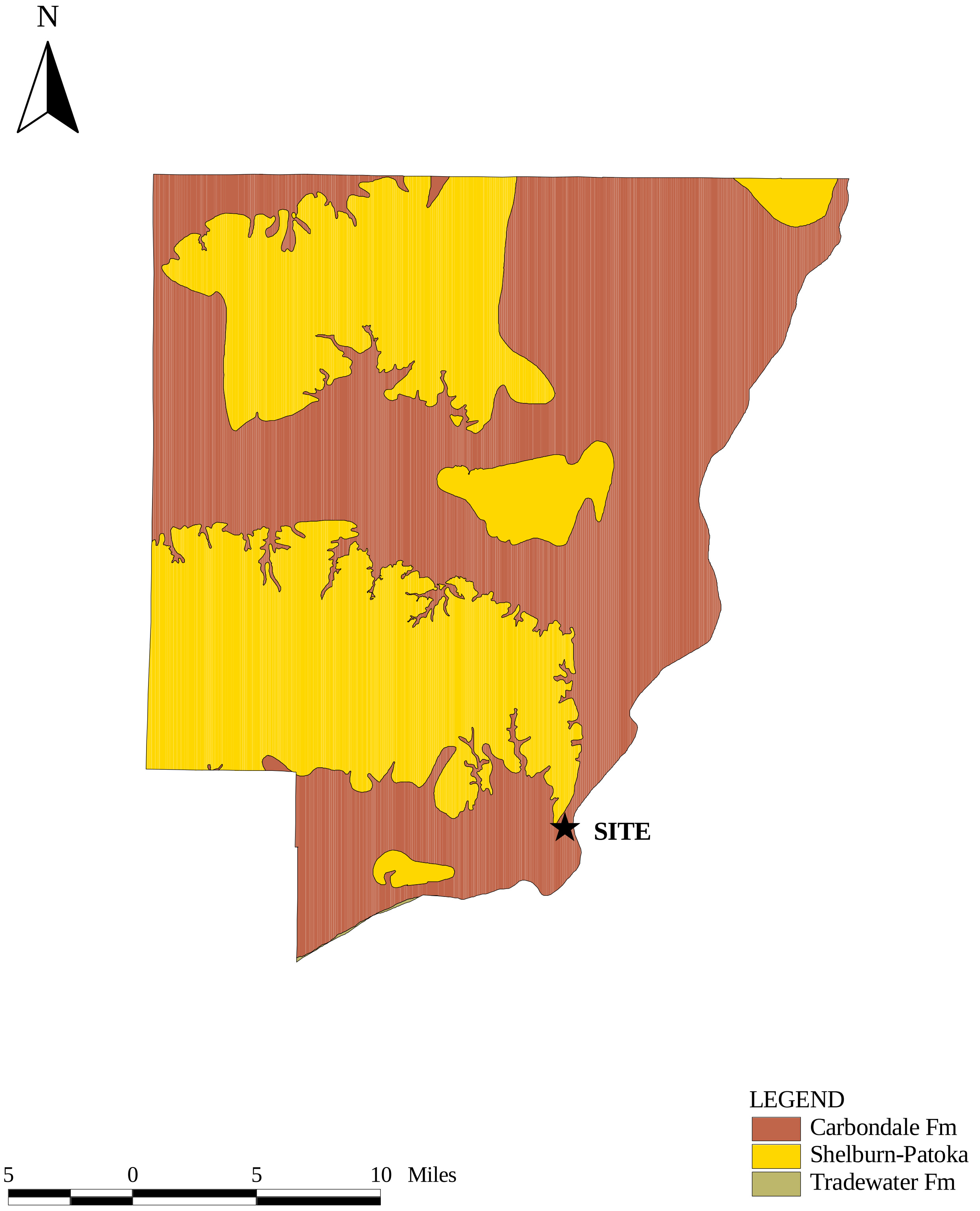


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FIGURE 4
BEDROCK GEOLOGY
(HORBERG, 1950)

AMERENENERGY RESOURCES GENERATING
E. D. EDWARDS PLANT
PEORIA COUNTY, ILLINOIS

PROJECT: SA09035 DRAWING: Bedgeo DATE: 11/09

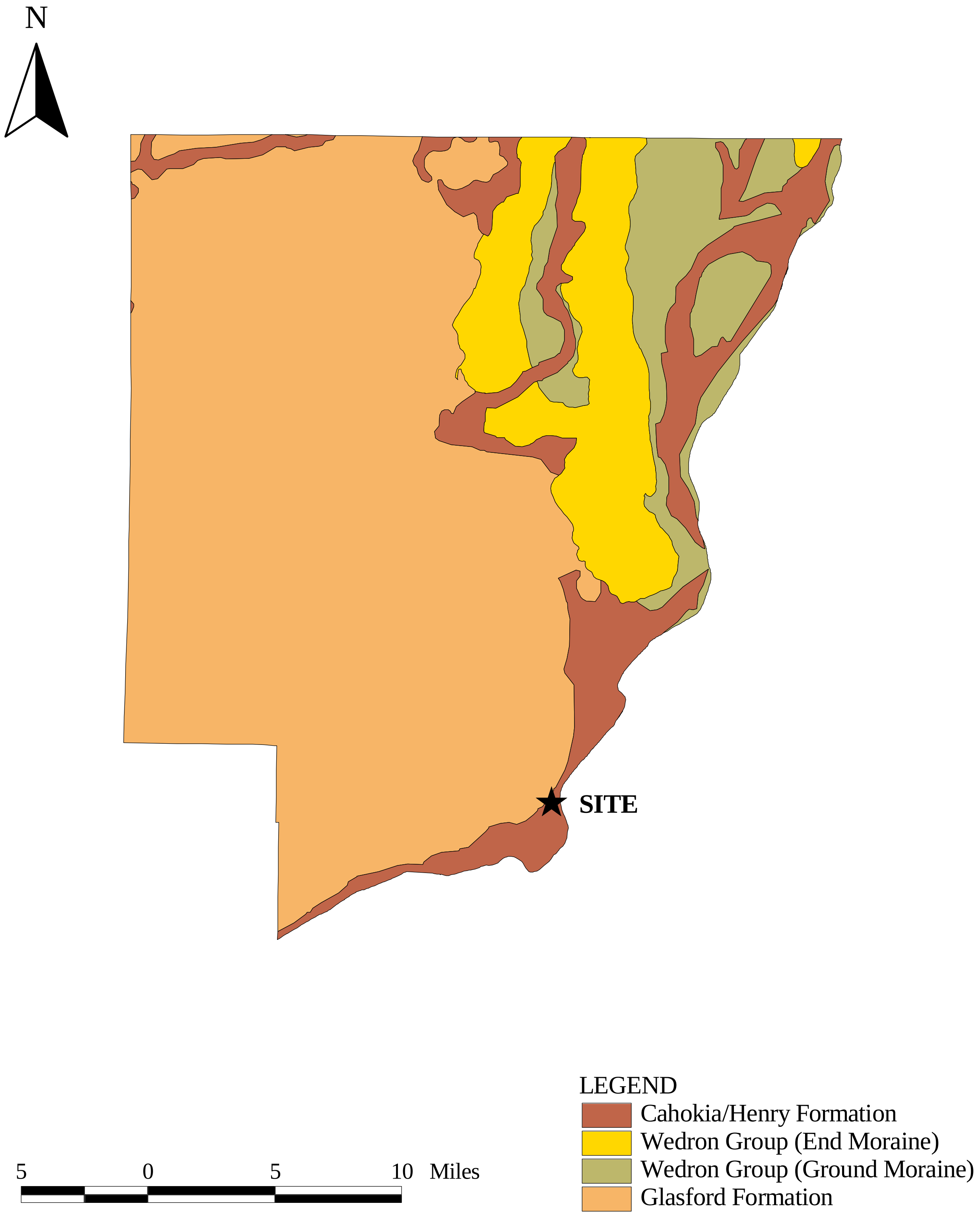

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FIGURE 5

QUATERNARY GEOLOGY
(HANSEL AND JOHNSON, 1996)

AMERENENERGY RESOURCES GENERATING
E. D. EDWARDS PLANT
PEORIA COUNTY, ILLINOIS

PROJECT: SA09035 DRAWING: Quat DATE: 11/09

APPENDIX B

WELL SURVEY RESULTS

B WELL SEARCH

B.1 Well Search Overview

The following sources of information were utilized in order to determine community water source and water well locations:

- Illinois State Geological Survey's Illinois Water Well (ILWATER) Internet Map Service
- Illinois State Water Survey Domestic Well Database
- Illinois EPA web-based Geographic Information System (GIS) files
- Illinois Department of Public Health
- Peoria County Health Department.

B.2 Illinois State Geological Survey (ISGS)

The ISGS website provided an ArcIMS View Map as well as a database query for water wells. ISGS database information including any boring logs and well construction information is provided in this Appendix. In Figure 3, Well 12, owned by Cargrill Fertilizer, appears to be incorrectly located in the ISGS database.

B.3 Illinois State Water Survey (ISWS)

All of the wells found on-line through the ISWS Domestic Well Database were previously identified on the ISGS website. Hard copy records contained within the ISWS database, consisting of public, industrial, and commercial water wells, were not all received as of the date of this report. Since the ISWS database generally contains the same well information as the ISGS and Illinois EPA databases, some ISWS well entries on the Appendix B-1 Table were marked as pending. Should any new information be acquired from the ISWS including additional water wells not previously identified from the on-line sources of well information, it will be provided as an addendum to this report. Table B-2 lists wells located by RAPPS (2009) that were not located and identified in the on-line search for this report.

B.4 Illinois Environmental Protection Agency (IEPA)

The Illinois EPA database website provided ArcIMS Viewer Maps showing information on community, non-community, and public water supply wells as defined on the Illinois EPA website:

- Community Water Supply (CWS): a public water supply that serves or is intended to serve at least 15 service connections used by residents or regularly serves at least 25 residents.
- Non-Community Water Supply (NCWS): a public water supply that is not a community water supply.
- Public Water Supply: all mains, pipes and structures through which water is obtained and distributed to the public, including wells and well structures, intakes and cribs, pumping stations, treatment plants, reservoirs, storage tanks and appurtenances, collectively or severally, actually used or intended for use for the purpose of furnishing water for drinking or general domestic use and which serve at least 15 service connections or which regularly serve at least 25 persons at least 60 days per year. A public water supply is either a community water supply or a non-community water supply.

Based on the IEPA maps, one NCWS well is located in Section 14 within 2,500 feet of the CCP impoundment. This NCWS also includes a phase I Wellhead protection area designated around the NCWS location. A wellhead protection area (WHPA) is the surface and subsurface area surrounding a water well or well field supplying a public water system through which contaminants from a source are theoretically likely to move and reach the water well or well field. All CWS systems utilizing groundwater in Illinois have a 1,000-foot wellhead / source water protection radius, also referred to as a Phase I WHPA.

Well 12 was also incorrectly located with in the IEPA database.

B.5 Peoria County Health Department

Personnel from the Peoria County Health Department indicated that the NCWS well located within Section 14 is not a potable well. Additionally, the Freedom Gas Station where this well is located hauls water to the site from an offsite location. No additional information was provided about the area.

Table B-1. Well Search Results
Phase I Hydrogeologic Assessment
E.D. Edwards Energy Center

Map	Source of Well Information				Location Name at Time of Well Completion	Well		Location				Year	Aquifer		Well
Well #	ISGS	ISWS***	IEPA	Other		Depth	County	Township	Range	Section	Subsection	Drilled	Type	Formation	Use
1	121430133300	--	1333	--	Cargo Carriers	33	Peoria	7N	7E	14	NESENE	1968	unconsolidated	gravel	FD
2	121430151500	119112	01515	--	Lewis, Eddie	43	Peoria	7N	7E	11	NENWNE	1969	unconsolidated	silt	FD
3	121432221000	119111	22210	--	Frazier, Sam	65	Peoria	7N	7E	11	NENWSE	1978	bedrock	rock	FD
4	121432480200	--	24802	--	Bridge FA R25 & 75, IL. River	95	Peoria	7N	7E	13	SESWNW	1971	--	--	IC
5	121432356000	--	23560	--	Clark oil & refining	60	Peoria	7N	7E	12	NWSWNW	--	bedrock	limestone-shale	IC
6	121432525900	--	25259	IDOT	Bridge over IL River	51	Peoria	7N	7E	13	--	1971	--	--	IC
7	121432526000	--	25260	IDOT	Bridge over IL River	96	Peoria	7N	7E	13	--	1971	--	--	IC
8	121432526100	--	25261	IDOT	Bridge over IL River	96	Peoria	7N	7E	13	--	1971	--	--	IC
9	121432526200	--	25262	IDOT	Bridge over IL River	92	Peoria	7N	7E	13	--	1971	--	--	IC
10	121432526300	--	25263	IDOT	Bridge over IL River	92	Peoria	7N	7E	13	--	1971	--	--	IC
11	121432526400	--	25264	IDOT	Bridge over IL River	35	Peoria	7N	7E	13	--	1971	--	--	IC
12	121433424000	--	34240	--	Cargill Fertilizer	20	Peoria	7N	7E	14	SWSENE (A)	2001	unconsolidated	clay	IC
13	--	--	14301048	--	NON-CWS Freedom Gas station	--	Peoria	7N	7E	14	--	--	--	--	NCWS

Sources of Information

IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
SWA	IEPA Source Water Assessment
IDOT	Illinois Department of Transportation

Well Use

FD	Farm and/or Domestic Water Well
IC	Industrial/Commercial Water Well
CWS	Community Water Supply
NCWS	Non-Community Water Supply
MW	Monitoring well

Notes

- -	Not applicable or no information available
**	ISWS data pending
A	Well is mislocated in ISGS and/or IEPA databases

Table B-2. Other Water Wells, Precise Location Not Available

Phase I Hydrogeologic Assessment

E.D. Edwards Energy Center

Well ID	Depth	Location			Well Use	Driller	Date Drilled
		Township	Range	Section			
119113	60	7N	7E	12	IC	SAUDER	9/17/1978
403294		7N	7E	12			
403295		7N	7E	12			
119114	30	7N	7E	14	IC	HAMPTON	1968
332808	20	7N	7E	14	IC	WHITE BROS.	8/17/2001
119060	40	7N	7E	15	DO		1956
119061	62	7N	7E	15	DO		1956
119116	25	7N	7E	15	DO	SCHERF	8/26/1972
119117	50	7N	7E	15	DO	SCHERF	9/2/1972
227020	40	7N	7E	15	DO		1956
307580	118	25N	5W	27	TH	WRIGHT'S	11/20/1998

Well Use

DO	Domestic
IC	not specified
TH	not specified

These wells are listed in RAPPS (2009). NRT has ordered but not yet received these records from the ISWS Domestic Wells Database.

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ILLINOIS STATE GEOLOGICAL SURVEY

Semi-Private Water Well	**Top**	**Bottom**
clay	0	20
Total Depth		**20**

Casing: 6" SDR 21 from -1' to 11'
36" CONCRETE WELL TILE from 11' to 20'

Grout: HOLE PLUG from 10 to 11.

Grout: PEA GRAVEL from 11 to 20.

Water from clay at 4' to 20'.

Address of well: same as above

Location source: Location from permit

Permit Date: July 2, 2001 **Permit #:**

COMPANY Greenfield, Edward K.
FARM Cargill Fertilizer
DATE DRILLED August 17, 2001 **NO.**
ELEVATION 0 **COUNTY NO.** 34240
LOCATION SW SE NE
LATITUDE 40.588081 **LONGITUDE** -89.664793
COUNTY **Peoria** **API** **121433424000** **14 - 7N - 7E**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Engineering Test	Top	Bottom
Total Depth		**35**

Permit Date: **Permit #:**

COMPANY IL Dept. of Transportation

FARM Bridge over Illinois River @ Pekin

DATE DRILLED November 1, 1971 **NO.** STH-1

ELEVATION 436GL **COUNTY NO.** 25264

LOCATION

LATITUDE 40.587184 **LONGITUDE** -89.659272

COUNTY **Peoria** **API** **121432526400** **13 - 7N - 7E**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Engineering Test	Top	Bottom
Total Depth		**92**

Permit Date: **Permit #:**

COMPANY IL Dept. of Transportation

FARM Bridge over Illinois River @ Pekin

DATE DRILLED November 1, 1971 **NO.** 9-prelim

ELEVATION 437GL **COUNTY NO.** 25263

LOCATION

LATITUDE 40.587184 **LONGITUDE** -89.659272

COUNTY **Peoria** **API** **121432526300** **13 - 7N - 7E**

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ILLINOIS STATE GEOLOGICAL SURVEY

Engineering Test	Top	Bottom
Total Depth		**92**

Permit Date:

Permit #:

COMPANY IL Dept. of Transportation

FARM Bridge over Illinois River @ Pekin

DATE DRILLED November 1, 1971

NO. 8-prelim

ELEVATION 437GL

COUNTY NO. 25262

LOCATION

LATITUDE 40.587184

LONGITUDE -89.659272

COUNTY **Peoria**

API **121432526200**

13 - 7N - 7E

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Engineering Test	Top	Bottom
Total Depth		**96**

Permit Date: **Permit #:**

COMPANY IL Dept. of Transportation

FARM Bridge over Illinois River @ Pekin

DATE DRILLED November 1, 1971 **NO.** 7-prelim

ELEVATION 436GL **COUNTY NO.** 25261

LOCATION

LATITUDE 40.587184 **LONGITUDE** -89.659272

COUNTY **Peoria** **API** **121432526100** **13 - 7N - 7E**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Engineering Test	Top	Bottom
Total Depth		96

Permit Date: **Permit #:**

COMPANY IL Dept. of Transportation
FARM Bridge over Illinois River @ Pekin
DATE DRILLED October 1, 1971 **NO.** 5-prelim
ELEVATION 445GL **COUNTY NO.** 25260
LOCATION
LATITUDE 40.587184 **LONGITUDE** -89.659272
COUNTY Peoria **API** 121432526000 13 - 7N - 7E

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Engineering Test	**Top**	**Bottom**
Total Depth		**51**

Permit Date: **Permit #:**

COMPANY IL Dept. of Transportation
FARM Bridge over Illinois River at Pekin
DATE DRILLED September 30, 1971 **NO.** 4-prelim
ELEVATION 450GL **COUNTY NO.** 25259
LOCATION
LATITUDE 40.587184 **LONGITUDE** -89.659272
COUNTY **Peoria** **API** **121432525900** **13 - 7N - 7E**

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ILLINOIS STATE GEOLOGICAL SURVEY

Engineering Test	**Top**	**Bottom**
C #9411 (Spls. 1-11)	0	0
Total Depth		**95**

Remarks: Rec'd. 3/73

Core #C 9411 (0' - 0') Received: March 1, 1973

Additional location info: Lot: Subdivision:
Elev updated - ABL

Permit Date:

Permit #:

COMPANY owner

FARM Bridge FA R25&75,Il.River

DATE DRILLED October 1, 1971

NO. 6-prelim

ELEVATION 454GL

COUNTY NO. 24802

LOCATION SE SW NW

LATITUDE 40.588073

LONGITUDE -89.660552

COUNTY **Peoria**

API **121432480200**

13 - 7N - 7E

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Water Well	**Top**	**Bottom**
clay	0	30
rock	30	65
Total Depth		**65**

Casing: 24" ID CEMENT from 11' to 51'

Water from rock at 37' to 38'.

Static level 37' below casing top which is 1' above GL

Driller's Log filed

Location source: Location from permit

Permit Date: August 8, 1978 **Permit #:** 77945

COMPANY Shaver, D.

FARM Frazier, Sam

DATE DRILLED August 19, 1978 **NO.**

ELEVATION 570GL **COUNTY NO.** 22210

LOCATION NE NW SE

LATITUDE 40.600805 **LONGITUDE** -89.667324

COUNTY Peoria **API 121432221000** **11 - 7N - 7E**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Water Well	**Top**	**Bottom**
yellow clay	0	20
yellow clay gravel, water bearing	20	21
yellow clay	21	43
Total Depth		**43**

Casing: 24" CONCRETE from 1' to 43'

Water from yellow clay gravel at 20' to 21'.

Driller's Log filed

Location source: Location from permit

Permit Date: December 9, 1969 **Permit #:** NF7549

COMPANY Hampton, E. T.

FARM Lewis, Eddie

DATE DRILLED November 25, 1969 **NO.** 1

ELEVATION 0 **COUNTY NO.** 01515

LOCATION 215'S line, 175'W line of NE NW NE

LATITUDE 40.60777 **LONGITUDE** -89.667938

COUNTY Peoria **API 121430151500** **11 - 7N - 7E**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Water Well	**Top**	**Bottom**
s.s. #55311	0	0
black dirt	0	10
grit gravel yellowish	10	12
dark tough clay black	12	30
Total Depth		**30**

Casing: 24" CONCRETE(TOP/BOTTOM) from 0' to 0'

Water from Gilbert gravel at 0' to 0'.

Remarks: tracing done by Dept. of Pub. Health

Driller's Log filed

Sample set # 55311 (1' - 25')

Location source: Location from the driller

Permit Date: January 1, 1968 **Permit #:** NF3700

COMPANY Hampton, E. T.

FARM Cargo Carriers

DATE DRILLED April 5, 1968 **NO.**

ELEVATION 0 **COUNTY NO.** 01333

LOCATION 200'S 250'W NE/c SE NE

LATITUDE 40.590234 **LONGITUDE** -89.662127

COUNTY Peoria **API 121430133300** **14 - 7N - 7E**

Page 1

ILLINOIS STATE GEOLOGICAL SURVEY

Industrial Water Well	**Top**	**Bottom**
clay,sand & gravel	0	3
clay-sticky,black	3	10
clay-softer	10	15
clay-dark	15	29
sandstone-gray,soft	29	35
limestone	35	36
shale-gray	36	37
limestone-shale	37	43
shale-softer	43	60
Total Depth		**60**

Size hole below casing: 0"

Remarks: no water

Location source: Location from permit

Permit Date: September 17, 1987 **Permit #:** 135221

COMPANY Sauder, Steven E.

FARM Clark Oil & Refining

DATE DRILLED **NO.**

ELEVATION 0 **COUNTY NO.** 23560

LOCATION 100'N line, 50'W line of NW SW NW

LATITUDE 40.605076 **LONGITUDE** -89.661192

COUNTY **Peoria** **API** **121432356000** **12 - 7N - 7E**

APPENDIX C

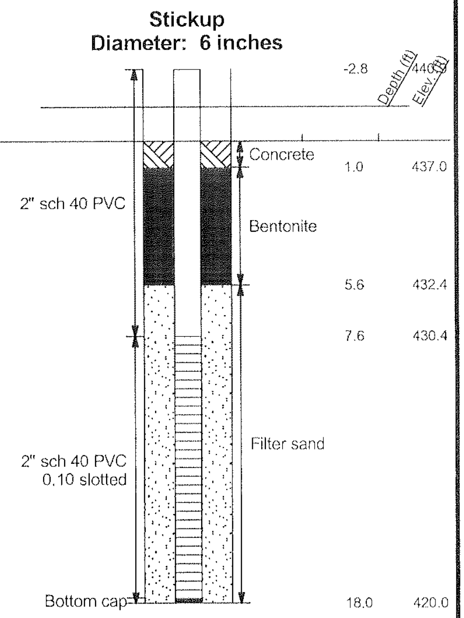
BORING LOGS WITH WELL DIAGRAMS

Surface Elevation: 438.02
Datum msl

Completion Date: 7/27/10
Northing 1432880.82
Easting 2435852.39

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL			GB1
5				
	Brown, silty CLAY - CL			GB2
10	∇			GB3
15				GB4
	Shaley LIMESTONE		10-0-0	SS5
20	Auger refusal at 18.5 feet.			
25				
30				
35				
40				

WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 10 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM
WASHBORING FROM __ FEET
PH DRILLER JPC LOGGER
CME 550X DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: Rgp
Date: 8/13/10	Date: 2/17/11	Date: 2/17/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Edwards, Illinois

LOG OF BORING: APW-1

Project No. J017150.01

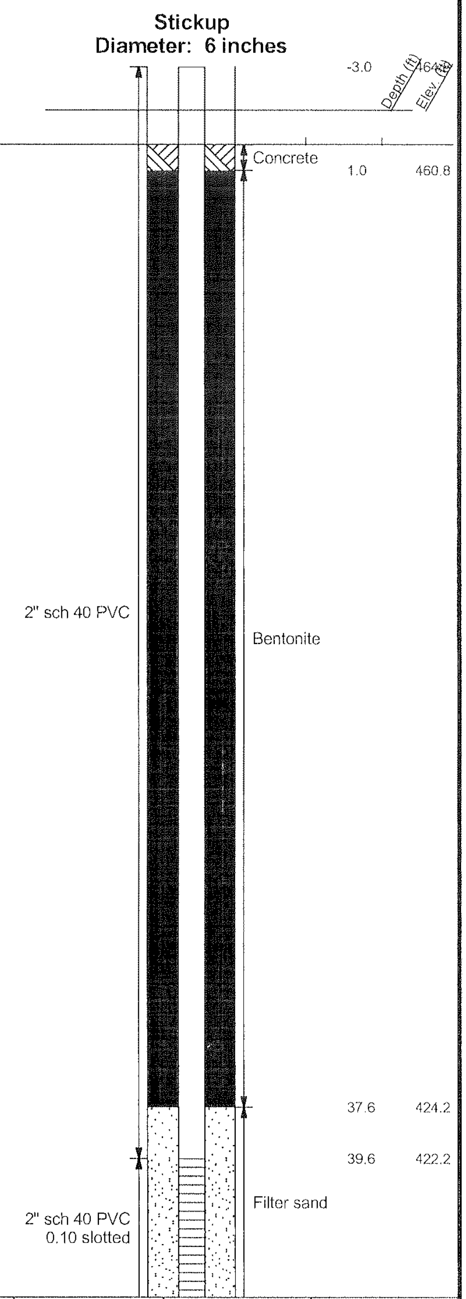
LOG OF BORING 2002 WL J017150.01 - EDWARDS.GPJ GTINC 0638301.GPJ 12/13/10

Surface Elevation: 461.80
Datum msl

Completion Date: 7/20/10
Northing: 1430732.11
Easting: 243579.28

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: ash	▩		GB1
5	Black, silty CLAY - CL	▨		GB2
10		▨		GB3
15		▨		GB4
20		▨		GB5
25	Gray, silty CLAY - CL	▨		GB6
30		▨		GB7
35	▽	▨		GB8
40		▨		GB9

WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 38 FEET ▽

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM
WASHBORING FROM __ FEET
PH DRILLER JPC LOGGER
CME 550X DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: RBP
Date: 8/13/10	Date: 2/17/11	Date: 2/17/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Edwards, Illinois

LOG OF BORING: APW-2

Project No. J017150.01

LOG OF BORING 2002 W/L J017150.01 - EDWARDS.GPJ GTINC 0638301.GPJ 12/13/10

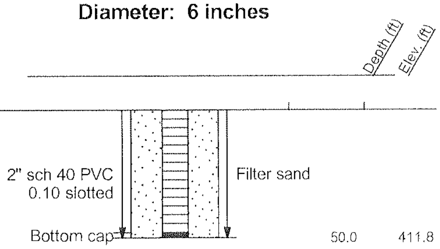
Surface Elevation: 461.80
Datum msl

Completion Date: 7/20/10
Northing: 1430732.11
Easting: 243579.28

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Gray, silty CLAY - CL *(continued)*	▨		GB10
50	Boring terminated at 50 feet.			
55				
60				
65				
70				
75				
80				
85				

WELL DIAGRAM

Stickup
Diameter: 6 inches



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J017150.01 - EDWARDS.GPJ GTINC 0638301.GPJ 12/13/10

GROUNDWATER DATA

ENCOUNTERED AT 38 FEET ⊻

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM
WASHBORING FROM __ FEET
PH DRILLER JPC LOGGER
CME 550X DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: RgP
Date: 8/13/10	Date: 2/17/11	Date: 2/17/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Edwards, Illinois

CONTINUATION OF
LOG OF BORING: APW-2

Project No. J017150.01

Surface Elevation: 444.26

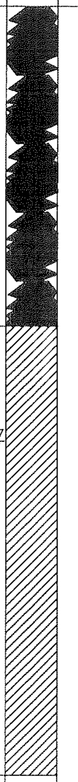
Datum msl

Completion Date: 7/19/10

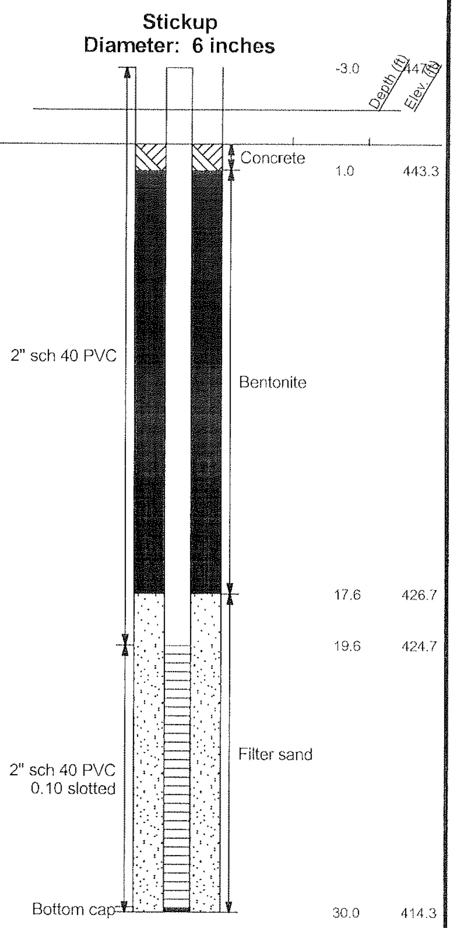
Northing: 1429652.72

Easting: 2436225.53

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Black COAL and ash			GB1
5				GB2
10				GB3
	Gray and brown, silty CLAY - CL			
15		∇		GB4
20				GB5
25				GB6
30	Boring terminated at 30 feet.			
35				
40				



WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J017150.01 - EDWARDS.GPJ GTINC 0638301.GPJ 12/13/10

GROUNDWATER DATA

ENCOUNTERED AT 17 FEET ∇

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: RSL
Date: 8/13/10	Date: 2/17/11	Date: 2/17/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Edwards, Illinois

LOG OF BORING: APW-3

Project No. J017150.01

Surface Elevation: 473.30

Datum msl

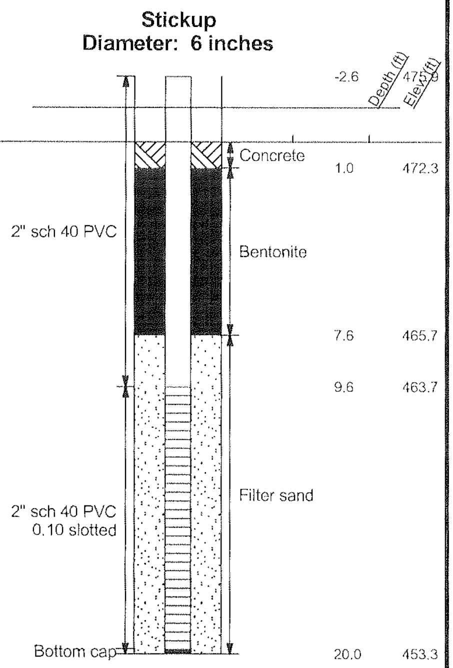
Completion Date: 7/27/10

Northing 1428432.43

Easting 2436265.52

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL	▩		GB1
	GRAVEL	○		GB2
5				
	Brown, silty CLAY, trace gravel - CL	∇ ▨		GB3
10		▨		
		▨		GB4
15		▨		
		▨		GB5
20	Boring terminated at 20 feet.			
25				
30				
35				
40				

WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J017150.01 - EDWARDS.GPJ GTINC 0638301.GPJ 12/13/10

GROUNDWATER DATA

ENCOUNTERED AT 7.5 FEET ∇

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: DTK	App'vd. by: KSP
Date: 8/13/10	Date: 2/17/11	Date: 2/17/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Edwards, Illinois

LOG OF BORING: APW-4

Project No. J017150.01

APPENDIX D

GROUNDWATER QUALITY DATA SUMMARY

December 11, 2012
7:34:03 AM

Edwards
Groundwater Monitoring Data: December 2010 - September 2012

Date Range: 12/14/2010 to 09/26/2012

Well Id	Date Sampled	Lab Id	Ag, diss, mg/L	As, diss, mg/L	B, diss, mg/L	Ba, diss, mg/L	Be, diss, mg/L	Cd, diss, mg/L
APW-1	12/14/2010		<0.005	<0.004	0.839	0.070	<0.004	<0.004
	03/30/2011	1033108-01	<0.005	0.005	0.880	0.065	<0.001	<0.001
	06/29/2011	1063038-01	<0.005	0.007	0.790	0.071	<0.001	<0.001
	09/29/2011	1100091-01	<0.005	0.007	0.800	0.063	<0.001	<0.001
	12/06/2011	1120662-01	<0.005	0.007	0.780	0.070	<0.001	<0.001
	03/28/2012	2033045-01	<0.005	0.008	0.950	0.066	<0.001	<0.001
	06/26/2012	2063392-01	<0.005	0.007	0.730	0.063	<0.001	<0.001
	09/26/2012	2093525-01	<0.005	0.008	0.730	0.093	<0.001	<0.001
APW-2	12/14/2010		<0.005	<0.004	<0.100	0.147	<0.004	<0.004
	03/31/2011	1033108-02	<0.005	0.002	0.087	0.160	<0.001	<0.001
	06/29/2011	1063038-02	<0.005	0.002	0.073	0.160	<0.001	<0.001
	09/29/2011	1100091-02	<0.005	0.004	0.065	0.180	<0.001	<0.001
	12/06/2011	1120662-02	<0.005	0.003	0.053	0.160	<0.001	<0.001
	03/28/2012	2033045-02	<0.005	0.002	0.057	0.110	<0.001	<0.001
	06/26/2012	2063392-02	<0.005	0.003	0.053	0.130	<0.001	<0.001
	09/26/2012	2093525-02	<0.005	0.003	0.062	0.140	<0.001	<0.001
APW-3	12/14/2010		<0.005	<0.004	0.253	0.219	<0.004	<0.004
	03/31/2011	1033108-03	<0.005	0.001	0.230	0.250	<0.001	<0.001
	06/29/2011	1063038-03	<0.005	<0.001	0.180	0.290	<0.001	<0.001
	09/29/2011	1100091-03	<0.005	0.002	0.170	0.330	<0.001	<0.001
	12/06/2011	1120662-03	<0.005	<0.001	0.200	0.330	<0.001	<0.001
	03/28/2012	2033045-03	<0.005	0.002	0.170	0.240	<0.001	<0.001
	06/26/2012	2063392-03	<0.005	<0.001	0.150	0.270	<0.001	<0.001
	09/26/2012	2093525-03	<0.005	0.001	0.140	0.300	<0.001	<0.001
APW-4	12/14/2010		<0.005	<0.004	1.650	0.180	<0.004	<0.004
	03/31/2011	1033108-04	<0.005	0.003	1.100	0.220	<0.001	<0.001
	06/29/2011	1063038-04	<0.005	0.002	1.200	0.210	<0.001	<0.001
	09/29/2011	1100091-04	<0.005	0.003	1.800	0.190	<0.001	<0.001
	12/06/2011	1120662-04	<0.005	0.003	1.700	0.170	<0.001	<0.001
	03/28/2012	2033045-04	<0.005	0.007	1.000	0.200	<0.001	<0.001
	06/26/2012	2063392-04	<0.005	0.008	1.100	0.230	<0.001	<0.001
	09/26/2012	2093525-04	<0.005	0.004	1.800	0.170	<0.001	<0.001

December 11, 2012
7:34:03 AM

Edwards
Groundwater Monitoring Data: December 2010 - September 2012

Date Range: 12/14/2010 to 09/26/2012

Well Id	Date Sampled	Lab Id	Cl, diss, mg/L	CN, total, mg/L	Co, diss, mg/L	Cr, diss, mg/L	Cu, diss, mg/L	F, diss, mg/L
APW-1	12/14/2010		39.500	<0.010	<0.050	<0.010	<0.025	0.170
	03/30/2011	1033108-01	39.000	<0.005	<0.002	<0.004	<0.003	<0.250
	06/29/2011	1063038-01	29.000	<0.005	<0.002	<0.004	<0.003	0.340
	09/29/2011	1100091-01	35.000	<0.005	<0.002	<0.004	<0.003	0.290
	12/06/2011	1120662-01	40.000	<0.005	<0.002	<0.004	<0.003	0.250
	03/28/2012	2033045-01	35.000	<0.005	<0.002	<0.004	<0.003	0.290
	06/26/2012	2063392-01	68.000	<0.005	<0.002	<0.004	<0.003	<0.250
	09/26/2012	2093525-01	270.000	<0.005	<0.002	0.011	<0.003	0.410
APW-2	12/14/2010		14.000	<0.010	<0.050	<0.010	<0.025	0.210
	03/31/2011	1033108-02	16.000	<0.005	<0.002	<0.004	<0.003	<0.250
	06/29/2011	1063038-02	11.000	<0.005	<0.002	<0.004	<0.003	0.320
	09/29/2011	1100091-02	14.000	<0.005	<0.002	<0.004	0.003	0.280
	12/06/2011	1120662-02	16.000	<0.005	<0.002	<0.004	<0.003	<0.250
	03/28/2012	2033045-02	13.000	<0.005	<0.002	<0.004	<0.003	0.290
	06/26/2012	2063392-02	11.000	<0.005	<0.002	<0.004	<0.003	<0.250
	09/26/2012	2093525-02	11.000	<0.005	<0.002	<0.004	<0.003	0.440
APW-3	12/14/2010		31.000	<0.010	<0.050	<0.010	<0.025	0.170
	03/31/2011	1033108-03	30.000	<0.005	<0.002	<0.004	<0.003	<0.250
	06/29/2011	1063038-03	23.000	<0.005	<0.002	0.005	<0.003	0.330
	09/29/2011	1100091-03	26.000	<0.005	<0.002	<0.004	<0.003	0.350
	12/06/2011	1120662-03	32.000	<0.005	<0.002	0.005	0.003	<0.250
	03/28/2012	2033045-03	27.000	<0.005	<0.002	<0.004	0.005	0.250
	06/26/2012	2063392-03	27.000	<0.005	<0.002	<0.004	<0.003	<0.250
	09/26/2012	2093525-03	32.000	<0.005	<0.002	<0.004	<0.003	0.410
APW-4	12/14/2010		84.000	<0.010	<0.050	<0.010	<0.025	0.190
	03/31/2011	1033108-04	75.000	<0.005	0.003	<0.004	<0.003	0.270
	06/29/2011	1063038-04	85.000	<0.005	0.003	0.004	<0.003	0.370
	09/29/2011	1100091-04	93.000	<0.005	<0.002	0.004	<0.003	0.360
	12/06/2011	1120662-04	95.000	<0.005	<0.002	<0.004	0.047	0.320
	03/28/2012	2033045-04	75.000	<0.005	0.002	<0.004	<0.003	0.350
	06/26/2012	2063392-04	92.000	<0.005	0.002	<0.004	<0.003	0.300
	09/26/2012	2093525-04	74.000	<0.005	<0.002	0.004	<0.003	0.530

Edwards
Groundwater Monitoring Data: December 2010 - September 2012

Date Range: 12/14/2010 to 09/26/2012

Well Id	Date Sampled	Lab Id	Fe, diss, mg/L	GW Depth (TOC), ft	Hg, diss, mg/L	Mn, diss, mg/L	Ni, diss, mg/L	NO3, diss, mg/L
APW-1	12/14/2010		<0.100	6.110	<0.0002	1.450	<0.040	0.280
	03/30/2011	1033108-01	6.000	6.310	<0.0002	1.500	0.010	<0.020
	06/29/2011	1063038-01	9.700	5.750	<0.0002	1.700	0.017	0.040
	09/29/2011	1100091-01	7.400	6.300	<0.0002	1.500	0.008	<0.020
	12/06/2011	1120662-01	8.900	5.750	<0.0002	1.800	0.014	0.070
	03/28/2012	2033045-01	7.700	6.000	<0.0002	1.700	0.007	0.040
	06/26/2012	2063392-01	7.400	7.170	<0.0002	1.700	0.008	0.020
	09/26/2012	2093525-01	12.000	4.330	<0.0002	2.300	0.015	<0.020
APW-2	12/14/2010		<0.100	11.120	<0.0002	0.885	<0.040	0.340
	03/31/2011	1033108-02	1.300	9.500	<0.0002	0.770	0.010	0.050
	06/29/2011	1063038-02	5.000	6.583	<0.0002	0.770	0.017	<0.020
	09/29/2011	1100091-02	7.500	11.300	<0.0002	0.750	0.008	<0.020
	12/06/2011	1120662-02	7.700	6.580	<0.0002	0.730	0.011	<0.020
	03/28/2012	2033045-02	3.600	8.330	<0.0002	0.220	<0.005	1.200
	06/26/2012	2063392-02	3.900	9.250	<0.0002	0.510	0.006	0.210
	09/26/2012	2093525-02	8.900	6.250	<0.0002	0.640	0.009	<0.020
APW-3	12/14/2010		1.430	8.890	<0.0002	0.664	<0.040	0.330
	03/31/2011	1033108-03	3.000	9.500	<0.0002	0.550	0.017	0.380
	06/29/2011	1063038-03	11.000	15.000	<0.0002	0.560	0.020	<0.020
	09/29/2011	1100091-03	16.000	9.400	<0.0002	0.560	0.011	0.050
	12/06/2011	1120662-03	12.000	15.000	<0.0002	0.650	0.018	0.270
	03/28/2012	2033045-03	6.400	8.500	<0.0002	0.440	0.008	0.210
	06/26/2012	2063392-03	10.000	9.420	<0.0002	0.490	0.011	<0.020
	09/26/2012	2093525-03	15.000	6.420	<0.0002	0.480	0.015	0.040
APW-4	12/14/2010		<0.100	6.180	<0.0002	1.190	<0.040	0.440
	03/31/2011	1033108-04	3.000	6.200	<0.0002	2.000	0.013	<0.020
	06/29/2011	1063038-04	4.500	6.000	<0.0002	1.800	0.016	0.090
	09/29/2011	1100091-04	3.500	7.600	<0.0002	1.300	0.010	0.220
	12/06/2011	1120662-04	2.400	6.000	<0.0002	1.200	0.012	0.120
	03/28/2012	2033045-04	8.700	6.580	<0.0002	2.100	0.009	<0.020
	06/26/2012	2063392-04	12.000	7.750	<0.0002	1.800	0.010	0.110
	09/26/2012	2093525-04	4.900	5.250	<0.0002	0.980	0.010	0.400

Edwards
Groundwater Monitoring Data: December 2010 - September 2012

Date Range: 12/14/2010 to 09/26/2012

Well Id	Date Sampled	Lab Id	Pb, diss, mg/L	pH (field), STD	Sb, diss, mg/L	Se, diss, mg/L	SO4, diss, mg/L	Spec. Cond. (field),
APW-1	12/14/2010		<0.0050	5.700	<0.006	<0.010	325.000	1,088.000
	03/30/2011	1033108-01	<0.0010	6.170	<0.003	<0.001	340.000	130.000
	06/29/2011	1063038-01	0.0014	6.800	<0.003	0.001	300.000	200.000
	09/29/2011	1100091-01	<0.0010	7.300	<0.003	<0.001	310.000	206.000
	12/06/2011	1120662-01	<0.0010	6.800	<0.003	<0.001	350.000	200.000
	03/28/2012	2033045-01	<0.0010	8.000	<0.003	<0.001	360.000	454.000
	06/26/2012	2063392-01	<0.0010	7.950	<0.003	0.002	350.000	448.000
	09/26/2012	2093525-01	<0.0010	7.950	<0.003	0.004	310.000	448.000
APW-2	12/14/2010		<0.0050	5.620	<0.006	<0.010	92.600	1,000.000
	03/31/2011	1033108-02	<0.0010	6.780	<0.003	0.001	74.000	246.000
	06/29/2011	1063038-02	<0.0010	6.700	<0.003	0.001	59.000	234.000
	09/29/2011	1100091-02	<0.0010	6.700	<0.003	<0.001	44.000	150.000
	12/06/2011	1120662-02	<0.0010	6.700	<0.003	<0.001	44.000	234.000
	03/28/2012	2033045-02	<0.0010	8.420	<0.003	<0.001	43.000	255.000
	06/26/2012	2063392-02	<0.0010	7.320	<0.003	0.004	27.000	230.000
	09/26/2012	2093525-02	<0.0010	7.320	<0.003	<0.001	27.000	230.000
APW-3	12/14/2010		<0.0050	5.500	<0.006	<0.010	401.000	1,673.000
	03/31/2011	1033108-03	<0.0010	6.750	<0.003	0.001	290.000	318.000
	06/29/2011	1063038-03	<0.0010	6.600	<0.003	0.002	230.000	608.000
	09/29/2011	1100091-03	<0.0010	6.600	<0.003	0.001	190.000	249.000
	12/06/2011	1120662-03	<0.0010	6.600	<0.003	0.002	180.000	608.000
	03/28/2012	2033045-03	<0.0010	7.420	<0.003	0.001	150.000	577.000
	06/26/2012	2063392-03	<0.0010	7.250	<0.003	<0.001	120.000	557.000
	09/26/2012	2093525-03	<0.0010	7.250	<0.003	0.002	91.000	557.000
APW-4	12/14/2010		<0.0050	5.600	<0.006	<0.010	35.300	1,077.000
	03/31/2011	1033108-04	<0.0010	6.450	<0.003	0.002	30.000	256.000
	06/29/2011	1063038-04	<0.0010	6.600	<0.003	0.003	23.000	445.000
	09/29/2011	1100091-04	<0.0010	6.400	<0.003	0.002	14.000	205.000
	12/06/2011	1120662-04	<0.0010	6.600	<0.003	0.003	21.000	445.000
	03/28/2012	2033045-04	<0.0010	7.520	<0.003	0.001	26.000	455.000
	06/26/2012	2063392-04	<0.0010	7.600	<0.003	0.002	39.000	285.000
	09/26/2012	2093525-04	<0.0010	7.600	0.003	0.003	44.000	285.000

December 11, 2012
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Edwards
Groundwater Monitoring Data: December 2010 - September 2012

Date Range: 12/14/2010 to 09/26/2012

Well Id	Date Sampled	Lab Id	TDS, mg/L	Temp (Fahrenheit),	Tl, diss, mg/L	Zn, diss, mg/L
APW-1	12/14/2010		1,810.000	57.200	<0.002	<0.020
	03/30/2011	1033108-01	870.000	51.800	<0.001	<0.006
	06/29/2011	1063038-01	820.000	54.680	<0.001	0.011
	09/29/2011	1100091-01	790.000	57.200	<0.001	<0.006
	12/06/2011	1120662-01	940.000	54.680	<0.001	<0.006
	03/28/2012	2033045-01	390.000	54.320	<0.001	<0.006
	06/26/2012	2063392-01	970.000	55.760	<0.001	<0.006
	09/26/2012	2093525-01	1,300.000	55.760	<0.001	<0.006
APW-2	12/14/2010		556.000	56.480	<0.002	<0.020
	03/31/2011	1033108-02	660.000	55.400	<0.001	<0.006
	06/29/2011	1063038-02	640.000	60.440	<0.001	<0.006
	09/29/2011	1100091-02	630.000	59.000	<0.001	<0.006
	12/06/2011	1120662-02	530.000	60.440	<0.001	<0.006
	03/28/2012	2033045-02	450.000	57.200	<0.001	<0.006
	06/26/2012	2063392-02	610.000	58.460	<0.001	<0.006
	09/26/2012	2093525-02	630.000	58.460	<0.001	<0.006
APW-3	12/14/2010		1,190.000	55.760	<0.002	<0.020
	03/31/2011	1033108-03	1,200.000	55.400	<0.001	<0.006
	06/29/2011	1063038-03	1,200.000	56.660	<0.001	<0.006
	09/29/2011	1100091-03	1,100.000	57.560	<0.001	<0.006
	12/06/2011	1120662-03	1,000.000	56.660	<0.001	<0.006
	03/28/2012	2033045-03	970.000	57.560	<0.001	<0.006
	06/26/2012	2063392-03	1,100.000	57.200	<0.001	<0.006
	09/26/2012	2093525-03	1,100.000	57.200	<0.001	<0.006
APW-4	12/14/2010		580.000	55.760	<0.002	<0.020
	03/31/2011	1033108-04	680.000	49.820	<0.001	<0.006
	06/29/2011	1063038-04	690.000	55.040	<0.001	<0.006
	09/29/2011	1100091-04	670.000	58.100	<0.001	<0.006
	12/06/2011	1120662-04	570.000	55.040	<0.001	<0.006
	03/28/2012	2033045-04	570.000	50.720	<0.001	<0.006
	06/26/2012	2063392-04	760.000	56.300	<0.001	<0.006
	09/26/2012	2093525-04	720.000	56.300	<0.001	<0.006

APPENDIX E

EXCEEDANCES OF CLASS I GROUNDWATER STANDARDS

Edwards
Exceedances of Class I Groundwater Standards: December 2010 - September 2012

Date Range: 12/14/2010 to 09/26/2012

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
State Std	Cl, diss	00941	mg/L	APW-1	09/26/2012	270.000		200.000
	Fe, diss	01046			03/30/2011	6.000		5.000
					06/29/2011	9.700		5.000
					09/29/2011	7.400		5.000
					12/06/2011	8.900		5.000
					03/28/2012	7.700		5.000
					06/26/2012	7.400		5.000
					09/26/2012	12.000		5.000
				APW-2	09/29/2011	7.500		5.000
					12/06/2011	7.700		5.000
					09/26/2012	8.900		5.000
				APW-3	06/29/2011	11.000		5.000
					09/29/2011	16.000		5.000
					12/06/2011	12.000		5.000
					03/28/2012	6.400		5.000
					06/26/2012	10.000		5.000
					09/26/2012	15.000		5.000
				APW-4	03/28/2012	8.700		5.000
					06/26/2012	12.000		5.000
	Mn, diss	01056		APW-1	12/14/2010	1.450		0.150
					03/30/2011	1.500		0.150
					06/29/2011	1.700		0.150
					09/29/2011	1.500		0.150
					12/06/2011	1.800		0.150
					03/28/2012	1.700		0.150
					06/26/2012	1.700		0.150
					09/26/2012	2.300		0.150
				APW-2	12/14/2010	0.885		0.150
					03/31/2011	0.770		0.150
					06/29/2011	0.770		0.150
					09/29/2011	0.750		0.150
					12/06/2011	0.730		0.150
					03/28/2012	0.220		0.150
					06/26/2012	0.510		0.150
					09/26/2012	0.640		0.150
				APW-3	12/14/2010	0.664		0.150
					03/31/2011	0.550		0.150

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Edwards
Exceedances of Class I Groundwater Standards: December 2010 - September 2012

Date Range: 12/14/2010 to 09/26/2012

LimitType	Parameter	Code	Units	Location	Sample Date	Analysis Result	Lower Limit	Upper Limit
State Std	Mn, diss	01056	mg/L	APW-3	06/29/2011	0.560		0.150
					09/29/2011	0.560		0.150
					12/06/2011	0.650		0.150
					03/28/2012	0.440		0.150
					06/26/2012	0.490		0.150
					09/26/2012	0.480		0.150
				APW-4	12/14/2010	1.190		0.150
					03/31/2011	2.000		0.150
					06/29/2011	1.800		0.150
					09/29/2011	1.300		0.150
					12/06/2011	1.200		0.150
					03/28/2012	2.100		0.150
					06/26/2012	1.800		0.150
					09/26/2012	0.980		0.150
	pH (field)	00400	STD	APW-1	12/14/2010	5.700	6.500	
					03/30/2011	6.170	6.500	
				APW-2	12/14/2010	5.620	6.500	
				APW-3	12/14/2010	5.500	6.500	
				APW-4	12/14/2010	5.600	6.500	
					03/31/2011	6.450	6.500	
					09/29/2011	6.400	6.500	
	SO4, diss	00946	mg/L	APW-3	12/14/2010	401.000		400.000
	TDS	00515		APW-1	12/14/2010	1,810.000		1,200.000
					09/26/2012	1,300.000		1,200.000

ENVIRONMENTAL CONSULTANTS

PHASE 1 HYDROGEOLOGIC ASSESSMENT REPORT

COAL COMBUSTION PRODUCT IMPOUNDMENT
GRAND TOWER ENERGY CENTER
JACKSON COUNTY, ILLINOIS

Project No. 2123

Prepared For:

AMEREN ENERGY GENERATING COMPANY

Prepared By:

Natural Resource Technology, Inc.
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March 19, 2013

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1 INTRODUCTION

1.1 Purpose

Ameren Energy Generating Company owns and operates the Grand Tower Energy Center in Jackson County, Illinois. The power station began operation in 1951 and formerly operated both coal- and oil-fired boilers, but converted to natural gas in 2001. The plant has one impoundment formerly used for coal combustion product (CCP) management and currently used for low volume wastewater (LVW) (Figure 1). To assess the potential for constituent migration from this impoundment as requested by the Agency in their correspondence dated May 15, 2009, Ameren commissioned a hydrogeologic study, water well survey, development of a groundwater monitoring plan, and an initial groundwater quality assessment.

The objectives of this report are to:

- Summarize hydrogeologic information pertinent to the site.
- Evaluate groundwater quality data to determine whether or not operation of the impoundment has adversely affected groundwater.
- Determine the potential for off-site migration and whether or not there are potential groundwater receptors in the event of a release.

2 SETTING

The information in this section incorporates material previously presented in the 2009 site characterization and groundwater monitoring plan developed by Rapps Engineering & Applied Services, and is included here for completeness.

2.1 Power Plant and CCP Impoundment

The Grand Tower Energy Center (GTEC) is located in Jackson County in southwestern Illinois, approximately 1 mile north of the town of Grand Tower (Figure 2). The plant is located on the floodplain on the east side of the Mississippi River adjacent to the levee. The GTEC has one impoundment, which straddles the boundary between Sections 13 and 14, Township 10 South, Range 4 West.

GTEC has produced electricity since 1951. The GTEC's sole CCP impoundment (also referred to as ash pond) covers 21.7 acres with a volume of approximately 157 acre-feet, and has a height of 22 feet. The impoundment formerly received bottom ash and fly ash from two coal-fired boilers (there were also two oil-fired boilers), but since the plant's conversion to natural gas in 2001 has received only low volume wastes and storm water from the plant. Historically, the CCP impoundment was constructed as separate bottom ash and fly ash impoundments with a shared intermediate berm, all constructed using native materials. However, sometime prior to 1976 it appears that the separate ponds may have been reconfigured into one pond by opening the shared berm.

The GTEC has an active NPDES permit for discharge to a tributary of the Mississippi River located to the south of the CCP impoundment.

2.2 Regional Geology

The GTEC is located in the Mississippi Valley, where Quaternary deposits consist of glacial outwash of the Henry Formation overlain by channel and floodplain deposits of the Cahokia Formation (Berg and Kempton, 1987; Lineback, 1979). The outwash constituting the Henry Formation is predominantly sand and gravel. Well logs suggest that the Henry Formation attains a maximum thickness of approximately 150 to 200 feet in vicinity of the GTEC. The Cahokia Formation consists of deposits in the floodplains and channels of modern rivers and streams, and is comprised of mostly poorly sorted sand, silt, and clay with wood and shell fragments, and local deposits of sandy gravel (Lineback, 1979). The upper part consists of overbank silts and clays, while the coarser-textured lower portion is mainly sandy channel and lateral accretion deposits.

The unlithified deposits are underlain by Mississippian age limestone, sandstone, and shale of the Upper Valmeyeran Series and the Upper and Lower Chesterian Series (Swann, 1963; Willman et al., 1967). Additional detail is provided in Appendix A.

2.3 Water Resources

2.3.1 Surface Water

The major surface water body in the vicinity of the GTEC is the Mississippi River, which flows from north to south and is located 150 to 350 feet west of the CCP impoundment. Other surface water bodies in the area include the Big Muddy River, which flows from northwest to southeast and is located approximately 4.5 miles east of the plant, and Tower Island Chute, a large oxbow lake approximately 3 miles south of the GTEC. In addition, minor streams and drainage channels cut across the valley floor in the area. These are either engineered structures or intermittent streams that drain into the Mississippi River and its tributaries.

2.3.2 Groundwater

Berg, Kempton, and Cartwright (1984) classified the area as AX (alluvium, a mixture of gravel, sand, silt, and clay along streams, variable in composition and thickness). Aquifers in southern Illinois have been classified as one of two main types: (1) unconsolidated sediments that are glacial or alluvial in origin and contain mostly sand and gravel deposits interbedded with clay and silt; and, (2) bedrock aquifers, primarily sandstone and fractured limestone, which vary widely in permeability (Roberts et al., 1957). The principal aquifer in the study area is the thick sand and gravel outwash deposits of the Henry Formation in the Mississippi Valley. Well logs indicate that high capacity wells with yields up to 1,100 gallons per minute (gpm) and specific capacities ranging from 40 to 90 gpm per foot of drawdown have been developed in this aquifer. Groundwater wells in adjacent upland areas are either shallow dug wells or drilled into bedrock to depths ranging from 100 to 500 feet. Most of these wells have low yields ranging from 5 to 10 gpm and specific capacities of up to 2 gpm per foot of drawdown (Ibid.).

2.3.3 Well Search

Public records were searched to identify water wells located within 2,500 feet of the CCP impoundment. The GTEC property boundary is located in Township 10 South, Range 4 West, and the unlined ash pond is located within Sections 13 and 14. The 2,500 foot boundary spans across Sections13, 14, 23, and 24. All wells within Sections 13, 14, 23, and 24 were searched. In addition, the search was expanded south to Sections 25 and 26 due to the hydrogeology of this site and occasional groundwater flow reversals as described in Section 4. Identified wells are shown on Figure 3 and tabulated in Appendix B.

The following sources of information were queried to identify water well locations.

- Illinois State Geological Survey's Illinois Water Well (ILWATER) Internet Map Service
- Illinois State Water Survey Domestic Well Database
- Illinois EPA's web-based Geographic Information System (GIS) files
- Illinois Department of Public Health
- Jackson County Health Department

Eleven water well records were identified within the six sections near the CCP impoundment, and are numbered 1 through 11 on Figure 3 and Appendix Table B-1. Wells 4 through 7 were not mapped due to insufficient location information provided from the ISWS database. These unmapped wells are owned by Ameren Energy and are likely industrial and commercial wells located on the GTEC property.

Three wells were identified as farm/domestic wells. The only one of these wells within 2,500 feet of the CCP impoundment (well number 1 on Figure 3) is on property currently owned by Ameren and there are no buildings in the vicinity of this location.

There are also two non-community water supply (NCWS) wells, well numbers 10 and 11, on the GTEC property (Figure 3). These wells are used for plant production water, rather than potable use. The GTEC obtains its potable water from the town of Grand Tower public water supply.

There are two community water supply (CWS) wells, well numbers 2 and 9, located in Section 25 in the town of Grand Tower. The IEPA database indicated that both CWS wells include a minimum setback zone (MSZ) of 200 radial feet and a Wellhead Protection Area (WHPA) of 1,000 radial feet (Figure 3).[1] These setback zones do not reach onto GTEC property. These wells are 1.3 miles from the CCP impoundment. The CWS wells were drilled to depths of 150 to 160 feet, where the available record indicates water is withdrawn from sand and gravel.

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[1] The Illinois Environmental Protection Act specifies a minimum setback zone of 200 feet around all CWS wells, and provides the option for well owners to establish a maximum zone and/or a wellhead protection area. Certain activities are regulated in these areas to reduce potential for contamination of groundwater withdrawn by the well.

3 MONITORING WELL INSTALLATION, DEVELOPMENT AND SAMPLING

3.1 Monitoring Well Installation and Development

Four monitoring wells (APW-1, APW-2, APW-3, and APW-4) were installed from October 9 to 15, 2010 (Figure 1) by Geotechnology, Inc. At each well location, subsurface borings were advanced with a rotary drill rig equipped with hollow-stem augers to facilitate soil classification. Soil was continuously sampled through the center of the hollow stem auger. Monitoring wells, constructed of 2” inside diameter schedule 40 PVC riser and screen, with steel above-ground well covers, were installed at each location to monitor groundwater within the uppermost water bearing unit adjacent to the impoundment. The wells were constructed consistent with monitoring well construction standards per IAC Title 35, Section 811.318. Drilling and sampling equipment was decontaminated before sampling and between sample locations to prevent cross contamination. The monitoring wells were surveyed by a licensed surveyor.

Monitoring well construction and survey data are summarized in Table 1. Boring logs and well diagrams are included in Appendix D. Boring depths were between 56 and 57.5 feet below ground surface (bgs). All four borings were logged to a depth of 40 feet; however, logging was discontinued below 40 feet due to the heaving sands intercepted at all of the boring locations. A cross-sectional view of the four monitoring wells showing ground surface and well screen elevations is provided in Figure 4.

Monitoring wells were developed from November 8 to 18, 2010 by surging and pumping a minimum of five well volumes and until specific conductivity stabilized or the wells were pumped dry. The depth to groundwater was measured in each monitoring well using an electronic water level indicator. Groundwater levels ranged from approximately 23.2 to 28.0 feet bgs at the time of well installation.

3.2 Groundwater Sampling and Chemical Analysis

The monitoring wells were sampled during eight consecutive quarterly monitoring events from November 2010 through August 2012 in order to establish a statistical baseline for groundwater quality. The monitoring wells were purged and sampled for the first quarterly sampling event on November 29, 2010 using disposable bailers. Each monitoring well was purged until three well volumes were removed. Water quality parameters including pH, specific conductivity, and temperature were monitored in the field. Groundwater depths ranged from 19.5 feet to 22.1 feet bgs in the four wells. Table 2 presents the groundwater depths and elevations.

Water samples were field filtered and preserved for all parameters (both general chemistry and metals) with the exception of cyanide. Sample containers were labeled, placed in an ice-filled cooler, and transported using standard chain-of-custody procedures. Groundwater sampling was performed by Geotechnology, Inc. and sample analyses were performed by Accutest Laboratories located in Marlborough, MA. All eight rounds of groundwater samples were analyzed for the inorganic constituents listed under Title 35, 620.410 with the exception of radium 226 and 228. Table 3 lists the field, general chemistry, and metal parameters monitored during the eight quarters of baseline sampling along with the analytical methods.

4 SITE HYDROGEOLOGY

4.1 Lithology

The information used to describe site hydrogeology is based on the local geology obtained from published sources as presented in Section 2.2 and Appendix A and boring data collected at the four monitoring well locations APW-1 through APW-4. The four borings ranged from 56 to 57.5 feet bgs and were advanced through the following unlithified materials in descending order:

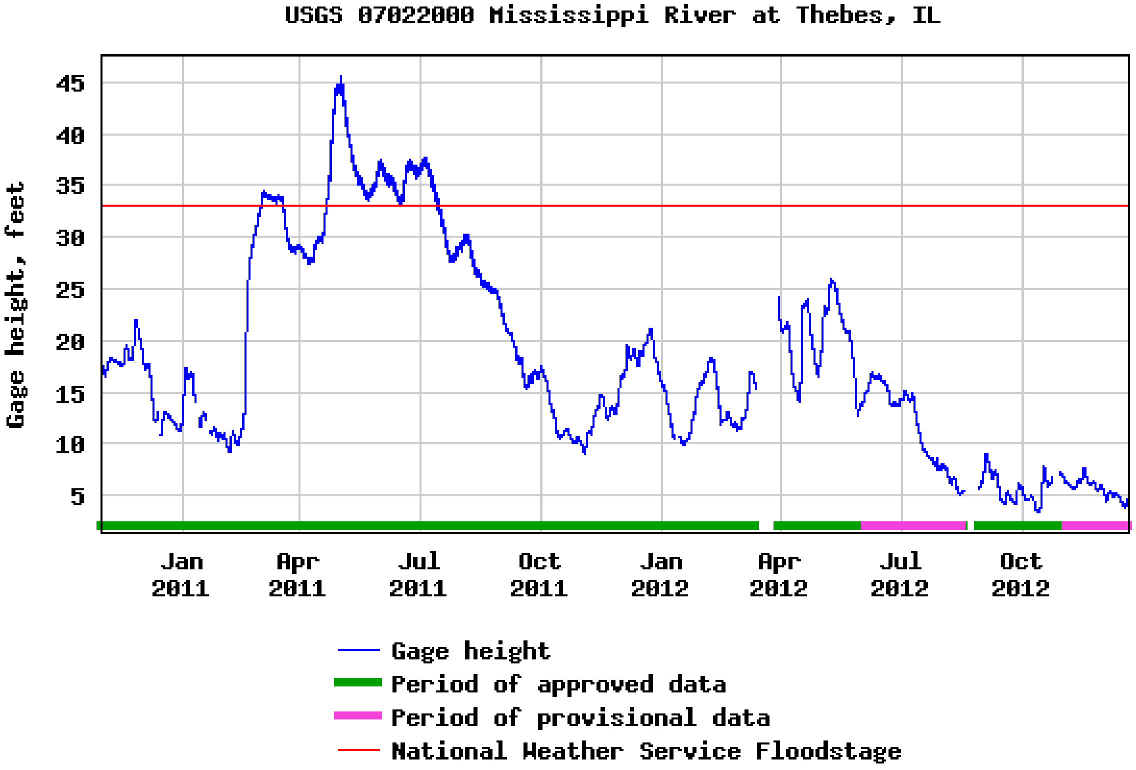
- 4.5 to 8 feet of fill, consisting of silty clay and some sand. Borings APW-2 and APW-3 also had some crushed rock within the fill material.
- 11.5 to 17.5 feet of predominantly clay, silty clay, clayey silt, and sandy silt between depths of 4.5 and 19 feet bgs. Boring APW-1 had a one foot thick layer of silty sand at 6.5 to 7.5 feet bgs within this zone, and boring APW-2 had a five foot layer of silty fine sand and fine sand at 9.5 to 14.5 feet bgs within this zone.
- 6 to 10.5 feet of sandy silt between depths of 16 and 32 feet bgs. Boring APW-4 also had occasional layers of clay and silty fine sand within this predominantly silt zone.
- Greater than 35 feet of fine to coarse sand with occasional layers of sandy silt and traces of gravel. The upper depth of this sand zone ranges from 22 to 32 feet bgs, and lower depth is below 58 feet bgs.

The uppermost water-bearing unit intercepted below the fill material in the area of the CCP impoundment is the Cahokia Formation. Based on the boring data, the Cahokia Formation consists of clay, silty clay, clayey silt, and some fine sand within its upper portion and predominantly sandy silt with some silty fine sand within its lower portion. The Cahokia Formation has a thickness ranging from 17.5 to 26.5 feet at the four boring locations around the impoundment.

Beneath the alluvial deposits of the Cahokia Formation are the outwash sands of the Henry Formation, which is the predominant water-bearing unit and aquifer in the vicinity of the GTEC. The Henry Formation was only logged to a depth of 40 feet bgs due to heaving sands, but the fine to coarse sands were drilled to a depth of approximately 58 feet bgs. The top of the Henry Formation sands were intercepted as shallow as 22 feet bgs at boring APW-3 to the south of the impoundment and as deep as 32 feet bgs at boring APW-1 to the north of the impoundment. All four monitoring wells were screened within the Henry Formation at depths between 45 and 58 feet bgs.

4.2 Groundwater Flow

Groundwater elevation data (potentiometric levels) were collected for the four monitoring wells installed within the sands of the Henry Formation. Groundwater depths and elevations for the eight quarterly monitoring events are provided in Table 2 and graphically illustrated on time-series plots in Figure 5. Groundwater depths ranged from 2.8 to 32.7 feet bgs from November 2010 through August 2012. The shallowest groundwater depths in the four wells, ranging from 2.8 to 4.9 feet bgs, were observed in June 2011. During this period the USGS Gaging Station on the Mississippi River at Thebes, Illinois (Station #07022000), the nearest station located downstream from the GTEC, recorded gage heights above the floodstage (see graph below). The deepest groundwater depths, ranging from 30.8 to 32.7 feet bgs, were observed in August 2012. During this period the gage height at the Thebes Station was below 10 feet and reached below 5 feet during September 2012. The time-series of groundwater elevations from November 2010 through August 2012 (Figure 5) illustrates that the highest groundwater elevations (i.e., shallowest) occurred in March 2011 and June 2011 and the lowest groundwater elevations (i.e., deepest) occurred in November 2011, February 2012, and August 2012.



During individual sample events, the highest groundwater elevations were recorded in APW-2, the closest monitoring well to the Mississippi River, during November 2010, March and June 2011, and February and May 2012 (Table 2), indicating groundwater flow away from the river at the time of these five measurements. The highest groundwater elevations were recorded in APW-4, the farthest well from the river, at the time of the other three measurements, indicating groundwater flow toward the river at these times. Potentiometric maps prepared using the June 2011 (Figure 6) and August 2012 (Figure 7) groundwater elevation data demonstrate groundwater flow near the CCP impoundment during the periods of maximum and minimum groundwater levels observed over the eight quarters of monitoring. Groundwater flow direction during June 2011 (Figure 6) was west to east away from the river at a very low gradient of 0.0006 (Appendix G), reflecting a period of above normal precipitation within the river basin, high river stage, and high groundwater elevations. Conversely, groundwater flow direction during August 2012 was east to west towards the river at a very low gradient of 0.0006 (Appendix G), reflecting a period of drought within the river basin with very low river stage and low groundwater elevations. The difference in groundwater elevations between measurement points was small (less than 2 feet) during each of the eight sample events, indicating that hydraulic gradients were low (0.0002 to 0.0018; Appendix G) throughout the monitoring period, regardless of flow direction.

Excluding a portion of the levee that is not owned by Ameren, the CCP impoundment is more than 200 feet from the closest property boundary, which is to the southeast (Figure 1); a direction that would normally be considered upgradient because groundwater typically flows toward major water bodies such as the Mississippi River). However, flow reversals frequently occurred during the monitoring period, and the impoundment is underlain by a transmissive sand and gravel aquifer. These observations suggest that there is potential for off-site migration, in the event of a release, if flow reversals occur over sufficiently long periods for groundwater to migrate from the impoundment toward the property boundary.

4.3 Potential For Groundwater Receptors

A potential groundwater receptor is a water supply well located in a position that can be interpreted as downgradient from the CCP impoundment, and screened within a geologic formation that can reasonably be expected to be a groundwater migration pathway in the event of a release.

Figure 3 shows water wells located within the vicinity of the CCP impoundment. As described in Section 2.3.3, there are no active water supply wells within 2,500 of the CCP impoundment other than plant production wells that are not used for potable water supply. The closest mapped water supply wells are 1.3 miles to the south, and provide the community water supply for the town of Grand Tower.

As noted in Section 4.2, there is potential for off-site migration to the southeast of the CCP impoundment if groundwater flow reversals occur for sufficiently long periods of time. There is currently insufficient data to establish whether or not such flow reversals occur. However, if there is potential for off-site migration to the southeast, then there is also potential for migration toward the Grand Tower CWS wells; although the potential for migration to the CWS wells will be lower than the potential for off-site migration due to the relatively large (for groundwater flow) distance from the CCP impoundment to the CWS wells.

5 GROUNDWATER CHEMISTRY

5.1 Overview

The purpose of the sampling and inorganic analysis of groundwater from monitoring wells at the GTEC CCP impoundment was to assess background and downgradient groundwater quality; to evaluate elevated concentrations and those exceeding groundwater standards; and to identify primary factors potentially influencing groundwater quality changes spatially and temporally.

All of the groundwater quality data collected and analyzed for both field and laboratory parameters, including the full list of inorganic constituents listed in IAC 35 Part 620 Section 410 except for radium 224/226, are provided in Appendix E for the eight quarters of monitoring conducted from November 2010 through August 2012 for the four monitoring wells APW-1, APW-2, APW-3, and APW-4.

A statistical summary of all of the water quality data at each of the four monitoring wells is provided in Table 4, including the mean, median, maximum, minimum, standard deviation, and percent non-detects. Based on low concentrations of coal ash indicator constituents, boron and sulfate, monitoring well APW-1, located to the northeast of the impoundment, is regarded as representing background groundwater quality, and APW-2, APW-3, and APW-4 characterize groundwater quality downgradient from the CCP impoundment.

Since the monitored unit at the CCP impoundment is the Henry Formation, which consists of thick sand deposits, the applicable groundwater standard is Class I. Constituents with exceedances of Class I groundwater standards are highlighted in Table 4.

5.2 Comparison of Groundwater Quality to Class I Standards

A listing of all exceedances of Class I groundwater quality standards, sorted by constituent, well location, and sample date, is provided in Appendix F. Constituents with exceedances are also highlighted in Table 4. Exceedances in groundwater based on the eight quarters of monitoring from November 2010 through August 2012 are sulfate, TDS, boron, iron, and manganese. These constituents exceeded their respective Class I groundwater standards as follows:

■ pH:	APW-1 (4 of 8 samples), APW-2 (1 of 8), APW-3 (1 of 8), APW-4 (1 of 8)
■ Sulfate:	APW-2 (4 of 8)
■ TDS:	APW-1 (1 of 8)

■ Boron:	APW-2 (8 of 8), APW-3 (8 of 8), APW-4 (8 of 8)
■ Iron:	APW-2 (4 of 8)
■ Manganese:	APW-2 (7 of 8), APW-3 (8 of 8), APW-4 (2 of 8)

Furthermore, the first two arsenic samples at monitoring well APW-2 exceeded the Class I arsenic standard that went into effect in October 2012; however, the results were in compliance with the arsenic standard at the time of sampling.

Values for pH at all monitoring wells were lower than the 6.5 standard in the first monitoring event. These site wide low values were most likely caused by systematic error due to instrument calibration or non-stabilized groundwater geochemistry at the time of sampling. There were no other values lower than 6.5 at APW-2, APW-3, and APW-4, while pH was lower than 6.5 in three of the subsequent seven quarterly monitoring events at APW-1. Coal ash leachate tends to be alkaline and is therefore not a source of low pH.

As noted in Section 5.3 below, the single TDS exceedance in APW-1 appears to be anomalous, and the iron and manganese concentrations are not associated with the CCP impoundment. However, the likely source of the boron and sulfate exceedances is leachate released from the CCP impoundment.

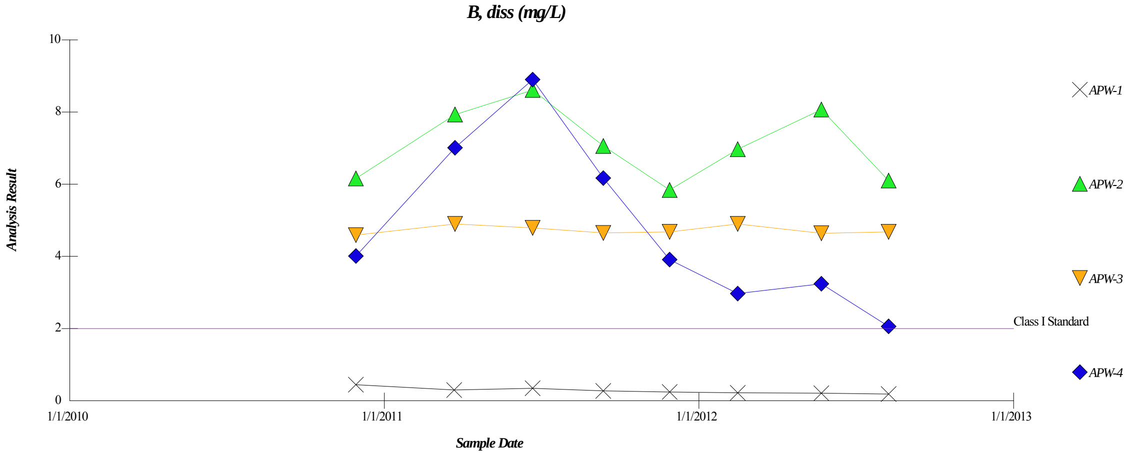
5.3 Groundwater Quality Analysis

5.3.1 Primary Coal Ash Leachate Indicators

Boron and sulfate are the primary indicator constituents for coal ash leachate. Median boron and sulfate concentrations in all downgradient monitoring wells (APW-2, APW-3, and APW-4) were higher than concentrations in background well APW-1.

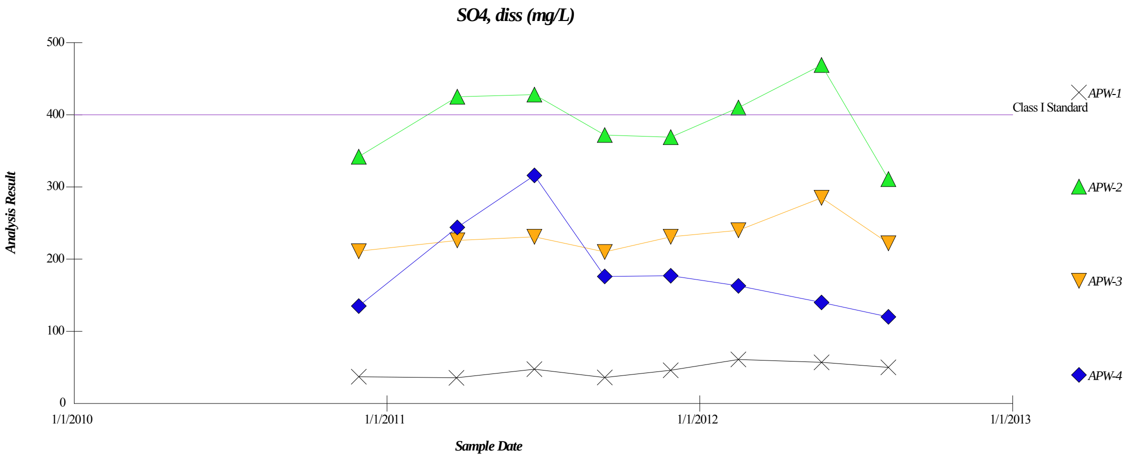
	Median Concentration	
Well No.	**Boron mg/L**	**Sulfate mg/L**
APW-1	0.26	47
APW-2	7.0	391
APW-3	4.7	229
APW-4	4.0	170
IL Class I Standard	*2.0*	*400*

Downgradient monitoring well APW-2 had the highest boron concentrations observed in the vicinity of the impoundment, with concentrations ranging from 5.8 to 8.6 mg/L. This well is located between the impoundment and the Mississippi River and is in the predominant direction of groundwater flow, westward from the impoundment (Figure 6), during periods of normal or low river stage. Monitoring well APW-3, located south of the impoundment, had boron concentrations ranging from 4.6 to 4.9 mg/L. Monitoring well APW-4, located east of the impoundment, had boron concentrations ranging from 2.1 to 8.9 mg/L. The maximum observed boron concentration of 8.9 mg/L (Table 4; Appendix E) occurred during the period of highest groundwater elevation and highest river stage over the eight quarters of monitoring, during which groundwater flow direction in the vicinity of the impoundment was west to east (Figure 7). The minimum observed boron concentration of 2.06 mg/L occurred during the period of lowest groundwater elevation and low river stage, during which groundwater flow direction was east to west (Figure 6). As shown in the graph below, concentration trends were flat during the sample period.



Graph showing boron concentrations as a function of time.

Similar to the distribution of boron in groundwater, well APW-2 had the highest sulfate concentrations, ranging from 311 to 469 mg/L. Well APW-3 had the lowest range of sulfate concentrations of the three downgradient wells, ranging from 210 to 285 mg/L. Well APW-4 had the widest range of sulfate concentrations, 120 to 316 mg/L, directly related to the reversal of groundwater flow directions from west to east during low and high river stages, respectively. As shown in the graph below, concentration trends were flat during the sample period.



Graph showing sulfate concentrations as a function of time.

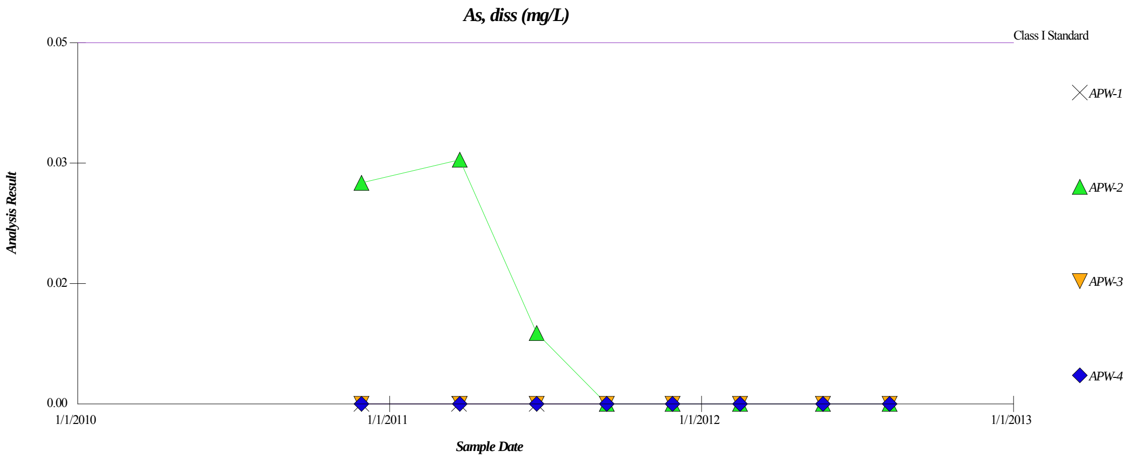
5.3.2 Other Constituents Potentially Impacted by Coal Ash Leachate

Several constituents had higher concentrations in one or more downgradient monitoring well samples than in samples from background well APW-1.

Well No.	**Median Concentrations**				
	Arsenic mg/L	**Barium mg/L**	**Chloride mg/L**	**Selenium mg/L**	**TDS mg/L**
APW-1	<0.025	0.14	2.0	<0.05	275
APW-2	<0.025	0.31	22	<0.05	829
APW-3	<0.025	0.076	19	<0.05	457
APW-4	<0.025	0.16	10	0.05	568
IL Class I Standard	*0.05**	*2.0*	*200*	*0.05*	*1200*

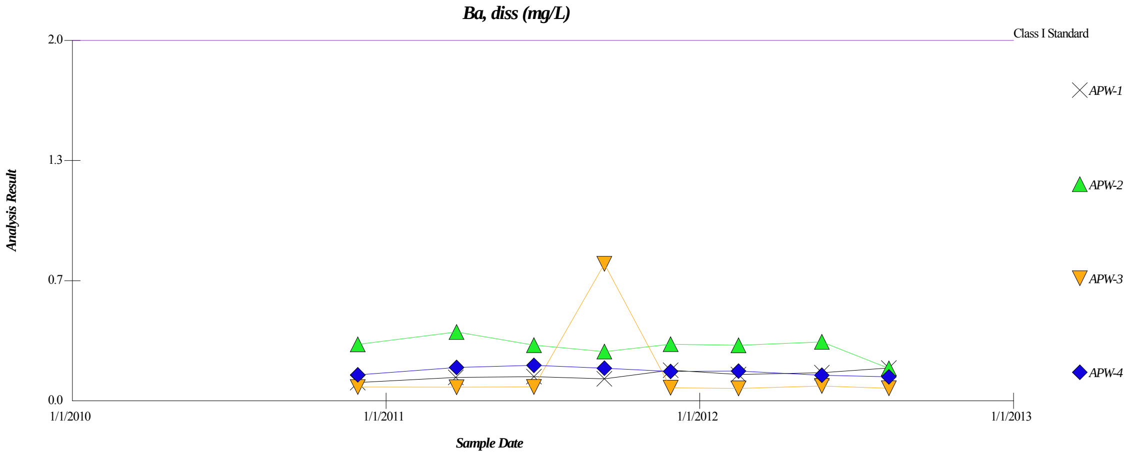
* Class I standard for arsenic at the time the samples were collected.

Arsenic concentrations were below the detection limit in all samples from background well APW-1 and downgradient monitoring wells APW-3 and APW-4. However, downgradient well APW-2 had arsenic concentrations of 0.031, 0.034 and 0.010 in the first three quarterly monitoring events (See graph below and Appendix E) followed by five consecutive quarters of arsenic concentrations below the detection limit of 0.025 mg/L. Decreasing concentration trends such as this typically indicate a geochemical disequilibrium caused by installation of the monitoring well; however, no other constituents exhibited a similar decreasing trend over time at APW-2 as might be expected with disequilibrium, so coal ash leachate cannot be ruled out as the source of the observed arsenic concentrations.



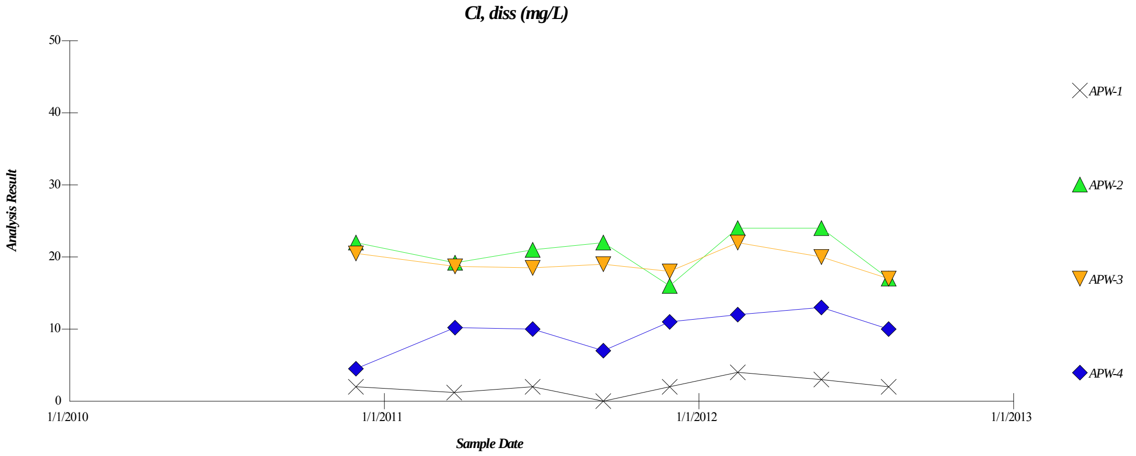
Graph showing arsenic concentrations as a function of time. Non-detects are plotted as zero.

Barium concentrations at APW-2 were slightly higher than background (APW-1), while concentrations at APW-3 and APW-4 were similar to or lower than background. A maximum concentration of 0.76 mg/L at well APW-3 occurred during the September 2011 monitoring event, but appears to be an outlier given that the other seven barium concentrations at that well ranged from 0.069 to 0.083 mg/L (see graph below). APW-2 has the highest concentrations of coal ash leachate indicator constituents; therefore, it is possible that the high barium concentrations relative to background (but lower than the Class I standard) observed in this monitoring well are also associated with coal ash leachate.



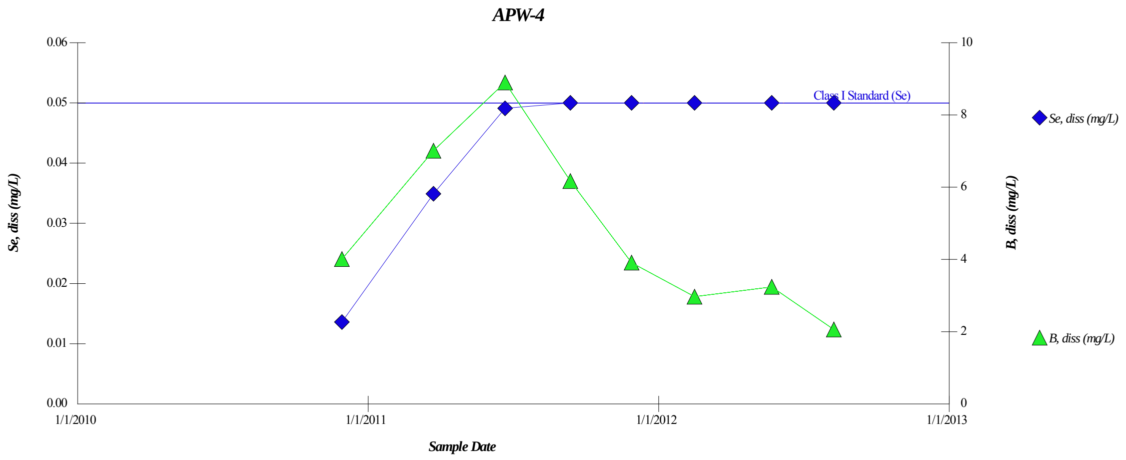
Graph showing barium concentrations as a function of time. The concentration spike for APW-3 in September 2011 is interpreted as an anomalous data value.

Median chloride concentrations in the three downgradient wells ranged from 10 to 22 mg/L compared to 2 mg/L in background well APW-1. The highest chloride concentrations occurred at wells APW-2 and APW-3, with maximum concentrations of 24 and 22 mg/L, respectively. These wells are distant from roads and other potential chloride sources, leading to the conclusion that the difference in concentration between background and downgradient is associated with the CCP impoundment. Chloride concentrations monitored in downgradient groundwater are low compared to the Class I standard of 200 mg/L.



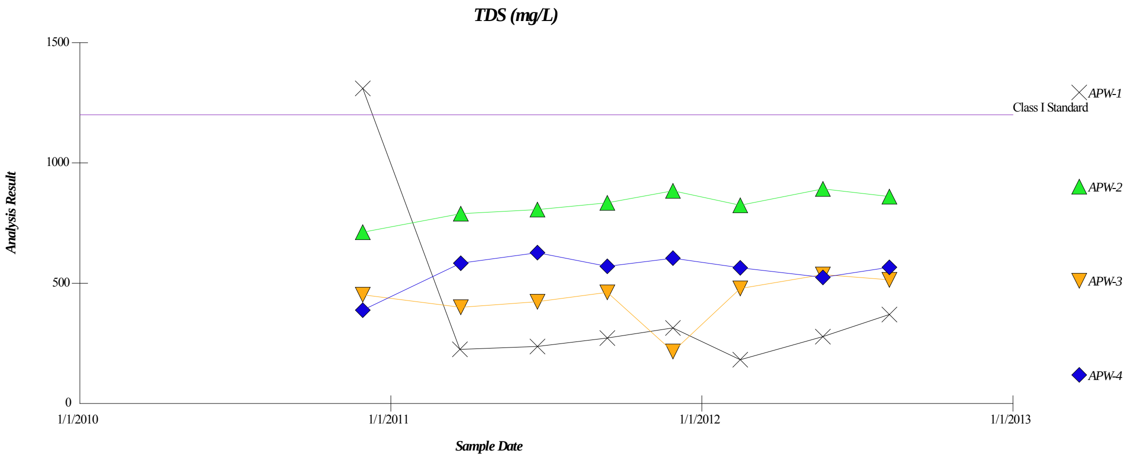
Graph showing chloride concentrations as a function of time. The Y axis is zoomed for clarity.

Selenium concentrations were below the detection limit in all eight sample events at APW-1, APW-2, and APW-3. Monitoring well APW-4 had detected selenium concentrations ranging from 0.014 to 0.050 mg/L during the first four sample events. These selenium concentrations increased with boron concentrations at APW-4, potentially suggesting a coal ash source; however, the reporting limit for selenium changed to 0.05 mg/L in November 2011, and it is not possible to determine if the similar trends continued after the first four sample events. As a result, it cannot be determined if the initial similarity was a correlation or coincidence.



Graph comparing selenium and boron concentrations as a function of time. Red-circled values are non-detects plotted at the reporting limit.

TDS is the sum of all dissolved constituents in water, and is largely based on the concentrations of major ions. Background monitoring well APW-1 had one TDS concentration of 1,310 mg/L during the first monitoring event in November 2010; however, there are no correspondingly high concentrations for other monitored constituents to explain this TDS concentration, and subsequent TDS concentrations during the next seven quarterly monitoring events ranged from 182 to 370 mg/L. These observations indicate that the November 2010 TDS concentration of 1,310 mg/L is anomalous, possibly due to the short period (less than two weeks) between well development and the first sampling event, or possibly due to a laboratory or recording error. Median TDS concentrations in downgradient monitoring wells APW-2, APW-3, and APW-4 were higher than background, and are largely a result of sulfate and a corresponding major cation that was not monitored.



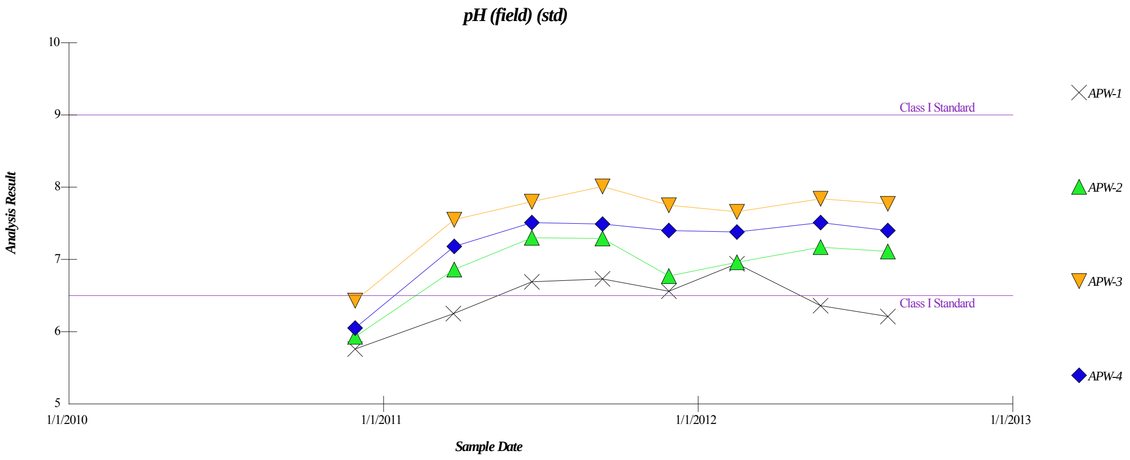
Graph showing total dissolved solids concentrations as a function of time. The concentration spike for APW-1 in November 2010 is interpreted as an anomalous data value.

5.3.3 Constituents with Elevated Concentrations Due to Causes Other than Coal Ash Leachate

As described below, observed iron and manganese concentrations are not associated with the CCP impoundment, nor are pH values.

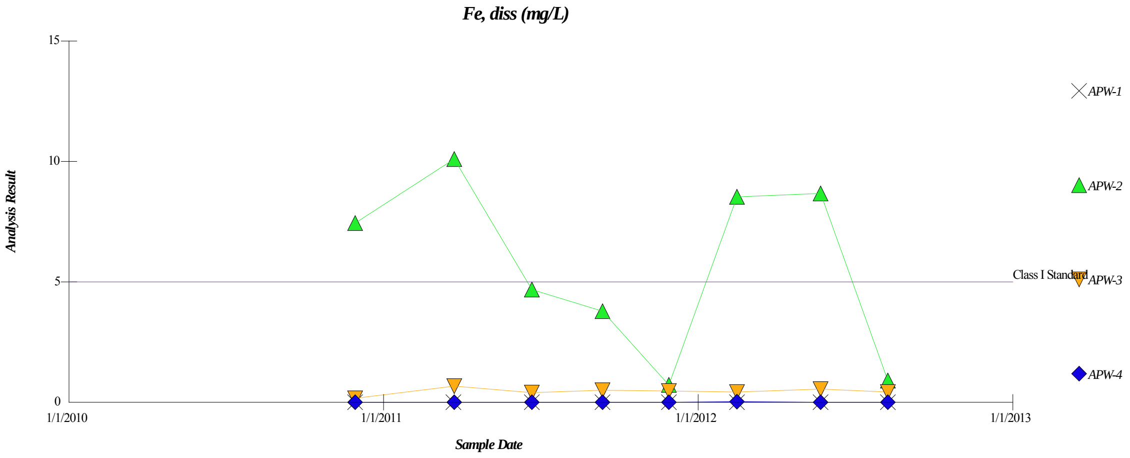
Well No.	**Median Concentrations**		
	Iron mg/L	**Manganese mg/L**	**pH SU**
APW-1	<0.10	<0.006	6.46
APW-2	6.1	0.66	7.04
APW-3	0.45	0.28	7.76
APW-4	<0.10	0.10	7.40
IL Class I Standard	*5.0*	*0.15*	*<6.5, >9.0*

All of the lowest pH readings at the four monitoring wells, ranging from 5.76 to 6.43, occurred in the first quarter sampling event. No similarly low pH readings were observed in the subsequent seven quarters of monitoring. Given this observation, it appears that the field instrumentation used to measure the pH was not calibrated accurately, leading to a systematic error of low pH readings in all of the groundwater samples in November 2010. An alternative explanation to account for the low pH readings is that the groundwater was not stabilized from the drilling and well installation.



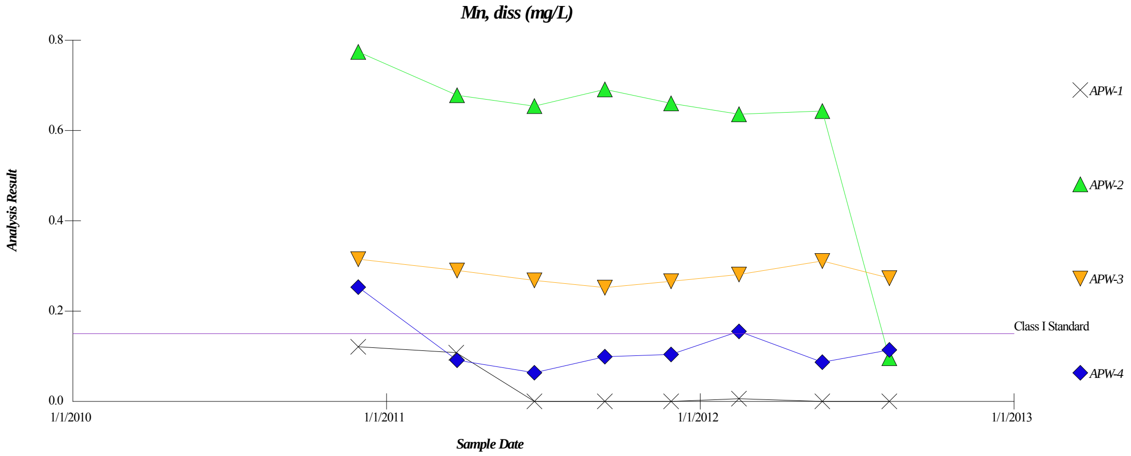
Graph showing pH as a function of time.

Iron concentrations were higher than background in APW-2 and APW-3, but not in APW-4.Iron concentrations were relatively low at well APW-3 to the south of the impoundment, with concentrations ranging from 0.16 to 0.67 mg/L. Conversely, downgradient monitoring well APW-2, located between the impoundment and the river, had iron concentrations ranging from 0.72 to 10.1 mg/L with a median concentration of 6.1 mg/L.



Graph showing iron concentrations as a function of time. Non-detects are plotted as zero.

Manganese concentrations were higher in all three downgradient monitoring wells than in the background well. Background well APW-1 had a median manganese concentration of 0.006 mg/L with five of eight groundwater samples below the detection limit of 0.005 mg/L. Downgradient wells APW-2 through APW-4 had median concentrations ranging from 0.10 to 0.66 mg/L with all concentrations above the detection limit. The highest downgradient manganese concentrations were observed in groundwater at well APW-2, the closest well to the Mississippi River, with concentrations ranging from 0.10 to 0.77 mg/L. The lowest downgradient concentrations were observed at well APW-4, the farthest well from the river, ranging from 0.06 to 0.25 mg/L.



Graph showing manganese concentrations as a function of time. Non-detects are plotted as zero.

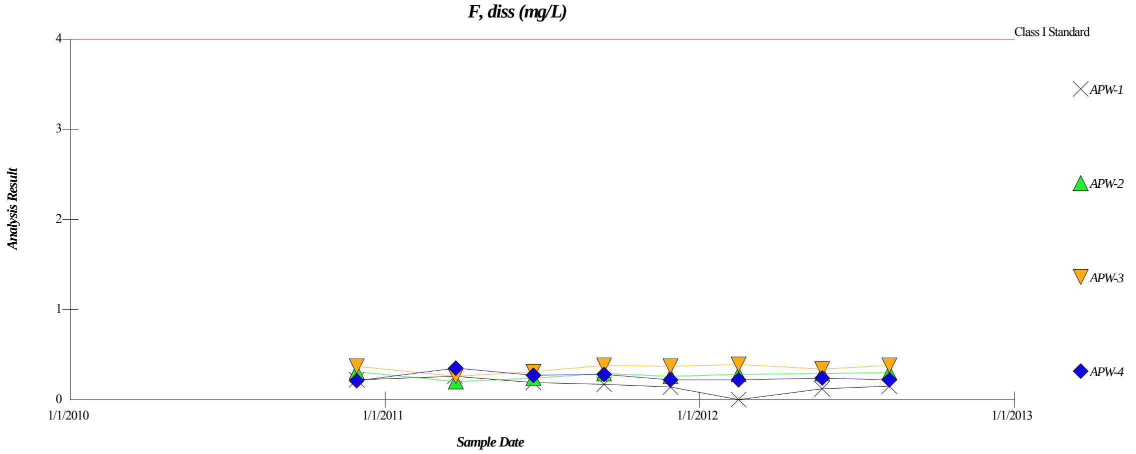
The iron and manganese concentrations observed in the four monitoring wells appear to be correlated, with highest concentrations occurring nearest to the river (APW-2) and lowest concentrations occurring distant from the river (APW-1 and APW-4). This relationship between iron and manganese concentration and proximity to the river is consistent with naturally occurring iron and manganese concentrations observed at other CCP impoundments in Illinois. Furthermore, the boring log for APW-1 lists the geologic materials encountered as brown (Appendix C), which is indicative of an oxic geochemical environment. The thickness of materials described as grey, which is indicative of a reduced geochemical environment, increases with the least grey material encountered at APW-4, next highest percentage at APW-3, and most grey material encountered at APW-2. Iron and manganese are soluble under reduced geochemical environments, and the concentrations of iron and manganese correlate with the thickness of grey geologic materials listed on the boring logs, again suggesting that the concentrations are naturally occurring.

5.3.4 Constituents with Concentrations Near or Below Background

Fluoride and nitrate concentrations in the downgradient monitoring wells were similar to or lower than concentrations in background well APW-1.

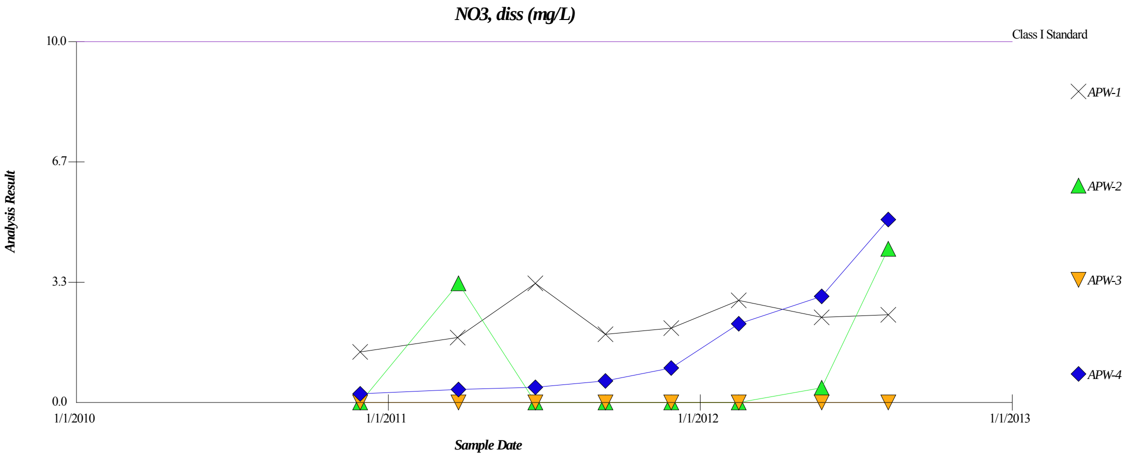
Well No.	Median Concentrations	
	Fluoride mg/L	**Nitrate mg/L**
APW-1	0.29	2.2
APW-2	0.29	0.080
APW-3	0.37	<0.050
APW-4	0.23	0.78
IL Class I Standard	*4*	*10*

Median fluoride concentrations in the downgradient wells ranged from 0.23 to 0.37 mg/L versus a background median (well APW-1) of 0.29 mg/L.



Graph showing fluoride concentrations as a function of time. Non-detects are plotted as zero.

Nitrate concentrations in the groundwater samples were variable both spatially and temporally. Some of the highest nitrate concentrations occurred at background well APW-1, with a range of 1.4 to 3.3 mg/L and median of 2.2 mg/L. Similarly high concentrations occurred at well APW-4, with nitrate ranging from 0.24 to 5.1 mg/L and median of 0.78 mg/L. Conversely, monitoring wells APW-2 and APW-3 had a high percentage of samples below the detection limit, 62.5 and 100 percent non-detects, respectively. However, APW-2 had a high level of variability in nitrate concentrations, ranging from below the detection limit to a maximum concentration of 4.3 mg/L during the final sample event in August 2012. The source of the nitrate is likely agricultural fields immediately east of the CCP impoundment.



Graph showing nitrate concentrations as a function of time. Non-detects are plotted as zero.

5.3.5 Constituents That Were Rarely or Not Detected

The following constituents had concentrations below their respective reporting limits in all samples: antimony, beryllium, cadmium, chromium, cobalt, copper, cyanide, lead, mercury, nickel, silver, and thallium. Zinc concentrations were below the reporting limit in six to seven of the eight sample events, with a maximum concentration of 0.053 mg/L at APW-2 during the first sample event in November 2010.

5.4 Boron Loading to the Mississippi River

The ultimate destination for groundwater in this region is the Mississippi River. A mixing calculation was performed to conservatively estimate the impact of boron discharge to the river on concentrations in river water. The loading rate was calculated by multiplying the volume of groundwater flowing into the river by the concentration of boron in the groundwater.

L = C * Q and

Q = K * I * A

Where

C = boron concentration in groundwater. To be conservative, the highest single boron concentration in groundwater monitoring wells at the site was used in this calculation (Cmax), rather than an average or a median.

Q = the volume of groundwater discharging to the river.

K =the hydraulic conductivity of the aquifer. Site-specific data are not available. As a surrogate, data from Ameren's Venice Ash Ponds 2 and 3 were used. The Venice ponds are in a hydrogeologically similar position as Grand Tower. Specifically, both are situated close to the Mississippi River, and both overlie a geologic sequence of fine-grained overbank deposits over coarse-grained glacial outwash that fills the valley.

I = the maximum hydraulic gradient for the site when groundwater flow was toward the river.

A = the cross-sectional area through which this groundwater discharge to the river occurs. To be conservative, it was assumed that the maximum concentration (Cmax) occurred over the entire thickness of the aquifer, and along the entire length of the CCP impoundment parallel to the river, plus 500 feet north and south of the impoundment. In reality, concentration will decrease with depth in the aquifer and with distance north and south of the impoundment.

The loading rate (L) was then divided by the 7-day 10-year low flow ($Q_{7,10}$) at Chester, IL (approximately 27 river miles north of Grand Tower) to estimate the incremental boron concentration increase (d_B) in the river due to discharge from the Grand Tower CCP impoundment. Due to the size of the Mississippi River, it is unlikely that concentration would initially be distributed across the entire width of the river. Therefore, an additional calculation was performed to calculate the incremental boron increase assuming that mixing occurred within 50 feet of the shoreline. This calculation was performed by multiplying d_B by 2,300/50 (2,300 feet being total river width and 50 feet being the assumed mixing width).

The result of this calculation (Appendix F) is a very conservative estimate of the increase in boron loading to the Mississippi River. This result (0.0002 mg/L) is lower than the instrument detection limit for boron as listed by the United States Environmental Protection Agency in method SW-846, 6010c, and is therefore not measurable.

6 CONCLUSIONS

6.1 Conclusions

The primary conclusion from voluntary monitoring of groundwater at the Grand Tower CCP impoundment is that operation of the impoundment has caused exceedances of Class I groundwater quality standards for boron and sulfate. The Class I standards for manganese and iron are also exceeded in places, although these concentrations are attributed to naturally occurring causes. Exceedances of Class I standards for pH and TDS are also not related to CCP impoundment operation. Furthermore:

- The surficial lithologic unit at the site consists of fine-grained alluvium; CCP indicator constituent concentrations in underlying groundwater indicate that there is a vertical migration pathway through the surficial deposits.
- Groundwater flow at the site is dependent on Mississippi River stage. Flow is inland during periods of high stage, and toward the river during periods of low stage.
- Due to occasional groundwater flow reversals, there is potential for off-site migration toward the closest property boundary southeast of the CCP impoundment. This potential for off-site migration during groundwater flow reversals also suggests that the town of Grand Tower community water supply wells cannot be ruled out as potential receptors; although this would be a large distance (1.3 miles) for groundwater to migrate from the CCP impoundment.
- Arsenic and barium had elevated concentrations relative to background in APW-2, a monitoring well between the impoundment and the river; and selenium had elevated concentrations in APW-4, which is located west of (inland from) the impoundment. The barium and selenium concentrations were lower than Class I groundwater quality standards, and the arsenic concentrations were lower than the Class I standard in effect at the time of sampling, although the first two arsenic samples had concentrations that would be higher than the standard that went into effect in October 2012. Chloride and TDS also have downgradient concentrations that, while lower than Class I standards, appear to reflect impacts from the CCP impoundment.
- A conservative estimate of boron loading to the Mississippi River suggests that the incremental boron concentration increase in the river caused by leachate released from the CCP impoundment is not measurable.

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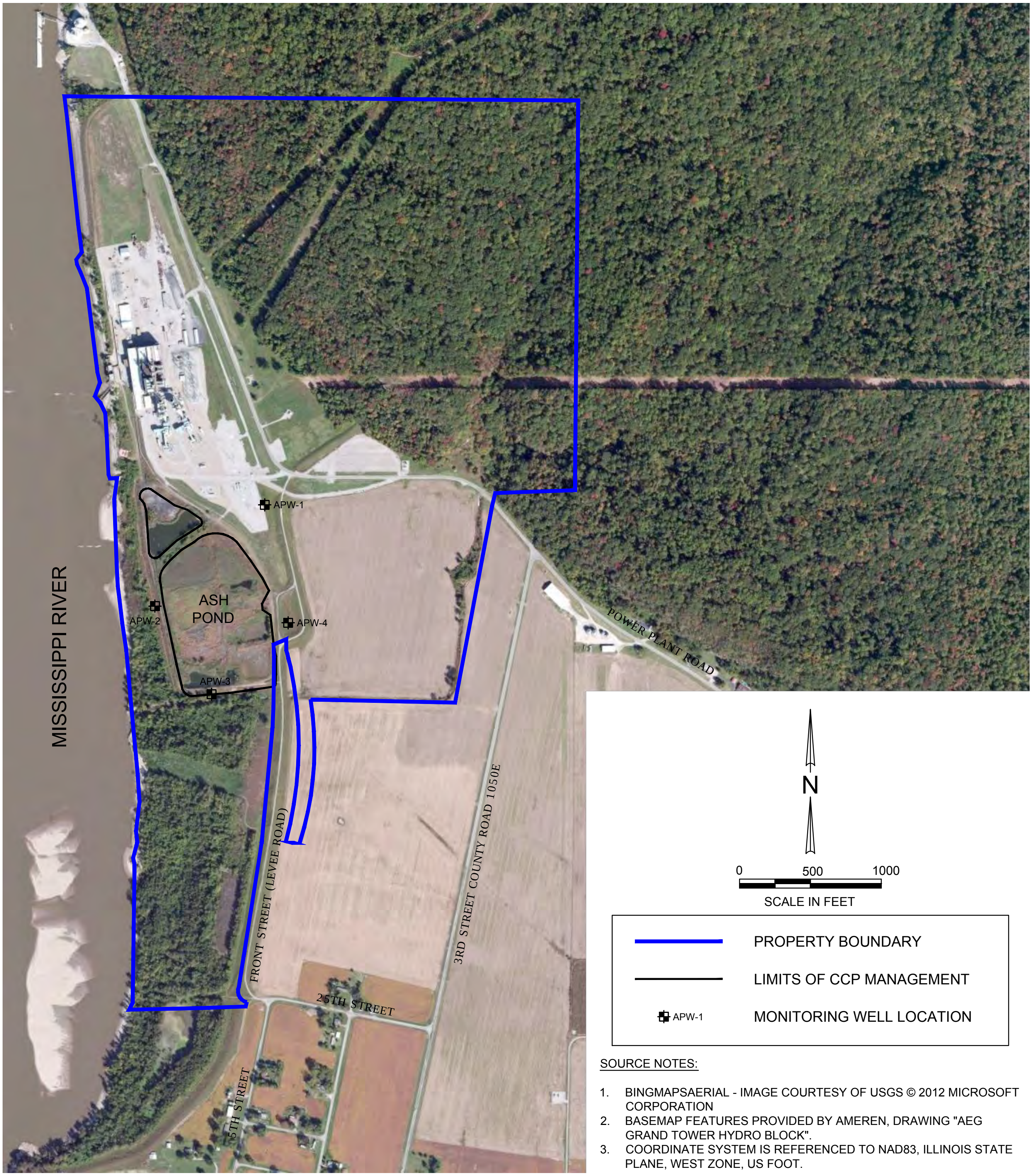
FIGURES



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SITE OVERVIEW MAP

NATURAL
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PHASE 1 HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
GRAND TOWER ENERGY CENTER
JACKSON COUNTY, ILLINOIS

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

PROJECT NO.
2123/2.0

DRAWING NO.
2123-2-A01C-SITE OVER

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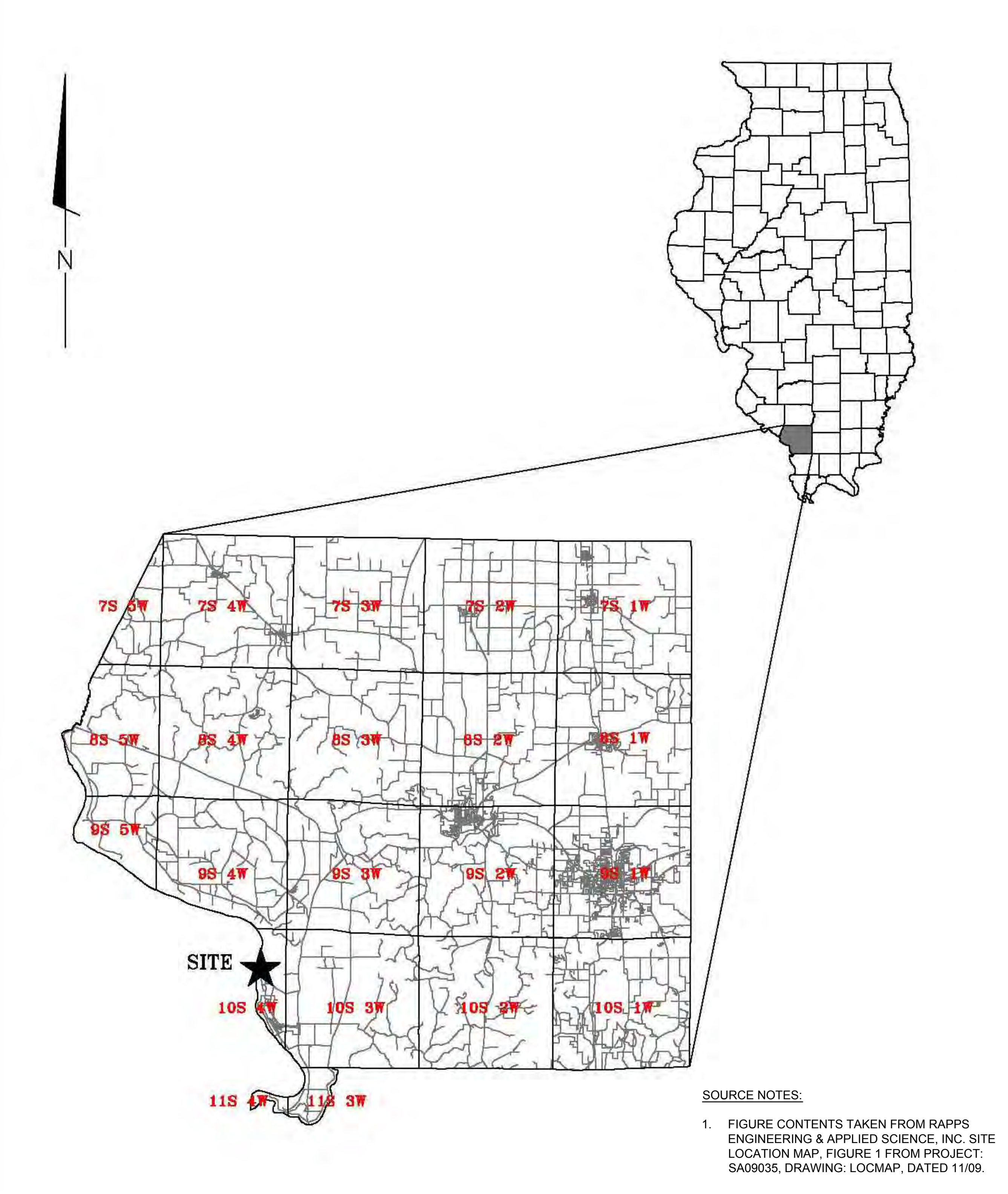

SOURCE NOTES:

1. FIGURE CONTENTS TAKEN FROM RAPPS ENGINEERING & APPLIED SCIENCE, INC. SITE LOCATION MAP, FIGURE 1 FROM PROJECT: SA09035, DRAWING: LOCMAP, DATED 11/09.

SITE LOCATION MAP

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PHASE 1 HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
GRAND TOWER ENERGY CENTER
JACKSON COUNTY, ILLINOIS

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2123/2.0

DRAWING NO.
2123-2-A02C-SITE LOC

FIGURE NO.
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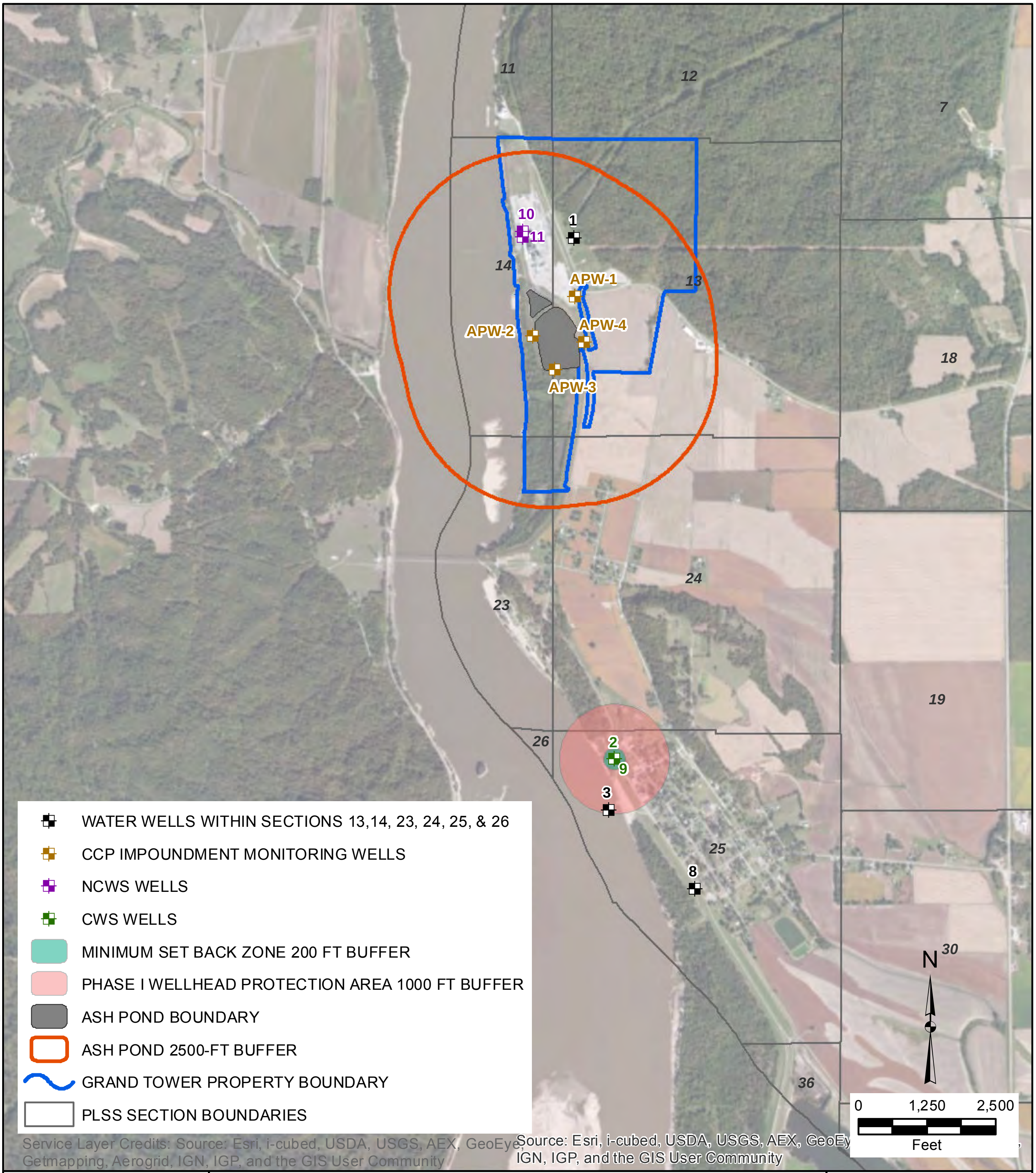

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TDC 2/12/13
APPROVED BY/DATE:
BRH 2/15/13

POTABLE WELL SEARCH RESULTS

PHASE I HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
GRAND TOWER ENERGY CENTER
JACKSON COUNTY, ILLINOIS

PROJECT NO: 2123

FIGURE NO: 3

Natural Resource Technology

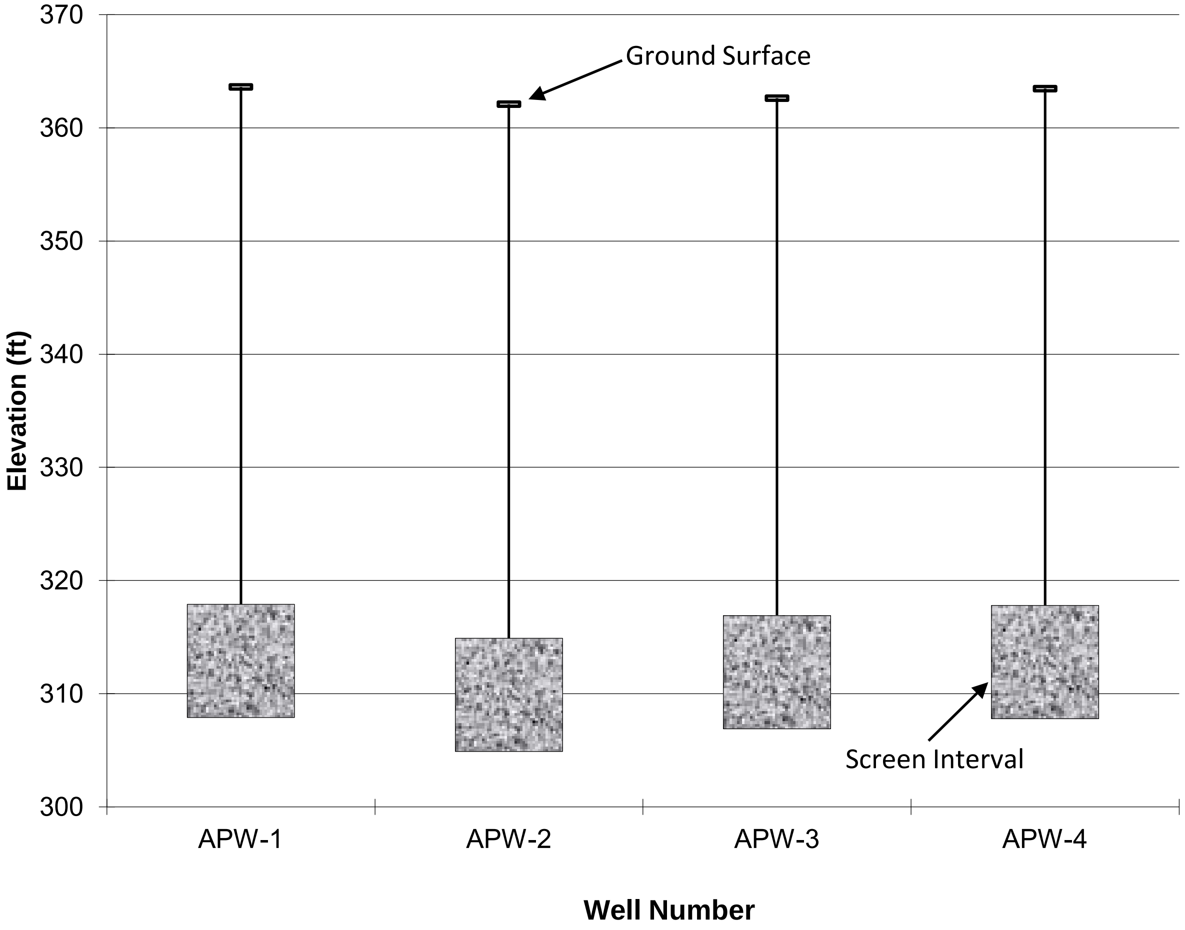


Figure 4. Monitoring Well Screen Elevations.

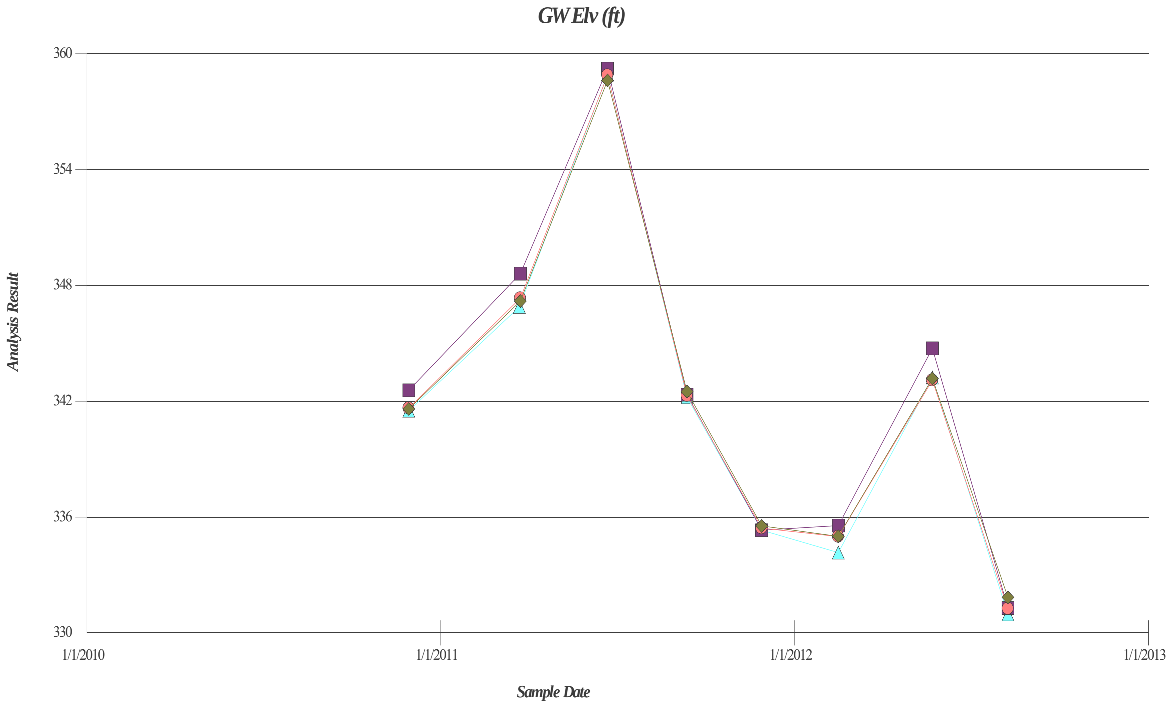
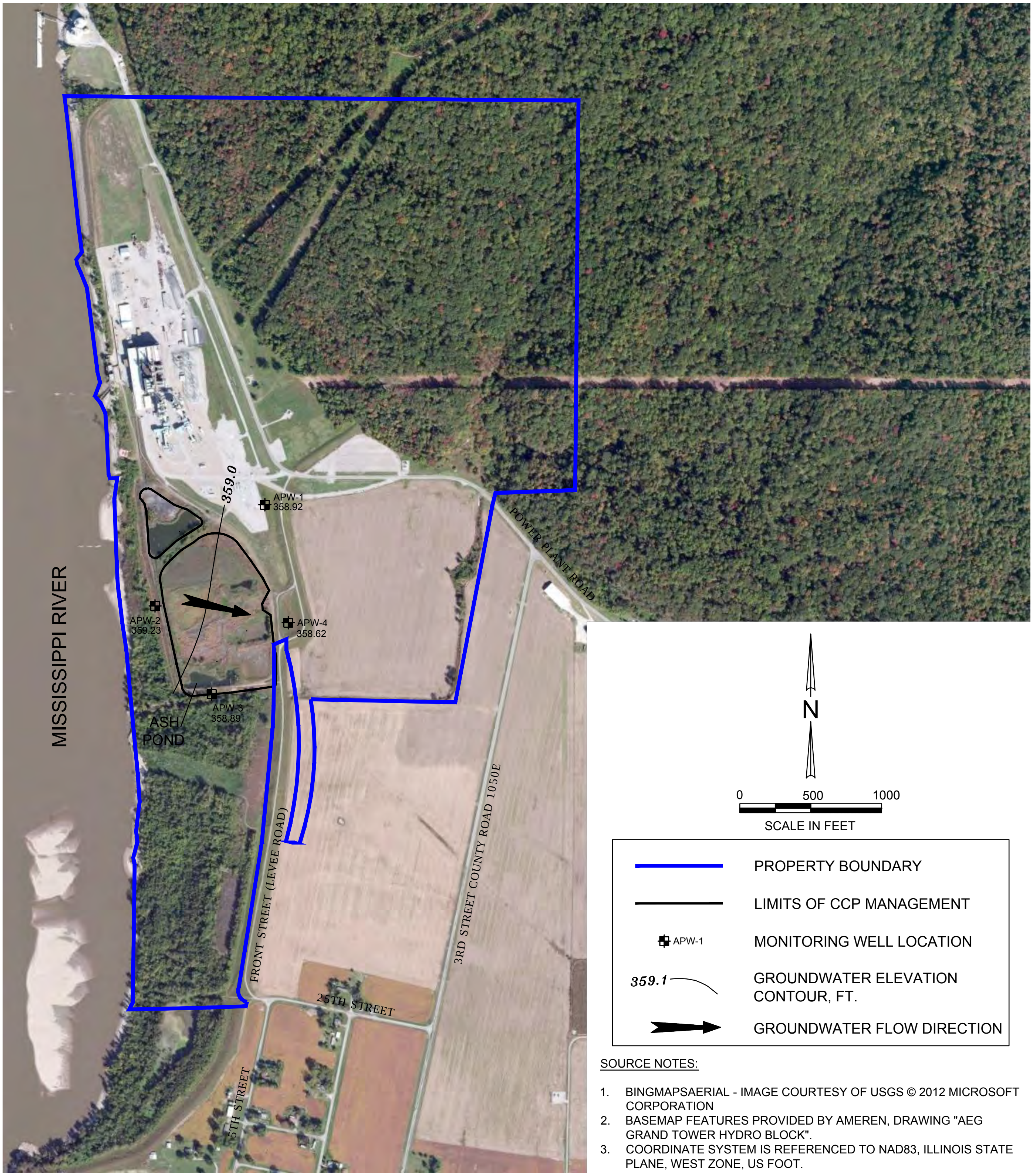


Figure 5. Groundwater Elevation Time Series.



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NATURAL
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TECHNOLOGY

GROUNDWATER ELEVATION CONTOURS
JUNE 22, 2011

PHASE 1 HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
GRAND TOWER ENERGY CENTER
JACKSON COUNTY, ILLINOIS

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

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FIGURE NO.
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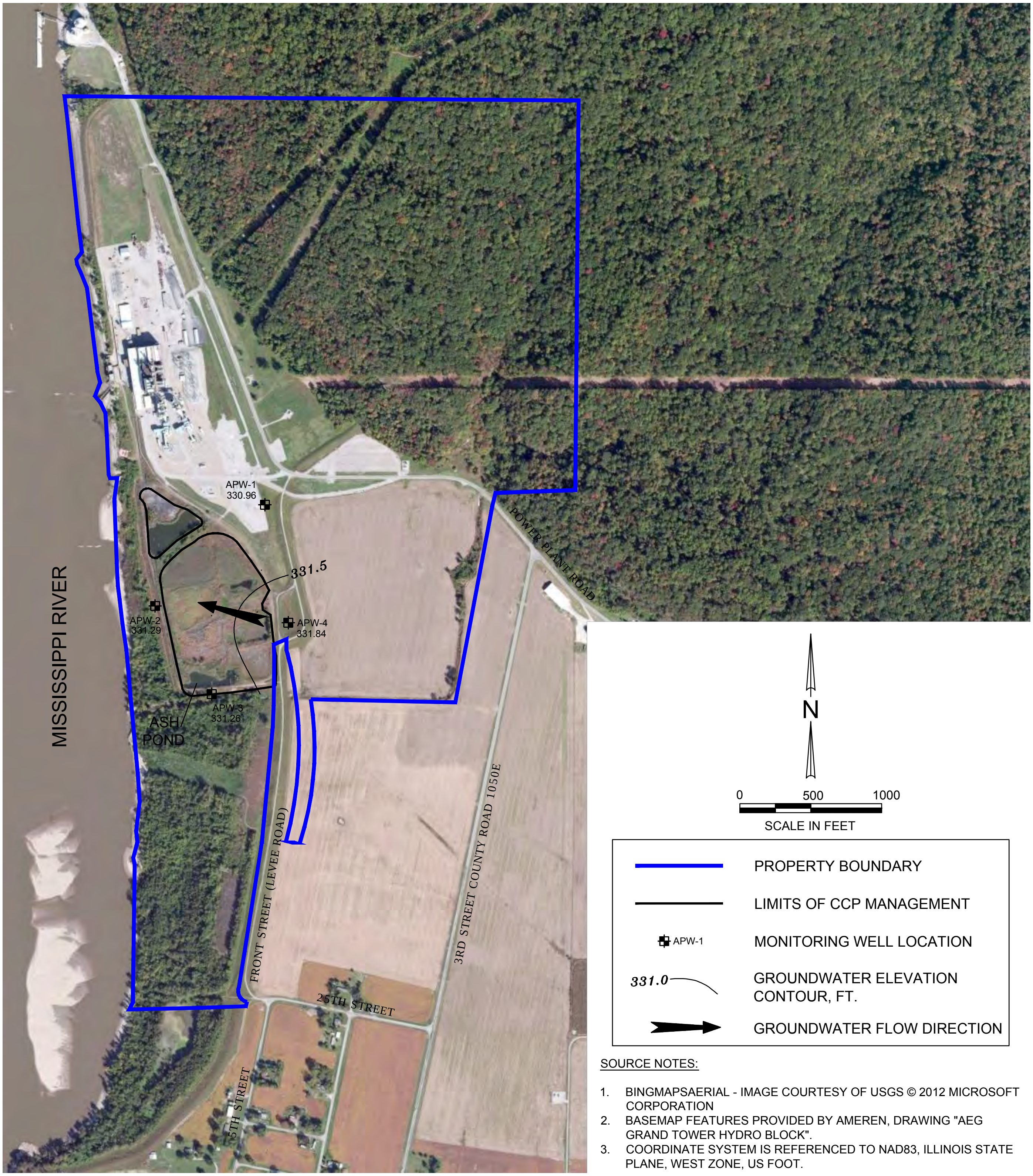

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GROUNDWATER ELEVATION CONTOURS
AUGUST 8, 2012

NATURAL
RESOURCE
TECHNOLOGY

PHASE 1 HYDROGEOLOGIC ASSESSMENT
AMEREN ENERGY GENERATING
GRAND TOWER ENERGY CENTER
JACKSON COUNTY, ILLINOIS

DRAWN: NWD DATE: 02/05/13 CHK'D: BRH DATE: 02/05/13 APP'D: BRH DATE: 03/05/13

PROJECT NO.
2123/2.0

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FIGURE NO.
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TABLES

Table 1. Monitoring Well Construction Details

Phase 1 Hydrogeologic Assessment
Grand Tower Power Station; Grand Tower, IL

Monitoring Well Number	Installation Date[1,2]	Top of Well Riser Elevation	Ground Elevation	Screen Top Depth (BGS)	Screen Bottom Depth (BGS)	Screen Top Elevation	Screen Bottom Elevation	Bottom of Boring Elevation	Slotted Screen Length	Bottom Screen Depth from Ground Surface	Bottom Screen Depth from Top of Casing	Total Boring Depth
APW-1	10/11/10	366.56	363.61	45.7	55.7	317.9	307.9	307.6	10	55.7	58.7	56.0
APW-2	11/15/10	365.24	362.09	47.2	57.2	314.9	304.9	304.6	10	57.2	60.3	57.5
APW-3	10/09/10	365.59	362.62	45.7	55.7	316.9	306.9	306.6	10	55.7	58.7	56.0
APW-4	10/09/10	367.20	363.46	45.7	55.7	317.8	307.8	307.5	10	55.7	59.4	56.0

Monitoring Well Number	Northing[3]	Easting[3]
APW-1	360,625.8	2,487,059.5
APW-2	359,912.4	2,486,285.3
APW-3	359,291.2	2,486,684.9
APW-4	359,794.7	2,487,224.5

Notes:

All depth and elevation measurements are in feet relative to NAVD 1988.

BGS = below ground surface.

[1] Drilling and well installation by Geotechnology, Inc.

[2] All wells constructed with 2-inch diametrer, 10-slot, Schedule 40 PVC screens.

[3] Coordinates are referenced to Illinois State Plane Coordinates, East Zone - NAD 1983.

Table 2. Groundwater Levels and Elevations

Phase 1 Hydrogeologic Assessment
Grand Tower Power Station; Grand Tower, Illinois

Monitoring Well Number	Ground Surface Elevation^1 (feet)	Measuring Point Elevation^1 (feet)	Groundwater Depth (feet below measuring point)							
			1 11/29/10	2 03/23/11	3 06/22/11	4 09/12/11	5 11/28/11	6 02/15/12	7 05/22/12	8 08/08/12
APW-1	363.61	366.56	25.05	19.67	7.64	24.35	31.24	32.40	23.33	35.60
APW-2	362.09	365.24	22.67	16.63	6.01	22.90	29.92	29.68	20.50	33.95
APW-3	362.62	365.59	23.95	18.25	6.70	23.30	30.16	30.60	22.50	34.33
APW-4	363.46	367.20	25.60	20.01	8.58	24.70	31.66	32.20	24.02	35.36

Monitoring Well Number	Groundwater Depth (feet below ground surface)							
	1 11/29/10	2 03/23/11	3 06/22/11	4 09/12/11	5 11/28/11	6 02/15/12	7 05/22/12	8 08/08/12
APW-1	22.10	16.72	4.69	21.40	28.29	29.45	20.38	32.65
APW-2	19.52	13.48	2.85	19.75	26.77	26.53	17.35	30.80
APW-3	20.98	15.28	3.73	20.33	27.19	27.63	19.53	31.36
APW-4	21.86	16.27	4.84	20.96	27.92	28.46	20.28	31.62

Monitoring Well Number	Groundwater Elevation (feet)							
	1 11/29/10	2 03/23/11	3 06/22/11	4 09/12/11	5 11/28/11	6 02/15/12	7 05/22/12	8 08/08/12
APW-1	341.51	346.89	358.92	342.21	335.32	334.16	343.23	330.96
APW-2	342.57	348.61	359.23	342.34	335.32	335.56	344.74	331.29
APW-3	341.64	347.34	358.89	342.29	335.43	334.99	343.09	331.26
APW-4	341.60	347.19	358.62	342.50	335.54	335.00	343.18	331.84

Notes:

[1] All depth and elevation measurements are in feet relative to NAVD 1988.