BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

ELECTRIC ENERGY, INC. Petitioner **v.** **ILLINOIS ENVIRONMENTAL PROTECTION AGENCY** Respondent.	**PCB 2023-________**

NOTICE OF FILING

To: Pollution Control Board, Attn: Clerk
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Division of Legal Counsel
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PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Pollution Control Board the attached **PETITION FOR REVIEW OF ILLINOIS ENVIRONMENTAL PROTECTION AGENCY'S NON-CONCURRENCE WITH ALTERNATIVE SOURCE DEMONSTRATION UNDER 35 ILL. ADM. CODE PART 845 AND MOTION FOR STAY**; **APPEARANCES OF JOSHUA MORE, BINA JOSHI, AND SAMUEL RASCHE**; and a **CERTIFICATE OF SERVICE**, copies of which are herewith served upon you.

/s/ *Samuel A. Rasche*
Dated: December 22, 2023

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BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

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APPEARANCE OF JOSHUA R. MORE
AND CONSENT TO E-MAIL SERVICE

I, Joshua R. More, hereby enter my appearance on behalf of ELECTRIC ENERGY, INC. and authorize the service of documents on me by email in lieu of receiving paper documents in the above-captioned proceeding. My email address to receive service is as follows:

Joshua.More@afslaw.com

/s/ *Joshua R. More*
Joshua R. More

Dated: December 22, 2023

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BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

ELECTRIC ENERGY, INC. Petitioner **v.** **ILLINOIS ENVIRONMENTAL PROTECTION AGENCY** Respondent.	**PCB 2023-________**

APPEARANCE OF BINA JOSHI
AND CONSENT TO E-MAIL SERVICE

I, Bina Joshi, hereby enter my appearance on behalf of ELECTRIC ENERGY, INC. and authorize the service of documents on me by email in lieu of receiving paper documents in the above-captioned proceeding. My email address to receive service is as follows:

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/s/ *Bina Joshi*
Bina Joshi

Dated: December 22, 2023

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BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

ELECTRIC ENERGY, INC. Petitioner **v.** **ILLINOIS ENVIRONMENTAL PROTECTION AGENCY** Respondent.	**PCB 2023-________**

APPEARANCE OF SAMUEL A. RASCHE
AND CONSENT TO E-MAIL SERVICE

I, Samuel A. Rasche, hereby enter my appearance on behalf of ELECTRIC ENERGY, INC. and authorize the service of documents on me by email in lieu of receiving paper documents in the above-captioned proceeding. My email address to receive service is as follows:

Sam.Rasche@afslaw.com

/s/ *Samuel A. Rasche*
Samuel A. Rasche

Dated: December 22, 2023

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BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

ELECTRIC ENERGY, INC. Petitioner **v.** **ILLINOIS ENVIRONMENTAL PROTECTION AGENCY** Respondent.	**PCB 2023-________**

PETITION FOR REVIEW OF ILLINOIS ENVIRONMENTAL PROTECTION AGENCY'S NON-CONCURRENCE WITH ALTERNATIVE SOURCE DEMONSTRATION UNDER 35 ILL. ADM. CODE PART 845 AND MOTION FOR STAY

Petitioner Electric Energy, Inc. ("EEI" or "Petitioner"), pursuant to Sections 105.200 *et seq.* and 845.650(e) of Title 35 of the Illinois Administrative Code, 35 Ill. Adm. Code §§ 105.200 *et seq.* and § 845.650(e), appeals the final decision of the Illinois Environmental Protection Agency ("IEPA" or the "Agency") that did not concur with the Alternative Source Demonstration for the Joppa East Ash Pond submitted to the Agency on October 21, 2023 (the "Joppa ASD"). IEPA's non-concurrence is stated in a letter from IEPA Bureau of Water Groundwater Section Manager Michael Summers to EEI dated November 16, 2023, and served upon EEI on November 20, 2023, via U.S. Mail, which is attached as **Exhibit A** (the "IEPA Denial"). As detailed in Section II below, IEPA's Denial is contrary to the applicable regulations and arbitrary and capricious. For the reasons set forth in Section III below, Petitioner also requests a partial stay of Part 845 requirements as they apply to the exceedances at issue in this Petition.

In support of this Petition and Motion for Stay, EEI states as follows:

I. BACKGROUND

A. Regulatory Background

1. IEPA regulates coal combustion residual ("CCR") surface impoundments under 35 Ill. Adm. Code Part 845 ("Part 845").[1] Part 845 includes requirements for regular groundwater monitoring. 35 Ill. Adm. Code § 845.650.

2. If, during groundwater monitoring, one or more constituents are detected and confirmed to be in exceedance of the groundwater protection standards in Section 845.600 ("GWPS"), a series of additional steps are triggered.

3. Within 60 days after detecting an exceedance of a GWPS, an owner or operator may submit an Alternative Source Demonstration ("ASD") to IEPA demonstrating "that a source other than the CCR surface impoundment caused the contamination and the CCR surface impoundment did not contribute to the contamination, or that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction." 35 Ill. Adm. Code § 845.650(e).

4. The ASD must "include a report that contains the factual or evidentiary basis for any conclusions and a certification of accuracy by a qualified professional engineer." *Id.*

5. IEPA must send a public notice of the ASD, and members of the public may submit written comments to IEPA within 14 days of the notice. *Id.*

6. Within 30 days after receiving an ASD, IEPA must provide a written response to the owner or operator of the CCR surface impoundment either concurring or not with the ASD. If IEPA concurs, the owner or operator must continue groundwater monitoring, but is not required to take additional actions in connection with the identified exceedance, including initiating an

[1] Subsequent references in this petition to "Section 845.xxx" or "§ 845.xxx" shall be to 35 Ill. Adm. Code, Part 845, unless otherwise specified.

assessment of corrective measures. If IEPA does not concur, the owner or operator may petition the Board for review of the non-concurrence. *Id.*

7. Other requirements are prompted in the absence of an ASD, or in the event an ASD is denied and a stay is not granted. For example, within 90 days after detecting an exceedance of a GWPS, the owner or operator of the CCR surface impoundment must initiate an assessment of corrective measures. 35 Ill. Adm. Code § 845.660(a). The owner or operator must, within 90 days of initiating its assessment of corrective measures (or up to 60 days longer if an extension is requested and granted), submit to the Agency an assessment of corrective measures. *Id.* at § 845.660(a)(2). Within a year of completing the assessment of corrective measures, an owner or operator must submit a construction permit application and corrective action plan to IEPA identifying the selected remedy. *Id* at § 845.670(b).

B. EEI's Alternative Source Demonstration

8. EEI owns the now retired Joppa Power Plant ("Joppa") located in Massac County, Illinois, west of the Village of Joppa, northeast of the Ohio River in Section 15 South, Range 3 East. Joppa includes the East Ash Pond ("EAP"), a CCR surface impoundment regulated under Part 845.

9. On August 22, 2023, groundwater monitoring at Joppa identified GWPS exceedances at multiple monitoring wells. Specifically, EEI identified GWPS exceedances for (1) cobalt at well G05 (the "Cobalt Exceedance"), and (2) pH at wells G11 and G51D (the "pH Exceedances").[2] EEI notified IEPA of its groundwater monitoring results, including these

[2] EEI also detected GWPS exceedances for Boron at multiple wells. EEI concluded the EAP may have caused or contributed to these exceedances and, therefore, did not address these exceedances in the Joppa ASD. EEI is addressing these exceedances by taking additional steps in accordance with Part 845, including 35 Ill. Adm. Code § 845.660.

exceedances, placed the information in its operating record, and contracted with an environmental consultant to further investigate the cause of the GWPS exceedances. Joppa Power Plant, East Ash Pond; IEPA ID # W1270100004-02, Groundwater Monitoring data and Detected Exceedances Quarter 2 2023 (Aug. 22, 2023), available at https://www.luminant.com/documents/ccr/il-ccr/Joppa/2023/2023-Joppa%202023%20Q2%2035%20IAC%20845%20GW%20rpt-W1270100004-02-Joppa-East%20Ash%20Pond-W1270100004%E2%80%9002.pdf.

10. On October 21, 2023, EEI submitted the Joppa ASD to IEPA. The Joppa ASD concluded that sources other than the EAP were responsible for the Cobalt Exceedance and the pH Exceedances and that the EAP did not contribute to the Cobalt Exceedance or the pH Exceedances. The Joppa ASD is attached as **Exhibit B**.

1. The Cobalt Exceedance

11. The Joppa ASD identified three lines of evidence to demonstrate that the EAP is not the cause of or contributing to the Cobalt Exceedance. First, the Joppa ASD demonstrated that cobalt concentrations at monitoring well G05 are consistent with cobalt mobilization from native soils due to reductive dissolution of manganese oxides. **Exhibit B** at 7-9. The ASD explained that "[c]obalt sorbs strongly to manganese oxides and is thus often associated with manganese" in soils. *Id.* at 7. As manganese oxides in soil naturally dissolve into groundwater (through a process known as reductive dissolution) "the cobalt previously sorbed to the manganese oxide surface is also released" into the groundwater. *Id.*

12. The Joppa ASD explained that, if reductive dissolution of manganese oxides is responsible for the presence of cobalt in groundwater, "cobalt and manganese concentrations in both soils and groundwater will be correlated with one another." *Id.* The Joppa ASD compiled evidence and analyzed nearby solid phase data and groundwater data and further identified additional groundwater wells with comparable geochemical signatures to G05 to evaluate the

relationship between cobalt and manganese using a regression analysis. *Id.* The Joppa ASD concluded that the "strong association between cobalt and manganese in both the soil and groundwater, in addition to groundwater conditions in the area of G05 favoring manganese reduction, supports the conclusion that reductive dissolution of manganese oxides in native soil is occurring and is strongly influencing the cobalt concentrations in the groundwater rather than the EAP." *Id.* at 9.

13. Second, the Joppa ASD demonstrated that the cobalt concentrations in G05 are greater than the concentrations in the EAP. *Id.* at 10. The Joppa ASD explained that, if "the EAP were the source of cobalt in downgradient groundwater, EAP porewater would be expected to be higher than the groundwater concentrations." *Id.* Because there were no detections of cobalt above the reporting limit of 0.001 mg/L in EAP porewater samples, the Joppa ASD concluded that "cobalt concentrations [in G05] are not related to the EAP." *Id.*

14. Third, the Joppa ASD demonstrated that the cobalt concentrations observed in G05 are not correlated with other constituents that typically indicate contamination from CCR. *Id.* The Joppa ASD explained that boron and sulfate are "Site-specific key indicators for CCR" at the EAP, meaning that "if an exceedance is identified for a monitored CCR parameter but concentrations of boron and sulfate are not correlated with that parameter, it is unlikely that the CCR unit is the source of the GWPS exceedance." *Id.* Because there is no correlation between cobalt and the CCR indicators (boron and sulfate) at G05, the indication is that "the EAP is not the source of the cobalt exceedance." *Id.*

15. For the above reasons, the Joppa ASD concluded that the evidence "demonstrated that sources other than the EAP (the CCR unit) caused the cobalt exceedance at G05." *Id.* at 14.

2. The pH Exceedances

16. The Joppa ASD additionally identified three lines of evidence demonstrating that "sources other than the EAP (the CCR unit) caused the pH exceedances at G11 and G51D." *Id.* at 12. First, the Joppa ASD demonstrated that both G11 and G51D are upgradient of the EAP, and "[t]herefore, it is unlikely that porewater from the EAP would flow in the direction of G11 and G51D" and further "it is unlikely that the EAP is the source of the exceedances." *Id.*

17. Second, "wells G11 and G51D exhibit a high degree of similarity" with upgradient groundwater from wells located to the west of G11 and G51D. *Id.* Conversely, EAP porewater (located to the east of G11 and G51D) is "distinctly separate from the groundwater samples." *Id.* Accordingly, the Joppa ASD concluded that "the EAP does not influence the groundwater at G11 and G51D and therefore is not the source of the pH exceedances." *Id.*

18. Third, the Joppa ASD demonstrated the pH Exceedances are consistent with iron oxidation that occurs due to changes in local redox conditions. *Id.* The Joppa ASD evaluated the surrounding groundwater and identified a "distinct redox transition . . . shifting from more reducing conditions in upgradient waters to more oxidizing conditions in downgradient wells, including the exceedance wells." *Id.* at 13. The Joppa ASD explained that the "oxidation of dissolved iron to iron oxides is known to produce acidity" and thus "upgradient waters from the northwest provide the constituent (*i.e.*, reduced iron) necessary to cause a drop in pH (*i.e.*, through iron oxidation) in G11 and G51D." *Id.* As a result, the Joppa ASD concluded that the "oxidized environment in wells G11 and G51D likely results from mixing with the upgradient oxidized background groundwater" and therefore "mixing of groundwater resulting in natural variability in the groundwater conditions is the likely driver of the pH exceedances in G11 and G51D." *Id.*

19. For the above reasons, the Joppa ASD concluded "that sources other than the EAP caused the pH exceedances at G11 and G51D." *Id.* at 14.

B. IEPA's Review of the Joppa ASD

20. On October 23, 2023, IEPA provided notice to its listserve regarding the posting of the Joppa ASD submittal, triggering a 14-day period for written comments on the Joppa ASD submittal pursuant to Section 845.650(e)(3).

21. After submittal of the Joppa ASD, EEI and IEPA engaged in communications regarding the Joppa ASD submittal. On November 6, 2023, within the 14-day period for written comments, EEI submitted a written comment regarding the Joppa ASD in the form of a letter to IEPA (the "Comment Letter"). The Comment Letter was delivered to IEPA via email and is attached as **Exhibit C.**

22. In response to requests from IEPA, the Comment Letter provided hydraulic conductivity and boring log data, all of which "was previously provided or referenced in the Joppa EAP operating permit application and/or construction permit application" or the October 2017 Hydrogeologic Monitoring Plan for the Joppa EAP. The Comment Letter also notified IEPA that "EEI (with this letter) is incorporating by reference the entirety of its April 2023 supplemental site investigation report, October 25, 2021 operating permit application and July 28, 2022 construction permit application for the Joppa EAP into its Joppa EAP ASD submittal." **Exhibit C** at 1.[3]

23. The Comment Letter also included a detailed explanation of why IEPA's requests for "source characterization that includes total solids sampling, analysis and reporting in accordance with SW-846 testing methods and [] sampling and analysis in accordance with 25 Ill. Admin. Code 845.640 of the alternative source" were impractical and unfounded. The Comment

[3] These documents or portions of them were also referenced in the original Joppa EAP ASD submittal. **Exhibit B** at 15.

Letter attached an additional letter from EEI's qualified professional engineer detailing why IEPA's requests were unnecessary. *Id.* at Attachment 2.

C. The IEPA Denial

24. On November 16, 2023, ten days after receiving the Comment Letter, IEPA sent a two-page letter notifying EEI of IEPA's non-concurrence with the Joppa ASD (the "IEPA Denial"). The IEPA Denial states that "IEPA does not concur" due to two "data gaps." **Exhibit A**. The two listed data gaps according to IEPA are:

25. First, "[s]ource characterization of the CCR at the East Ash Pond must include total solids sampling in accordance with SW846" ("Data Gap 1"). *Id.* IEPA cited to the requirement of § 845.650(e) that an ASD demonstrate the CCR surface impoundment "did not contribute to the contamination" and asserted that "[IEPA] cannot concur with ASDs that do not include source characterization of the CCR with adequate sampling and analysis of the CCR horizontally and vertically within the [CCR surface impoundment]." *Id.* The IEPA Denial does not discuss, analyze, or explain why the porewater-based source characterization conducted by EEI was insufficient.

26. Second, "[c]haracterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with ASD" ("Data Gap 2"). *Id.* Specifically, IEPA referenced the groundwater monitoring requirements of § 845.640(a) and asserted that "evidence of field collection methods and field and laboratory quality control and quality assurance" was required by that section, but does not provide a basis for § 845.640(a)'s application to an alternative source. *Id.* IEPA further asserts that § 845.650(e) requires "alternative source data as evidence of the alternative source" but does not explain why the data provided by EEI was insufficient. *Id.*

27. These two “Data Gaps” are similar to the issues discussed in EEI’s Comment Letter. However, the IEPA Denial does not respond to or acknowledge the existence of the Comment Letter.

II. Discussion

28. IEPA’s bases for its non-concurrence, the two “Data Gaps,” are each arbitrary and capricious and not supported by IEPA’s regulatory authority under Section 845.650.

A. There are no data gaps in the ASD

29. IEPA’s Denial unreasonably demands data and analysis that is not required by Section 845.650. The regulation requires only that EEI submit a “demonstration . . . that a source other than the CCR surface impoundment caused the contamination and the CCR surface impoundment did not contribute to the contamination.” 35 Ill. Adm. Code § 845.650(e). In support of the demonstration, the regulations require that an ASD “include a report that contains the factual or evidentiary basis for any conclusions and a certification of accuracy by a qualified professional engineer.” *Id.* The Joppa ASD report does just that through a scientifically supported analysis that contains multiple lines of evidence. **Exhibit B**; *See also*, **Exhibit C** at Attachment 2, pg. 1; *See also*, Declaration of Mindy Hahn at 2-10 (December 22, 2023), attached as **Exhibit D**. The information identified by IEPA’s “Data Gaps” is not necessary to form a “factual and evidentiary basis” for the conclusions reached in an ASD. The information would not lead to a different result, and the fact that the data was not submitted is inadequate to support the Agency’s nonconcurrence with the Joppa ASD.

1. “Data Gap 1”

30. “Data Gap 1” demands that the Joppa ASD should have included a “source characterization of the CCR at the East Ash Pond” including “total solids sampling in accordance with SW846.” **Exhibit A**. However, there is no requirement in Part 845 that source

characterization of CCR for an ASD be conducted "in accordance with SW846" and "characterize the CCR horizontally and vertically within the [CCR surface impoundment]" and IEPA's Denial provides no justification for its demand. *Id*. Further, from a technical basis, the porewater analysis conducted in the Joppa ASD is a more appropriate and accurate method to characterize the EAP's source material than SW846.

31. There is no legal requirement that a source characterization for purposes of an ASD conducted under Section 845.650(e) utilize SW846. Method SW846 is incorporated by reference into Part 845 by Section 845.150. However, inclusion in the general "incorporations by reference" section of Part 845 does not create an affirmative obligation to use SW846 in all circumstances. The Board has explained that where Illinois rules incorporate analytical methods by reference via a "centralized listing of incorporations by reference" such as Section 845.150, "Illinois rules further indicate where each method is used *in the body of the substantive provisions*." *See In the Matter of: SDWA Update, USEPA Amendments (January 1, 2013 through June 30, 2013)*, R 14-8, slip op. at 24-25 (Jan. 23, 2014) (emphasis added). Further, Chapter 2 of SW846 states that the methods in that document are not "mandatory" unless specifically specified as such by regulation. United States Environmental Protection Agency ("USEPA"), *SW-846 Update V*, (July 2014) at 1.[4] USEPA guidance also makes clear that SW846 is only legally required where "explicitly specified" in a regulation. USEPA, *Disclaimer for Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, (July 2014), at 1.[5] The only substantive provision of Part 845 specifically requiring analysis using SW846 is Section 845.640(e), which applies to analyzing groundwater monitoring samples under a groundwater monitoring program and is not at issue here

[4] Available at https://www.epa.gov/sites/default/files/2015-10/documents/chap2_1.pdf.
[5] Available at https://www.epa.gov/sites/default/files/2015-10/documents/disclaim.pdf.

where IEPA is referencing solids sampling. 35 Ill. Adm. Code § 845.640(e). There is no requirement to use SW846 under Section 845.650(e). The plain language of the rules does not require the utilization of SW846 for purposes of an ASD, and IEPA has provided no justification for any alternative interpretation.

32. Additionally, source characterization of the EAP was conducted using the best scientifically available procedure. As detailed in the November 6, 2023, letter from Ramboll to IEPA included with the Comment Letter, laboratory leach tests such as those prescribed by SW846 are used "to predict the potential concentration of chemicals under laboratory controlled conditions . . . which may or may not represent conditions observed in the field." **Exhibit C** at Attachment 2, pp. 2-3. Because "ASDs are prepared to evaluate the potential of *actual porewater* leaking from a CCR [surface impoundment] to be the cause of a detected exceedance observed," SW846's "use of leach test results performed under variable conditions collected from any number of locations within the CCR [surface impoundment] to estimate a total potential for chemical leaching from CCR into groundwater under a variety of different conditions is irrelevant to an ASD." *Id.* (emphasis added). The porewater analysis used for the Joppa ASD is the best and most accurate scientifically available information for source characterization of the EAP and demonstration that the EAP did not contribute to the cobalt contamination in well G05 and pH contamination in wells G11 and G51D. *Id.*; **Exhibit D** at 13-16. That analysis provided evidence that cobalt was non-detect in EAP porewater and that EAP porewater is "distinctly separate" from and does not influence the groundwater collected at wells G11 and G51D. **Exhibit B** at 10, 12.

33. The IEPA Denial is not clear regarding what procedure under SW846 IEPA believes should have been utilized for source characterization including total solids sampling in accordance with SW846. **Exhibit A**. However, no method under SW846 would have been

preferable to or provide better information than the source characterization methodology utilized for the Joppa ASD. **Exhibit D** at 13-15. That sampling would have included laboratory simulated and/or indirect analysis of potential leaching from material in the EAP, while the methodology utilized for the Joppa ASD included a direct analysis of porewater to determine what constituents are actually leaching from the EAP. **Exhibit C** at Attachment 2, p. 2; *see also* **Exhibit D** at 5-7, 9, 13-15.

34. If source characterization of CCR at the EAP did include total solids sampling in accordance with SW846, it would not be expected to change the results of the Joppa ASD. **Exhibit D** at 15.

35. IEPA's denial of the Joppa ASD based on "Data Gap 1" is accordingly arbitrary and capricious.

2. <u>"Data Gap 2"</u>

36. "Data Gap 2" demands that the Joppa ASD should have provided a characterization "in accordance with 35 IAC 845.640 of [the] alternative source . . ." including "evidence of field collection methods and field and laboratory quality control and quality assurance." **Exhibit A**. However, there is no requirement to conduct groundwater sampling of an alternative source in accordance with Section 845.640 as part of an ASD as suggested by IEPA.

37. IEPA suggests that such monitoring is required because SW846 guides the Agency to make its regulatory decisions based on "environmental data." *Id.* As explained above in Section II.A.1., there is no requirement that SW846 apply to an ASD under § 845.650(e). Nonetheless, the Joppa ASD was prepared using quality environmental data as contemplated by SW846, and nothing in Chapter 1 of SW846 supports IEPA's conclusion that groundwater sampling under § 845.640 is an appropriate (let alone required) means of collecting environmental data for purposes of an ASD. Chapter 1 of SW846 states that its guidance is intended to "ensure data are of sufficient

quality *for their intended use.*" USEPA, *SW-846 Update V, Chapter 1* at 1 (July, 2014) (emphasis added).[6] However, SW846 acknowledges that "[d]ue to the diversity of data collection efforts, it is not possible to provide all details necessary to meet the needs of all members of the intended audience." *Id.* There is no specific guidance under SW846 for preparing an ASD. EEI prepared the Joppa ASD in accordance with industry guidance and standards to ensure that the data presented was the best available for the intended use. *See* **Exhibit C** at Attachment 2, pp. 1-2; **Exhibit D** at 2-4.

38. Further, IEPA's assertion that the regulations require direct groundwater sampling of an alternative source ignores the reality that exceedances may be caused by dynamic geochemical processes (such as the "release of naturally occurring cobalt from manganese oxides" or the "mixing of oxidizing and reducing waters" the Joppa ASD identified as the likely sources of the Cobalt Exceedance and pH Exceedances) which cannot be directly sampled as contemplated by IEPA. *See* **Exhibit C** at Attachment 2, pg. 3. Section 845.640 provides groundwater monitoring requirements for a specific *physical* source of groundwater contaminants (namely, a CCR surface impoundment) which allows for the collection of direct groundwater samples. By contrast, in situations such as here, where the source of the contamination is a geochemical process the "closest approximation of direct sampling would involve using collected materials in complex laboratory simulations which would attempt to replicate field conditions." *Id.* Rather than attempting to conduct an artificial laboratory replication, the Joppa ASD relied upon facts and evidence consisting of "*site-specific* hydrogeologic, groundwater composition, and solid phase data" to support the conclusions that the Cobalt Exceedance and pH Exceedances were caused by other

[6] Available at https://www.epa.gov/sites/default/files/2015-10/documents/chap1_1.pdf.

sources and that the EAP did not contribute to that contamination. *Id*. (emphasis added). For pH specifically, there is no feasible solution to sample the source of pH exceedances because they are a result of complex chemical reactions within the aquifer. Any attempt to collect materials for evaluation of reactions in a laboratory would alter the geochemical conditions and provide unrepresentative results. The Joppa ASD demonstrated the pH Exceedances are consistent with iron oxidation and a geochemical analysis was performed using site-specific data.

39. The Joppa ASD included a detailed explanation of how each conclusion was reached and the evidence supporting each conclusion, and provided significant data as attachments as well as references to any report or other document referred to or relied on. This is more than sufficient to provide the "factual and evidentiary basis" required by Section 845.650(e). No provision of Part 845 requires that an ASD be supported by a characterization of the alternative sources "in accordance with" the groundwater monitoring requirements of § 845.640, and IEPA has provided no justification or support for its one-size-fits-all interpretation of the precise data required.

40. The facts and evidence provided with the Joppa ASD are supportive of a conclusion that "the East Ash Pond is not the source of the cobalt exceedance at G05 or the low pH at G11 and G51D (and did not contribute to these exceedances) and that the likely source is natural variability in groundwater due to water-solid interactions and groundwater mixing, respectively," and any "additional lines of evidence" based on sampling and leach test data requested by IEPA would not "change the conclusion of the full body of evidence presented in the [Joppa] ASD. . ." **Exhibit C** at Attachment 2, p. 4; *see also,* **Exhibit D** at 13-16.

41. As noted above in Section II.A., the Joppa ASD was prepared using a multiple lines of evidence approach in accordance with guidance for the development of ASDs at CCR sites.

Exhibit C at Attachment 2, p. 2; **Exhibit D** at 2-4. Following such guidance, the Joppa ASD reviewed and analyzed "site specific hydrogeologic, groundwater composition, and solid phase data . . . using industry-standard geochemical and statistical methods . . . ." including principal component analysis ("PCA"). **Exhibit C** at Attachment 2, pp. 3, 7-8. The Joppa ASD used these data sets and analytical methods to develop evidence supporting the conclusions that (1) regarding the Cobalt Exceedance at G05, cobalt is naturally associated with manganese in the area and that the hydrogeologic conditions are favorable for the reductive dissolution of manganese oxides that would release cobalt into the groundwater; and (2) regarding the pH Exceedances at G11 and G51D, a "distinct redox transition" between the groundwater at G11 and G51D and upgradient groundwater that would result in lower iron concentrations at G11 and G51D that are the likely cause of the low pH. **Exhibit B** at 7, 13.

42. The Joppa ASD's use of site-specific information and identification of specific geochemical reactions is more than sufficient to provide the "demonstration" required by § 845.650(e). IEPA's request for a complete characterization of the alternative sources in accordance with the groundwater monitoring requirements of § 845.640 is unfounded and unexplained. Further, as detailed below in Section II.B., IEPA's request is practically infeasible, particularly in a situation like this one where the exceedances are the result of dynamic geochemical reactions rather than a stationary "source." Accordingly, IEPA's use of "Data Gap 2" as a grounds for nonconcurrence is arbitrary and capricious.

B. IEPA's Denial imposes practically infeasible requirements.

43. IEPA's interpretation of Section 845.650(e) is further unreasonable because "Data Gaps" 1 and 2 demand complex sampling and analysis that cannot feasibly be completed within the timeframes contemplated by the regulations, if at all. Section 845.650(e) requires owners and operators to submit an ASD within 60 days after detecting a GWPS exceedance. The regulations

further require IEPA to reach a final decision within 30 days after receiving an ASD. 35 Ill Adm. Code § 845.650(e)(4).

44. "Data Gap 1" requests that EEI provide source characterization of the CCR at the EAP that includes "total solids sampling in accordance with SW846." **Exhibit A**. Such a characterization could take approximately 21-42 weeks to complete. **Exhibit E**, Declaration of Cynthia Vodopivec at 1. Thus, even if EEI anticipated IEPA's request for this data and began the CCR source characterization at the exact moment the GWPS exceedance is detected, the characterization could not reasonably be completed until months *after* IEPA's deadline to reach a final decision on the Joppa ASD (let alone EEI's deadline to submit an ASD).

45. "Data Gap 2" requests a full characterization of the alternative sources "in accordance with 35 IAC 845.640[.]" **Exhibit A**. As explained above, the direct sampling contemplated by Section 845.640 is not feasible where an exceedance is caused by local geology and geochemistry and the "closest approximation" would involve complex laboratory simulations "which would attempt to replicate field conditions." **Exhibit C** at Attachment 2, p. 3; **Exhibit E** at 1. Such simulations would likely take at least 10-15 weeks and would not be expected to provide representative results. **Exhibit E** at 1-2.[7] Again, there is no regulatory requirement that EEI conduct such analysis, and thus there would have been no reason for EEI to begin any such characterization until a GWPS exceedance is detected. Once again, even if EEI had fully anticipated IEPA's requests, it would not have been able to complete the analysis until months

[7] Undertaking the steps required to provide the information IEPA seeks through "Data Gaps" 1 and 2 would also be costly: collecting the information requested by "Data Gap 1" would likely cost approximately $325,000-$680,000, while "Data Gap 2" would cost approximately $55,000 for cobalt and $35,000-$45,000 for pH. **Exhibit E** at 1-2. While cost is not the driver of actions taken for completing an ASD, as Dr. Hahn explains, accepted scientific practice is to not develop costly additional lines of evidence when sufficient evidence exists from other, accessible and solid lines of evidence to support a conclusion. **Exhibit D** at 2-4.

past the deadline to submit an ASD. Even then, it is unclear whether such analysis could be done "in accordance with" § 845.640's groundwater monitoring requirements because those requirements do not contemplate "sources" such as those identified by the Joppa ASD.

46. The data the IEPA Denial categorizes as "gaps" in the Joppa ASD could not feasibly be completed before the prescribed deadline for submitting an ASD, if at all. IEPA's interpretation that Section 845.650 requires these characterizations would thus make the entire ASD provision meaningless, as it would be impossible for any owner or operator to submit a sufficient ASD.

47. Accordingly, IEPA's Denial is arbitrary and capricious and also ignores reality.

48. Furthermore, even if the data requested was required to be collected elsewhere under Part 845, there is no requirement in Section 845.650 that such data be used in connection with an ASD. Here, qualified professionals used best available information to develop an ASD within the regulatory deadline and in conformance with regulatory requirements. Certainly, additional lines of evidence could be added to the ASD analysis; however, professional judgment and practicality dictate that every possible line of evidence need not and cannot be developed. **Exhibit D** at 2-4. Doing so would take an unreasonable amount of time. Additionally, doing so is unnecessary when existing information is sufficient to support the conclusion that an alternative source caused the contamination detected and that the CCR surface impoundment at issue did not contribute to that contamination. *Id*.

C. IEPA's Denial was not based on a reasonable review of the data presented.

49. Finally, IEPA simply failed to fully evaluate the information presented to it before issuing its nonconcurrence. As noted above, EEI submitted its Comment Letter via email on November 6, 2023, 14 days after IEPA provided public notice of the Joppa ASD and thus within

the period for written comments required by Section 845.650(e)(3). The Comment Letter included significant information regarding the "Data Gaps" identified in the IEPA Denial.

50. However, the IEPA Denial, dated November 16, 2023 (ten days *after* IEPA received the Comment Letter), makes no reference to the Comment Letter whatsoever.

51. IEPA's failure to address or consider data and arguments provided to it well within the prescribed comment period was arbitrary and capricious.

III. MOTION FOR PARTIAL STAY

52. Because Part 845 does not authorize an automatic stay, EEI asks the Board to stay the requirements of Sections 845.650(d), 845.660, 845.670, and 845.680 for the Cobalt Exceedance and pH Exceedances at issue in this Petition until the later of (a) the Board's final resolution of this Petition, or (b) if this Petition is granted, IEPA's issuance of a concurrence.

A. The Board has authority to issue a stay.

53. The Board has long recognized its authority under Illinois law to issue discretionary stays. *See Community Landfill Co. and City of Morris v. IEPA*, PCB 01-48, PCB 01-49 (consol.), slip op. at 4 (Oct. 19, 2000); *see also, e.g.*, *Ill. Power Generating Co. v. IEPA*, PCB 16-60, slip op. at 1 (Dec. 17, 2015). Section 845.650(e)(7), which authorizes a petition for review of an IEPA nonconcurrence with an ASD, "would be rendered meaningless" if the Board had no authority to stay the associated regulations. *See Id.* An IEPA nonconcurrence with an ASD triggers corrective measure requirements that must be initiated within a short timeframe, likely far before the Board reaches a final resolution of this petition.[8]

[8] Section 845.660(a) requires: "The assessment of corrective measures must be initiated within 90 days after finding [of any GWPS exceedance]" and the "assessment of corrective measures must be completed and submitted to the Agency within 90 days after initiation of assessment of corrective measures . . ."

54. Further, the rules specifically contemplate that the Board may stay certain regulatory requirements pending resolution of a petition for review: "The filing of a petition for review under subsection (e)(7) does not automatically stay any requirements of this Part as to the owner or operator, including the 90-day deadline to initiate an assessment of corrective measures (see Section 845.660(a)(1))." Section 845.650(e)(7). If the Board had no authority to stay the corrective measure requirements, there would have been no need for the rules to specify that the stay is not automatic.

B. A partial stay is appropriate under Illinois law.

55. The Board considers four factors[9] when determining whether to grant a discretionary stay of a final Agency decision:

a. a certain and clearly ascertainable right needs protection;

b. irreparable injury will occur without injunction;

c. adequate remedy at law exists;

d. a probability of success on the merits.

PCB 16-60, slip op. at 2 (Dec. 17, 2015), citing *Community Landfill Co. and City of Morris v. IEPA*, PCB 01-48, PCB 01-49 (consol.), slip op. at 4 (Oct. 19, 2000). The Board need not find that all of these factors exist in order to grant a discretionary stay. *Id.* The Board will also consider the likelihood of environmental harm should stay be granted. *Id.*, citing *Motor Oils Refining Co. v. IEPA*, PCB 89-116, slip op. at 2 (Aug. 31, 1989).

[9] When reviewing a request for a discretionary stay in the context of a permit appeal or appeal of final agency decision, the Board has held that "although there are no specific standards set by the Board for issuing stays, Illinois law provides for standards under which such equitable relief is appropriate." *Motor Oils Refining Co. v. IEPA*, PCB 89-116, slip op. at 1 (Aug. 31, 1989), *citing Junkunc v. S.J. Advanced Technology & Mfg.*, 101 Ill. Dec. 671, 498 N.E.2d 1179 (Ill. App. 1 Dist. 1986).

56. For the reasons stated in this Petition, a stay is necessary to protect EEI's right to appeal the IEPA Denial and to prevent EEI from being unlawfully and unreasonably required to comply with costly and potentially unnecessary corrective measure requirements before it is able to exercise its right to appeal and be heard by the Board. Accordingly, EEI has an ascertainable right that needs protection.

57. EEI will suffer irreparable injury if it is subject to the corrective measure requirements of Sections 845.650(d), 845.660, 845.670, and 845.680 for the Cobalt Exceedance and pH Exceedances at issue in this Petition. Compliance with these requirements would require EEI to expend resources to complete assessments of corrective measures, prepare corrective action plans and take other steps under Part 845 for alleged discharges that, as explained in detail in the Joppa ASD and this Petition, likely never occurred. The assessments of corrective measures alone would likely cost approximately $35,000. **Exhibit E** at 2. Selecting an appropriate remedy and developing a corrective action plan could cost an additional $400,000. *Id*. at 2. These expenditures would further divert resources from the corrective measures EEI is currently conducting in response to GWPS exceedances not at issue in this Petition. *Id.* If EEI complied with the corrective measure requirements for cobalt and pH at the Joppa EAP and then succeeded on the merits of this Petition, costs, as well as time and other resources, would be lost. *Id*. Thus, EEI would suffer irreparable injury.

58. EEI has no other adequate remedy at law to prevent these injuries or to contest the IEPA Denial.

59. It is also likely that EEI will succeed on the merits of this Petition. EEI has demonstrated by a preponderance of the evidence that an alternative source other than the EAP is responsible for the Cobalt Exceedance and the pH Exceedances and that the EAP did not contribute

to that contamination as evidenced through the thorough analysis of a qualified professional engineer, and EEI is prepared to demonstrate that IEPA's nonconcurrence was arbitrary and capricious and/or inconsistent with applicable laws and regulations. *See, e.g.*, **Exhibit C**; **Exhibit D**.

60. Finally, no harm to human health or the environment will result from a stay of these requirements. The Cobalt Exceedance is limited to a single monitoring well and the pH Exceedances to two monitoring wells located upgradient to the EAP. As demonstrated in the Joppa ASD and this Petition, the Joppa EAP is not the source of the Cobalt Exceedance or the pH Exceedances. Notably, the IEPA Denial does not suggest that IEPA believes the EAP is the cause of or is contributing to the GWPS exceedances – rather, the IEPA Denial is based on alleged "data gaps." **Exhibit A**. Moreover, the corrective measure requirements of Sections 845.650(d), 845.660, 845.670, and 845.680 include an assumption that the impoundment under assessment is at least a partial cause of the exceedances.[10] It is impossible to complete a corrective action assessment or to determine the optimal corrective action for a source that is not the cause of the exceedances, and to do so would provide no benefit to human health and the environment. Further, EEI has conducted a human health and risk assessment for the EAP demonstrating that even the worst-case exposure scenario through direct consumption of contaminated groundwater would be below levels that cause adverse health effects. Human Health and Ecological Risk Assessment, East Ash Pond, Joppa Power Plant, Joppa, Illinois at 22, 31 (Jul. 28, 2022), available at https://www.luminant.com/documents/ccr/Illinois/Joppa/2022/Joppa%20EAP%20Construction%20Permit%20Application.pdf. Furthermore, as of July 2022, there was no indication of any

[10] *See, e.g.*, Section 845.660(a) (". . .the owner or operator must initiate an assessment of corrective measures to prevent further releases, to remediate any releases, and to restore the affected area.").

residential use of groundwater for drinking water that could be impacted by the Joppa EAP, and no other exposure pathway presented a significant risk. *Id.* at 32. Lastly, the EAP has and will continue to be subject to the groundwater monitoring requirements of Section 845.650, which ensures that any changes in circumstances during the stay that could pose a risk to human health or the environment will be quickly identified.

IV. CONCLUSION

61. For the above reasons, EEI respectfully requests that the Board stay the requirements of Sections 845.650(d), 845.660, 845.670, and 845.680 relating to the Cobalt Exceedance and pH Exceedances at issue in this Petition until the later of (a) the Board's final resolution of this Petition, or (b) if this Petition is granted, IEPA's issuance of a concurrence. Moreover, EEI respectfully requests that the Board grant this Petition for Review and remand to IEPA to issue a new final written response concurring with the Joppa ASD.

Respectfully submitted,

/s/ Joshua R. More
Joshua R. More

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Attorneys for Electric Energy Inc.

BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

ELECTRIC ENERGY, INC.	
Petitioner	**PCB 2023-________**
v.	
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY	
Respondent.	

CERTIFICATE OF SERVICE

I, the undersigned, certify that on this 22nd day of December, 2023:

I have electronically served a true and correct copy of the attached Petition for Review of Illinois Environmental Protection Agency's Non-Concurrence with Alternative Source Demonstration Under 35 Ill. Admin. Code Part 845 and Motion for Stay and Appearances of Joshua R. More, Bina Joshi, and Samuel A. Rasche by electronically filing with the Clerk of the Illinois Pollution Control Board and by e-mail upon the following persons:

Pollution Control Board, Attn: Clerk
100 West Randolph Street
James R. Thompson Center
Suite 11-500
Chicago, Illinois 60601-3218
PCB.Clerks@illinois.gov

Division of Legal Counsel
Illinois Environmental Protection Agency
1021 N. Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276
epa.dlc@illinois.gov

My e-mail address is sam.rasche@afslaw.com

The number of pages in the e-mail transmission is X.

The e-mail transmission took place before 5:00 p.m.

/s/ Samuel A. Rasche
Samuel A. Rasche

Dated: December 22, 2023

ARENTFOX SCHIFF LLP

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Attorneys for Electric Energy, Inc.

BEFORE THE
ILLINOIS POLLUTION CONTROL BOARD

ELECTRIC ENERGY, INC. Petitioner **v.** **ILLINOIS ENVIRONMENTAL PROTECTION AGENCY** Respondent.	**PCB 2023-________**

INDEX OF EXHIBITS

Exhibit A	Letter from Michael Summers, P.G., Manager, Groundwater Section, Division of Public Water Supplies, Bureau of Water, Illinois Environmental Protection Agency to Dianna Tickner, Electric Energy, Inc. (November 16, 2023)
Exhibit B	Ramboll, 35 I.A.C. § 845.650(e): Alternative Source Demonstration, East Ash Pond, Joppa Power Plant, Joppa, Illinois, IEPA ID: W1270100004-02 (October 21, 2023)
Exhibit C	Letter from Dianna Tickner, Sr. Director – Decommission and Demolition, Electric Energy, Inc. to Lauren Martin, Illinois Environmental Protection Agency (November 6, 2023)
Exhibit D	Declaration of Melinda W. Hahn, PhD (December 22, 2023)
Exhibit E	Declaration of Cynthia Vodopivec on behalf of Electric Energy, Inc. (December 22, 2023)

Exhibit A

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 · (217) 782-3397
JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

217-782-1020

November 16, 2023

Dianna Tickner
Electric Energy, Inc.
1500 Eastport Plaza drive
Collinsville, Illinois 62234

Re: Joppa Power Plant East Ash Pond; W1270100004-02
Alternative Source Demonstration Submittal

Dear Ms. Tickner:

The purpose of this correspondence is to notify you that the Illinois Environmental Protection Agency (Illinois EPA) does not concur with the Joppa East Ash Pond Alternative Source Demonstration (ASD) dated October 21, 2023. The Illinois EPA does not concur due to the following data gaps:

1. Source characterization of the CCR at the East Ash Pond must include total solids sampling in accordance with SW846.
    a. 35 IAC 845.650(e) states "the owner or operator of a CCRSI may…submit a demonstration to the Agency that a source other than the CCRSI caused the contamination and the CCRSI did not contribute to the contamination… Either type of ASD must include a report that contains the factual or evidentiary basis for any conclusions…"
        i. The Illinois EPA cannot concur with ASDs that do not include source characterization of the CCR with adequate sampling and analysis of the CCR which must characterize the CCR horizontally and vertically within the CCRSI.
2. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.
    a. 35 IAC 845.640(a) requires evidence of field collection methods and field and laboratory quality control and quality assurance.
    b. 35 IAC 845.650(e) requires alternative source data as evidence of the alternative source, see item 1(a)(i) above. SW846 chapter 1, incorporated by reference in 35 IAC 845, states that regulatory decisions must be made with environmental data.

If you have any questions, please contact: **Lauren Hunt** Illinois EPA, Bureau of Water, WPC #15, P.O. Box 19276, Springfield, Illinois 62794-9276. If you have any questions concerning the investigation described above, please call 217-782-1020.

Sincerely,

Michael Summers, P.G.
Manager, Groundwater Section
Division of Public Water Supplies
Bureau of Water

cc: Lauren Hunt
Keegan MacDonna
Records Files 06M
Jenny Cassel, EARTHJUSTICE

Exhibit B

Luminant

Electric Energy, Inc.
1500 Eastport Plaza Drive
Collinsville, IL 62234

October 21, 2023
Illinois Environmental Protection Agency
DWPC – Permits MC#15
Attn: 35 I.A.C. § 845.650(e) Alternative Source Demonstration Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: Joppa Power Plant East Ash Pond; IEPA ID # W1270100004-02

Dear Mr. LeCrone:

In accordance with Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845.650(e), Electric Energy, Inc. (EEI) is submitting this Alternative Source Demonstration (ASD) for exceedances observed from the Quarter 2 2023 sampling event at the Joppa Power Plant East Ash Pond, identified by Illinois Environmental Protection Agency (IEPA) ID No. W1270100004-02.

This ASD is being submitted within 60 days from the date of determination of an exceedance of a groundwater protection standard (GWPS) for constituents listed in 35 I.A.C. § 845.600. As required by 35 I.A.C. § 845.650 (e)(1), the ASD was placed on the facility's website within 24 hours of submittal to the agency.

One hard copy is provided with this submittal.

Sincerely,

Dianna Tickner

Dianna Tickner
Sr. Director – Decommission and Demolition

Enclosures

Alternate Source Demonstration, Quarter 2 2023, East Ash Pond Joppa Power Plant, Joppa Illinois

Intended for
Electric Energy, Inc.

Date
October 21, 2023

Project No.
1940103649-011

35 I.A.C. § 845.650(e): ALTERNATIVE SOURCE DEMONSTRATION

EAST ASH POND
JOPPA POWER PLANT
JOPPA, ILLINOIS
IEPA ID: W1270100004-02

RAMBOLL Bright ideas. Sustainable change.

CERTIFICATIONS

I, Anne Frances Ackerman, a qualified professional engineer in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used other than for its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.

____
Anne Frances Ackerman
Qualified Professional Engineer
062-060586
Illinois
Ramboll Americas Engineering Solutions, Inc.
Date: October 21, 2023

I, Brian G. Hennings, a professional geologist in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used other than for its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.

____
Brian G. Hennings
Professional Geologist
196-001482
Illinois
Ramboll Americas Engineering Solutions, Inc.
Date: October 21, 2023

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA
T 414-837-3607
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CONTENTS

TABLES (IN TEXT)

FIGURES (IN TEXT)

FIGURES (ATTACHED)

APPENDICES (ATTACHED)

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
ASD	Alternative Source Demonstration
CCR	coal combustion residuals
E001	Event 1
EAP	East Ash Pond
Geosyntec	Geosyntec Consultants
GWPS	groundwater protection standard
JPP	Joppa Power Plant
LAU	Lower aquifer unit
LCU	lower confining unit
LOE(s)	Line(s) of evidence
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
NRT/OBG	Natural Resource Technology, an OBG Company
NTU	nephelometric turbidity units
OBG	O'Brien and Gere Engineers, Inc.
ORP	oxidation reduction potential
PCA	principal component analysis
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
UA	uppermost aquifer
UCU	upper confining unit
WAP	West Ash Pond

1. INTRODUCTION

Under Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.650(e), within 60 days from the date of determination of an exceedance of a groundwater protection standard (GWPS) for constituents listed in 35 I.A.C. § 845.600, an owner or operator of a coal combustion residuals (CCR) surface impoundment (SI) may complete a written demonstration that a source other than the CCR SI caused the contamination and the CCR SI did not contribute to the contamination, or that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction (Alternative Source Demonstration [ASD]).

This ASD has been prepared on behalf of Electric Energy Inc. by Ramboll Americas Engineering Solutions, Inc (Ramboll), to provide pertinent information pursuant to 35 I.A.C. § 845.650(e) for the Joppa Power Plant (JPP) East Ash Pond (EAP) (*i.e.,* Site) located near Joppa, Illinois.

The most recent quarterly sampling event (Event 1 [E001]) was completed on May 3, 2023, and analytical data were received on June 23, 2023. In accordance with 35 I.A.C. § 845.610(b)(3)(C), comparison of statistically derived values with the GWPSs described in 35 I.A.C. § 845.600 to determine exceedances of the GWPS was completed by August 22, 2023, within 60 days of receipt of the analytical data (Ramboll, 2023). The statistical comparison identified the following GWPS exceedances at compliance groundwater monitoring wells:

- Boron at wells G06, G07, G08, G09, G10
- Cobalt at well G05
- pH at wells G11 and G51D

Pursuant to 35 I.A.C. § 845.650(e), the lines of evidence (LOE) presented in **Section 3** and **Section 4** demonstrate that sources other than the EAP are the cause of the cobalt and pH GWPS exceedances (respectively) listed above. Cobalt is believed to be naturally occurring and pH is associated with iron oxidation. This ASD was completed by October 21, 2023, within 60 days of determination of the exceedances (August 22, 2023), as required by 35 I.A.C. § 845.650(e).

Boron GWPS exceedances at the EAP will be addressed in accordance with 35 I.A.C. § 845.660.

2. BACKGROUND

2.1 Site Location and Description

The JPP is west of the Village of Joppa in Massac County, Illinois, northeast of the Ohio River in Section 14, Township 15 South, Range 3 East. The JPP property is bordered by LaFarge North America cement plant to the west, Trunkline Gas Company-Joppa Compressor Station to the north and west, the Village of Joppa to the east, and the Ohio River to the south. The EAP is located in the west half of Section 14 directly north of the JPP and is bounded immediately to the east by the railway right-of-way, which is adjacent to forested portions of residential property in the Village of Joppa.

2.2 Description of East Ash Pond CCR Unit

The JPP operated the EAP for management of CCR waste streams between 1973 and 2022. Another inactive SI, referred to as the West Ash Pond (WAP), is present in the western portion of the JPP property, and a permit exempt landfill is present in the northwestern portion of the JPP property. The landfill and the WAP are not the subject of this ASD but are relevant to the discussion of the LOEs presented below.

The EAP is an unlined CCR SI which was used to manage both fly ash and bottom ash. The EAP perimeter embankment height varies from approximately 15 to 45 feet above the outboard toe of slope and the crest is at an approximate elevation of 380 feet North American Vertical Datum of 1988 (NAVD88) (O'Brien and Gere Engineers, Inc. [OBG], 2010).

2.3 Geology and Hydrogeology

The information used to describe the hydrogeology is based on the local geology obtained from published sources, hydrogeologic investigation data, and boring data collected during site investigations conducted from 1997 to 2022 (Natural Resource Technology, an OBG Company [NRT/OBG], 2017; Ramboll, 2021a; Geosyntec, 2023).

Quaternary deposits in the Joppa area consist mainly of diamictons and lacustrine/alluvial deposits that were deposited during Illinoian and Pre-Illinoian glaciations (Lineback, 1979; Willman et al., 1975). The unconsolidated deposits include the following units (beginning at the ground surface):

- **Upper Confining Unit (UCU):** The uppermost hydrostratigraphic unit is comprised of the Equality Formation, the Silt Unit, and Metropolis Formation deposits. The average thickness of this unit is approximately 40 feet with a range of 8 to 58 feet. The UCU underlies the CCR fill in all locations and is thinnest in the southeast portion of the unit. These deposits are predominantly fine-grained, comprised of clay, silt, and silty clay with limited intervals of sandy material. This hydrostratigraphic unit was encountered at all locations and extends down to the McNairy Formation.
- **Uppermost Aquifer (UA):** The UA consists of the McNairy Formation and Mounds Gravel which are composed of highly permeable sands and gravels with isolated lenses of finer grained material. The Mounds Gravel has been interpreted as a braided river deposit, located within eroded portions of the McNairy Formation (Nelson and Masters, 2008). The McNairy formation, underlying the Mounds Gravel, at the site is mostly composed of medium to fine grained sand with mica and lenses of silt and clay. At the EAP, this unit has been further divided into the Upper McNairy Formation consisting of relatively thick fine to medium grained

sand with some gravel while the Lower McNairy exhibits more variability including lenses and zones with higher silt and clay content.

A northwest to southeast trending stratigraphic high in the UA is present through the center of the EAP and bifurcates near the eastern extent of the unit. This stratigraphic high (elevations higher than 305 ft) is illustrated on **Figure 1** where the UA is bounded by the UCU which is shaded purple where elevations extend below 305 feet. Wells screened within the UA along the southern fork of the stratigraphic high (G07, G08, G12S/D, G13S/D) generally encountered thicker gravel layers at higher elevations and reported higher hydraulic conductivities (Ramboll, 2021a; Geosyntec, 2023). The thicker gravels at higher elevations also extend east and southeast of the EAP (G12S/D, G13S/D, G16S/D) and connect to the Ohio River as illustrated in **Figure 1**. The UA was encountered at a thickness of up to 58 feet thick, with elevations ranging from 215 to 316.6 feet, and is underlain by the lower confining unit (LCU).

- **Lower Confining Unit (LCU):** Clay, silt, or chert gravel residuum in on-Site wells (Nelson, 1997) has been interpreted and characterized as part of the Lower McNairy Formation, Post Creek (Tuscaloosa) Formation, or weathered limestone residuum. This material has been encountered in all borings advanced to bedrock. Based on material descriptions (high clay and/or silt content, and partial cementation), continuous lateral extent, and vertical gradients observed between the UA and the lower aquifer unit (LAU), this unit is identified as the LCU.
- **Lower Aquifer Unit (LAU):** The LAU, composed of the Salem Limestone bedrock, is the lowermost hydrostratigraphic unit identified and is considered a potential migration pathway (PMP). The limestone bedrock is encountered at an elevation of approximately 200 feet NAVD88 below the EAP, slopes towards a syncline to the east (Nelson and Masters, 2008), and has a reported thickness of 200 to 500 feet. The Salem Limestone is used to supply water for various uses in the region and provides non-potable water for the JPP and potable water for the Village of Joppa.

Groundwater elevations in the UA (referenced to NAVD88) across the EAP ranged from approximately 312 to 322 feet during E001 (**Figure 2**). Historically they have ranged from approximately 305 feet near the Ohio River to 330 feet near the northern property boundary. Depth to groundwater measurements used to generate the groundwater elevation contours shown on **Figure 2** were collected on May 1, 2023. Groundwater elevations vary seasonally and may fluctuate by about 10 feet within a well.

Groundwater flow directions are largely a result of the aquifer geology described above. The shallow highly permeable gravels present a path of least resistance (preferential flow pathway) for groundwater migrating toward the Ohio River which is the receiving body of water in the region (**Figure 1**). Wells located to the north of the UA stratigraphic high, such as G05, were terminated shortly after penetrating the UA and did not encounter significant gravel layers indicating gravel may be at a lower elevation or not present, and flow through this area may not be as significant. Interpreted groundwater flow directions are illustrated on **Figure 1** with flow to the southeast, generally parallel to the UA stratigraphic high across the EAP, and then south toward the Ohio River.

2.4 Groundwater and EAP Monitoring

The monitoring system for the EAP is shown on **Figure 2** and consists of two background monitoring wells (G01D and G02D) and 12 compliance monitoring wells (G03, G05, G06, G07, G08, G09, G10 G11, G51D, G52D, G53D, and G54D) screened within the UA. The monitoring system also includes two temporary water level only surface water staff gage (XSG01 and SG02) to monitor potential impacts from the EAP (Ramboll, 2021b). Porewater samples are collected from locations XPW01 and XPW02 on the northern side of the EAP, and from XPW03 on the southern side of the EAP (**Figure 2**). To further delineate potential boron exceedances, 10 monitoring wells were installed in September 2021 (nests G12 through G16) and 21 wells (10 off-Site) were installed between May 2022 and September 2023 (nests G17 through G24, and G13; Geosyntec Consultants [Geosyntec], 2023).

3. ALTERNATIVE SOURCE DEMONSTRATION: LINES OF EVIDENCE FOR COBALT

As allowed by 35 I.A.C. § 845.650(e), this ASD demonstrates that sources other than the EAP (the CCR unit) caused the cobalt exceedance at G05. LOEs supporting the ASD for the pH exceedances at G11 and G51D are presented in **Section 4**. This section presents the LOEs supporting the ASD for cobalt at G05, which include the following:

1. Cobalt concentrations at G05 are consistent with cobalt mobilization from native soils due to reductive dissolution of manganese oxides.
2. Cobalt concentrations at G05 are greater than source concentrations.
3. Cobalt concentrations at G05 are not correlated with concentrations of CCR indicator parameters.

3.1 LOE #1: Cobalt Concentrations at G05 are Consistent with Cobalt Mobilization from Native Soils Due to Reductive Dissolution of Manganese Oxides

Cobalt and manganese are often closely associated with each other in soils due to their similar chemical properties (Uren, 2013). Under oxidizing conditions, manganese is present in the solid phase as manganese oxides. Cobalt sorbs strongly to manganese oxides and is thus often associated with manganese in the solid phase. When solid-phase manganese oxides in soils are dissolved by reduction of manganese to a more soluble species (a process called reductive dissolution), the cobalt previously sorbed to the manganese oxide surface is also released. If cobalt concentrations in groundwater are primarily controlled by the reductive dissolution of manganese oxides, cobalt and manganese concentrations in both soils and groundwater will be correlated with one another. This LOE demonstrates that cobalt concentrations at G05 are consistent with reductive dissolution of manganese, and the cobalt exceedance at G05 is therefore likely due to natural variation in groundwater quality. Solid phase data were used to determine if cobalt and manganese are associated in the solid phase. Groundwater redox potential and pH were assessed to determine if reductive dissolution of manganese oxides is thermodynamically favorable under observed groundwater conditions. To inform further analysis of groundwater data, wells with a geochemical signature similar to G05 were identified using principal component analysis (PCA). The relationship between cobalt and manganese in similar groundwater was then evaluated using regression analysis.

Figure A on the following page shows the relationship between total cobalt and total manganese in soil samples from the UA at five soil boring locations (data tabulated in **Appendix A**). The strong correlation between cobalt and manganese in these data (R^2 of 0.99) indicates that they are likely physically associated in soils, consistent with literature data (Uren, 2013). It is possible that cobalt released from CCR porewater could become associated with naturally occurring manganese oxides in the downgradient environment and accumulate in the soils; however, this is not likely at the site based on the following observations: 1) Cobalt is not present in CCR porewater (described further in **Section 3.2**), indicating that the EAP could not be a source of cobalt to the downgradient solid phase; 2) The ratio of cobalt to manganese is consistent across five different samples, some of which are from areas of the site with no known influence from

CCR porewater (*i.e.*, have had no reported exceedances). Therefore, the cobalt present in the UA soil is likely naturally occurring.

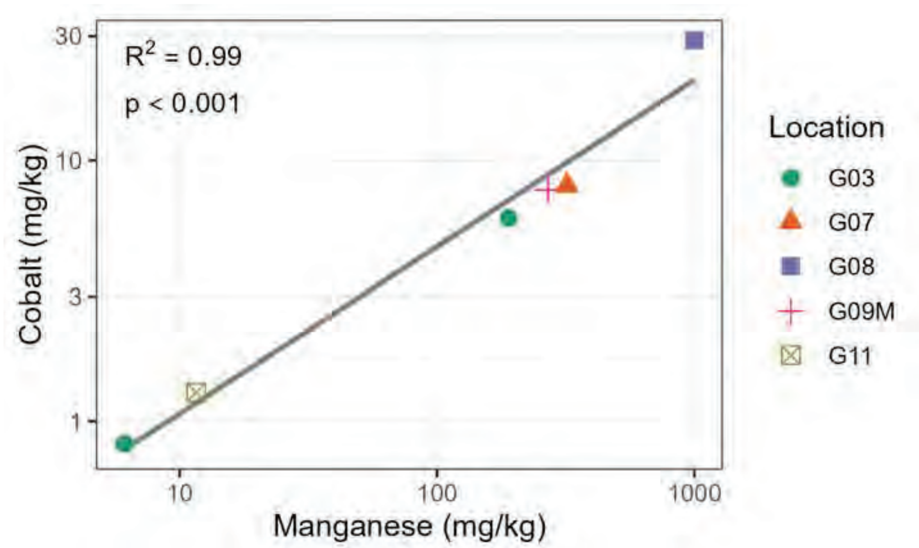

Figure A. Scatter Plot and Linear Regression Results of Cobalt and Manganese in UA Solids
mg/kg = milligrams per kilogram

The thermodynamic favorability of manganese oxide reductive dissolution depends on the oxidation reduction potential (ORP) and pH of the groundwater. The pH and ORP of the groundwater samples collected from the EAP monitoring network all indicate that manganese is expected to exist in the reduced Mn^{2+} form in groundwater (**see Appendix B**), supporting the conclusion that reductive dissolution of manganese oxides can occur in the groundwater.

To determine if cobalt and manganese are correlated in groundwater, locations with a similar groundwater signature to G05 were identified for appropriate inclusion in the correlation analysis. PCA, a multivariate statistical approach, was used to evaluate how the groundwater composition at G05 related to the groundwater composition of EAP porewater, background groundwater, and downgradient groundwater north versus south of the UA stratigraphic high (**Section 2.3**). Details about the PCA analysis are included in **Appendix B**. The PCA results indicate that the geochemical signatures of the UA wells located on either side of the northwest to southeast trending stratigraphic high in the UA that extends through the EAP are largely distinct from one another, with wells to the north of the stratigraphic high being more similar to background. This difference may be related to the differences in stratigraphic conditions, with wells to the north of the stratigraphic high having less gravel beds, while the wells to the south of the stratigraphic high have shallow highly permeable gravels which create a preferential flow pathway to the south. Groundwater from well G05 is most like other northeast wells, suggesting similar geochemical influences.

Figure B on the following page shows the relationship between total cobalt and total manganese in wells to the north of the stratigraphic high (data tabulated in **Appendix C**). To avoid potential confounding effects due to the presence of suspended solids in the groundwater sample, only samples with a turbidity less than 50 nephelometric turbidity units (NTU) were used in the correlation analysis. The strong (R^2 of 0.77) statistically significant ($p < 0.001$) correlation between total cobalt and total manganese in the groundwater suggests similar controls on concentrations.

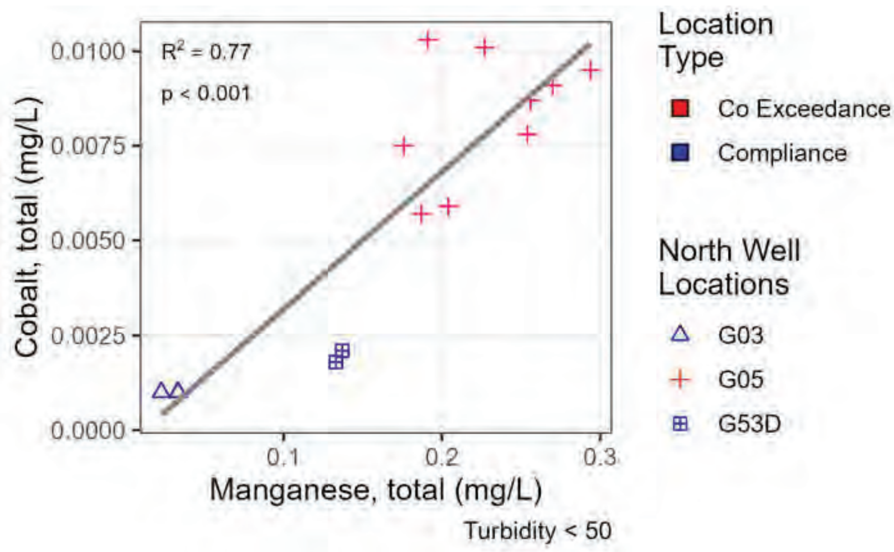

Figure B. Scatter Plot and Linear Regression Results of Total Cobalt and Total Manganese in Groundwater

The strong association between cobalt and manganese in both the soil and groundwater, in addition to groundwater conditions in the area of G05 favoring manganese reduction, supports the conclusion that reductive dissolution of manganese oxides in native soil is occurring and is strongly influencing the cobalt concentrations in the groundwater rather than the EAP.

3.2 LOE #2: Cobalt Concentrations at G05 are Greater Than Source Concentrations

Table A on the following page provides the range of cobalt concentrations detection in G05 between March 2021 and May 2023. Porewater samples collected from XPW01, XPW02 and XPW03 between March 2021 and May 2023 did not have cobalt concentrations above the reporting limit. A summary of the laboratory data is included in **Appendix C**.

Table A. Cobalt Concentration Ranges in G05 and EAP Porewater (March 2021 to May 2023).

Sample Location	Cobalt (mg/L)			
	Samples	Non-Detects	Minimum	Maximum
Composite Porewater[1]	24	24	<0.0001	<0.001
G05	11	0	0.0057	0.0103

[1] Composite Porewater includes summary statistics of data collected at EAP porewater locations XPW01, XPW02, and XPW03
mg/L = milligrams per liter

The following observations can be made from **Table A**:

- The concentration of cobalt in compliance monitoring well G05 ranged from 0.0057 mg/L to 0.0103 mg/L.
- Cobalt was not detected in EAP porewater, with reporting limits ranging from 0.0001 mg/L to 0.001 mg/L.
- The minimum cobalt concentration observed at G05 is five times the highest reporting limit for cobalt in porewater.

If the EAP were the source of cobalt in downgradient groundwater, EAP porewater concentrations of cobalt would be expected to be higher than the groundwater concentrations. Cobalt was not detected above the reporting limit in any porewater samples, indicating that cobalt concentrations are not related to the EAP.

3.3 LOE #3: Cobalt Concentrations at G05 Are Not Correlated with Concentrations of CCR Indicator Parameters

Boron is commonly used as an indicator parameter for contaminant transport of CCR because: (i) it is commonly present at elevated concentrations in coal ash leachate; (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater; and (iii) it is less likely than other constituents to be present at elevated concentrations in background groundwater from natural or other anthropogenic sources. Porewater in the EAP is elevated in both boron and sulfate (**Appendix C**), indicating that these parameters are Site-specific key indicators for CCR. If an exceedance is identified for a monitored CCR parameter but concentrations of boron and sulfate are not correlated with that parameter, it is unlikely that the CCR unit is the source of the GWPS exceedance.

A scatter plot of cobalt versus boron and sulfate concentrations for G05 between March 2021 and May 2023 is presented in **Figure C** on the following page and laboratory data is included in **Appendix C.** The p-value of a Kendall correlation test for non-parametric data are also included on **Figure C**. Typically, a p-value greater than 0.05 is considered to be a statistically insignificant relationship.

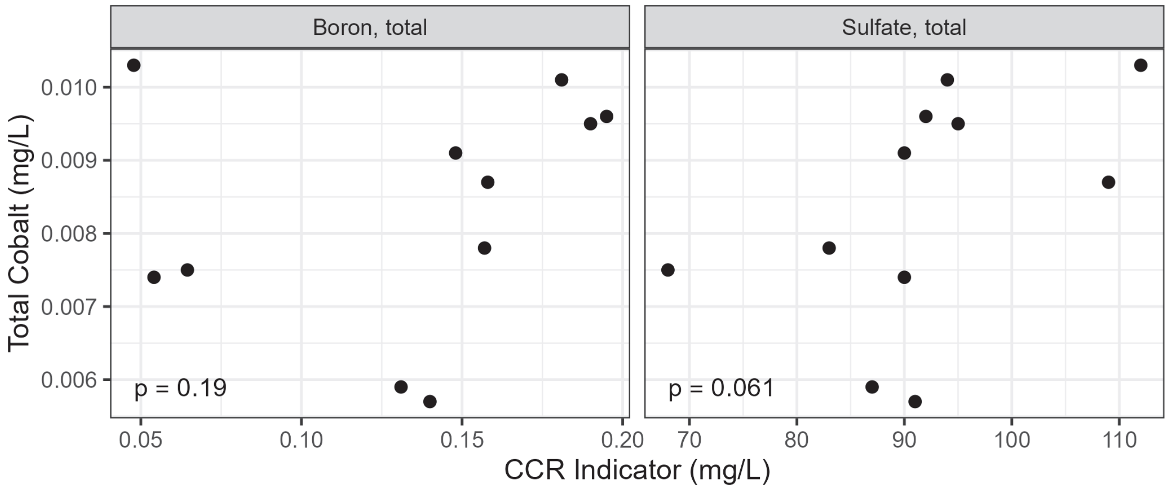

Figure C. Scatter Plot of Cobalt Versus Boron and Sulfate Concentrations at Monitoring Well G05

Calculated p-values greater than 0.05 indicate that cobalt is not correlated with boron and sulfate at monitoring well G05. A lack of correlation between cobalt and CCR indicators in the compliance monitoring well indicates the EAP is not the source of the cobalt exceedance.

4. ALTERNATIVE SOURCE DEMONSTRATION: LINES OF EVIDENCE FOR pH

As allowed by 35 I.A.C. § 845.650(e), this ASD demonstrates that sources other than the EAP (the CCR unit) caused the pH exceedances at G11 and G51D. This section presents the LOEs supporting the ASD for pH at G11 and G51D, which include the following:

1. G11 and G51D are upgradient of the EAP.
2. Groundwater chemistry at G11 and G51D is aligned with the groundwater signature observed west of the monitoring wells.
3. pH exceedances at G11 and G51D are consistent with iron oxidation.

These LOEs are summarized below and described in greater detail in **Appendix D**.

4.1 LOE #1: G11 and G51D are Upgradient of the EAP

As described in **Section 2.3** dominant UA groundwater flow direction at the EAP is to the southeast, generally parallel to the UA stratigraphic high across the EAP, and then south toward the Ohio River (**Figure 1**). Wells G11 and G51D are located on the western edge of the EAP and are upgradient of the EAP. Therefore, it is unlikely that porewater from the EAP would flow in the direction of G11 and G51D. Because the wells with pH exceedances are upgradient of the unit, it is unlikely that the EAP is the source of the exceedances.

4.2 LOE #2: Groundwater Chemistry at G11 and G51D is Aligned with the Groundwater Signature Observed West of the Monitoring Wells

Groundwater from exceedance wells G11 and G51D exhibit a high degree of similarity with groundwater from upgradient UA wells west of G11 and G51D (western groundwater) as opposed to eastern groundwater or CCR porewaters from other compliance wells in the EAP monitoring network (eastern groundwater). PCA (**Appendix D**) was used to compare the geochemical compositions of the western groundwater, CCR porewaters, and pH exceedance wells G11 and G51D. The PCA found that:

- Exceedance wells G51D and G11 exhibit a high degree of similarity with the western (*i.e.*, upgradient) wells screened in the UA.
- The CCR porewaters are distinctly separate from the groundwater samples.

The similarity of the groundwater composition at G11 and G51D to upgradient western groundwater, as opposed to eastern groundwater or CCR porewater, suggests that the EAP does not influence the groundwater at G11 and G51D and therefore is not the source of the pH exceedances.

4.3 LOE #3: pH Exceedances at G11 and G51D are Consistent with Iron Oxidation

The PCA analysis (**Appendix D**) suggests chemical evolution and/or communication within the western groundwater. The western UCU groundwater composition is dominated by the redox-sensitive parameters manganese, iron, and sulfate. The UA groundwater composition is spread between a composition similar to the UCU and a composition similar to background. Groundwater composition at wells G11 and G51D is very similar to (*i.e.*, plots close to on the PCA diagram) the background wells, all of which are dominated by alkalinity, chloride, fluoride and sodium.

Redox conditions were evaluated along the flow path from upgradient (further northwest) to downgradient (further southeast) groundwater wells. A distinct redox transition was identified, shifting from more reducing conditions in upgradient waters to more oxidizing conditions in downgradient wells, including the exceedance wells. The reducing upgradient waters are characterized by lower ORP and higher iron concentrations, while downgradient waters are largely the opposite with higher ORP and lower iron concentrations.

This change in redox condition is the likely source of acidity in G11 and G51D. It is likely that dissolved iron present in reducing environments moves downgradient with groundwater and subsequently oxidizes. The oxidation of dissolved iron to iron oxides is known to produce acidity. In this way, reduced upgradient waters from the northwest provides the constituent (*i.e.*, reduced iron) necessary to cause a drop in pH (*i.e.*, through iron oxidation) in G11 and G51D, once transported into an area with sufficient dissolved oxygen to drive the precipitation reaction. The oxidized environment in wells G11 and G51D likely results from mixing with the upgradient oxidized background groundwater. Therefore, mixing of groundwater resulting in natural variability in the groundwater conditions is the likely driver of the pH exceedances at G11 and G51D.

5. CONCLUSIONS

Based on the LOEs presented below and described in **Section 3**, it has been demonstrated that sources other than the EAP (the CCR unit) caused the cobalt exceedance at G05.

1. Cobalt concentrations at G05 are consistent with cobalt mobilization from native soils due to reductive dissolution of manganese oxides.
2. Cobalt concentrations at G05 are greater than source concentrations.
3. Cobalt concentrations at G05 are not correlated with concentrations of CCR indicator parameters.

Furthermore, based on the LOEs presented below and described in **Section 4**, it has been demonstrated that sources other than the EAP caused the pH exceedances at G11 and G51D.

1. G11 and G51D are upgradient of the EAP.
2. Groundwater chemistry at G11 and G51D is aligned with the groundwater signature observed west of the monitoring wells.
3. pH exceedances at G11 and G51D are consistent with iron oxidation.

Pursuant to 35 I.A.C. § 845.650(e), the LOEs presented in **Section 3** and **Section 4** demonstrate that sources other than the EAP were the cause of the cobalt and pH GWPS exceedances (respectively) listed above. Boron GWPS exceedances at the EAP will be addressed in accordance with 35 I.A.C. § 845.660.

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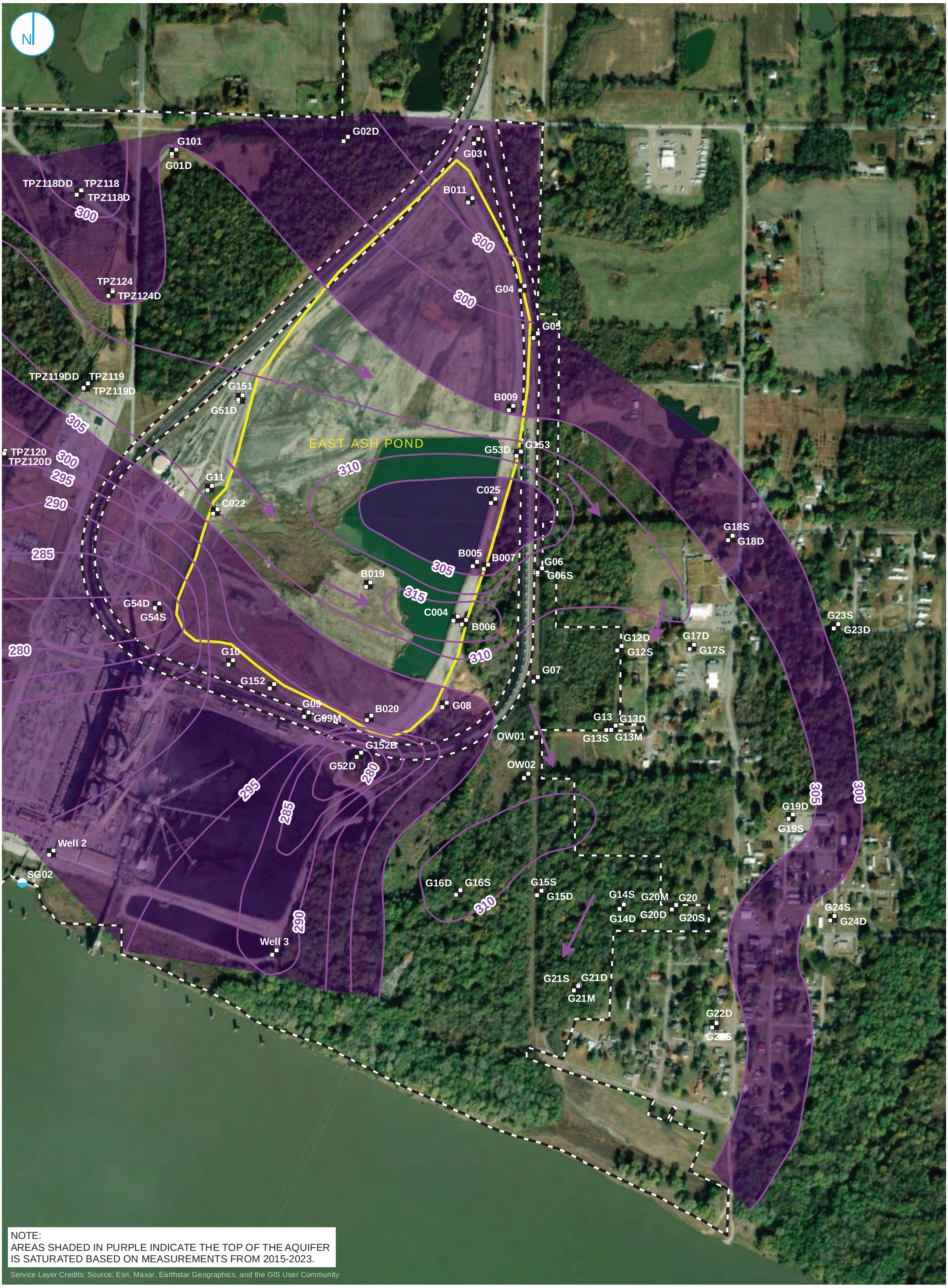
FIGURES

PROJECT: 169000XXXX | DATED: 10/12/2023 | DESIGNER: GALARNMC

Y:\Mapping\Projects\22\2285\MXD\Alt_Source_Dem\JOP_EAP\E001\Figure 1_Top of Upper Aquifer.mxd



MONITORING WELL

STAFF GAGE, RIVER

TOP OF MCNAIRY FORMATION ELEVATION (5-FT CONTOUR INTERVAL)

FLOW DIRECTION

AREA WHERE TOP OF AQUIFER IS SATURATED BASED ON MEASUREMENTS FROM 2015-2023

REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 300 600 Feet

TOP OF UPPERMOST AQUIFER

FIGURE 1

35 I.A.C. § 845.650(e): ALTERNATIVE SOURCE DEMONSTRATION
EAST ASH POND
JOPPA POWER PLANT JOPPA, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 10/12/2023 | DESIGNER: GALARNMC

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COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
PORE WATER WELL
STAFF GAGE, RIVER
MONITORING WELL
STAFF GAGE, CCR UNIT

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 300 600 Feet

NOTES
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
*GAGING DATA FROM USGS 03612600 OHIO RIVER AT OLMSTED, IL LOCATED APPROXIMATELY 12 MILES DOWNSTREAM OF JOPPA POWER PLANT.

SAMPLING LOCATIONS AND POTENTIOMETRIC SURFACE MAP - MAY 1, 2023

FIGURE 2

35 I.A.C. § 845.650(e): ALTERNATIVE SOURCE DEMONSTRATION
EAST ASH POND
JOPPA POWER PLANT
JOPPA, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

APPENDICES

APPENDIX A
SUPPORTING SOLID PHASE ANALYTICAL DATA

APPENDIX A.
SUPPORTING SOLIDS PHASE ANALYTICAL DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Boring ID	Sample Elevation (feet NAVD88)	Cobalt (mg/kg)	Manganese (mg/kg)
G03	284.84 - 297.34	6.0	190
G03	294.84 - 296.84	0.82	6.1
G07	294.34 - 300.34	8.0	320
G08	261.72 - 266.72	29	1000
G09M	264.60 - 266.60	7.7	270
G11	303.38 - 305.38	1.3	11.6

Notes:
NAVD88 = North American Vertical Datum of 1988
mg/kg = milligrams per kilogram

APPENDIX B
SUPPORTING ANALYSIS OF REDUCTIVE DISSOLUTION OF MANGANESE OXIDES AS A LIKELY SOURCE OF COBALT CONCENTRATIONS AT G05

RAMBOLL

ENVIRONMENT
& HEALTH

TECHNICAL MEMORANDUM

Project no. 1940103649-011
Client Electric Energy, Inc.
Prepared by Alison O'Connor, Ph.D.

Supporting Analysis for Reductive Dissolution of Manganese Oxides as a Likely Source of Cobalt Concentrations at G05
Joppa Power Plant, East Ash Pond

October 12, 2023

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1 INTRODUCTION

This document serves as an appendix for the October 21, 2023, Alternative Source Demonstration (ASD) for Joppa Power Plant (JPP) East Ash Pond (EAP) for monitoring Event 1 (E001), completed to fulfil the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.650(e).

Cobalt and manganese are often closely associated in soils due to their similar chemical properties (Uren, 2013). In igneous rocks, cobalt and manganese occur together in minerals due to carrying +2 charge and having similar atomic radii (Uren, 2013). Cobalt and manganese are released together during weathering processes and are often transported together through the environment. In highly oxidizing environments, manganese 2+ can be oxidized to manganese 4+ which exists as solid phase manganese oxide minerals. Cobalt sorbs strongly to manganese oxides compared to other divalent cations (McKenzie, 1967; Backes et al., 1995). Therefore, manganese-associated cobalt is released when solid-phase manganese oxides in soils are dissolved by reduction to a more soluble species.

This line of evidence (LOE) demonstrates that cobalt concentrations at G05 are consistent with reductive dissolution of manganese, and the cobalt exceedance at G05 is therefore likely due to natural variation in groundwater quality. Solid phase data were used to determine if cobalt and manganese are associated in the solid phase. To inform further analysis of groundwater data, wells with a geochemical signature like G05 were identified using principal component analysis (PCA). The relationship between cobalt and manganese in similar groundwater was then evaluated using regression analysis.

2 METHODS

2.1 Solid Phase Measurements

Total cobalt and total manganese data were available for samples collected from the uppermost aquifer (UA) at five boring locations. Six total samples were available (two samples were collected from G03). These soil data represent the acid-digestible portion of the solids phase, which may be mobilized under environmental relevant geochemical conditions. Any metals entrained within the highly refractory aluminosilicate matrix are not extracted.

2.2 Regression Analysis

Least squares linear regression (abbreviated here as regression analysis) was used in this work to understand correlations between data. Regression analysis determines the equation for the line that minimizes the sum of the squared differences between the data and the regression estimate. Regression analysis assumes that the errors in the regression (called residuals) have a mean of zero and are randomly distributed around the mean following a normal distribution. The distribution of regression residuals can be visualized by plotting the residuals against the fitted values.

The relationship between the variables is assessed using the p value and the R^2 of the regression. The p value represents the chance the relationship between the data is due to random variability. A cut off p value of 0.05 often is used to determine if a regression is statistically significant (*i.e.,* it has less than a 5 percent (%) chance of being due to random variability). The R^2 value represents the proportion of the variance in the dependent variable that is explained by the independent variable. A higher R^2 value indicates a close relationship between the two variables (with an R^2 of 1 representing a perfectly straight line).

2.3 Principal Component Analysis

Groundwater data is frequently defined by many chemical parameters and may therefore be described statistically as "multivariate". PCA is a common multivariate statistical approach that simplifies multivariate data by combining those variables into a smaller number of new variables called principal components. This is possible because in multivariate data sets, there is often some correlation between variables. These correlations represent "redundant" information that may be mathematically removed by PCA. The principal components represent linear combinations of the original data which maximize the variance between the samples, and which are uncorrelated with one another. PCA thereby allows patterns in the data to be more easily recognized and correlations between input variables to be assessed.

The goal of this PCA was to identify wells similar to G05 and which are therefore likely affected by similar geochemical processes. The groundwater potentiometric map (E001 ASD Figure 2) and stratigraphic conditions in the UA (E001 ASD Section 2.3) suggest that wells in different areas downgradient of the EAP may be influenced by different areas of upgradient water. Additionally, as discussed in Appendix D, compliance wells G11 and G51D are strongly influenced by groundwater west of the EAP. To focus this analysis on identifying distinct populations of downgradient groundwater, the dataset for this PCA included only background wells, EAP porewater, and compliance wells east and south of the EAP (*i.e.*, downgradient from the unit; see E001 ASD Figure 2) screened in the UA.

Samples with a turbidity greater than 50 nephelometric turbidity units (NTU) were excluded from the analysis to mitigate the confounding influence of suspended solids. Geochemical parameters excluded from the PCA were to have measurements in over half the samples or to have an overall proportion of detected measurements exceeding 50 %. Individual samples missing data for more than half of the parameters (7 of 14 included in the PCA) were excluded from the analysis. Any measurements that were below the reporting limit were assumed to be half the reporting limit. Results for pH were converted to milligrams per liter (mg/L) H^+ ion for consistency with other analytes. Any missing values were imputed (*i.e.,* interpolated based on the available data) using the nearest neighbor method. The final data set (**Attachment A**) contained 1,232 parameter measurements (67 of which were imputed) from 88 individual groundwater samples at 15 wells in the vicinity of the EAP (three porewater wells, two background wells, and 10 compliance wells). All data were log transformed, scaled, and centered so that parameters with larger concentrations did not have disproportionate influence on the results.

Results of the PCA analysis are presented in a biplot. In a PCA biplot, the axes represent the new "variables," or principal components (PCs). The length of the arrows represents how strongly each individual variable contributes to the PCs, and the direction of the arrow along the respective axis represents the direction of the contribution (positive or negative). Each data point represents a sample plotted according to the PCs.

2.4 Pourbaix Diagrams

Pourbaix diagrams, also called Eh-pH diagrams, are visual representations of redox speciation under equilibrium conditions at a given pH (x axis) an Eh (y axis). Eh is the measure of redox potential based on the standard hydrogen electrode and is calculated by converting an oxidation reduction potential (ORP) measurement using an equation appropriate to the type of electrode used in the ORP sensor (typically silver/silver chloride or calomel). An Aqua TROLL field meter was used to measure ORP in the field. The equation to convert ORP to Eh for this meter is[1]:

Eh = ORP (mV) + 221.4 – 0.9*Temperature (°C)

3 RESULTS AND DISCUSSION

3.1 Regression quality

The results of the regressions of aquifer solids and groundwater data are presented in the main text of the ASD. This section discusses how the regressions meet the standard assumptions.

For the regression of aquifer solids data, the residuals are most extreme in the negative direction, but the mean of the residuals is zero and there is considerable scatter (**Figure B-1**). Therefore, the regression meets the assumptions relatively well.

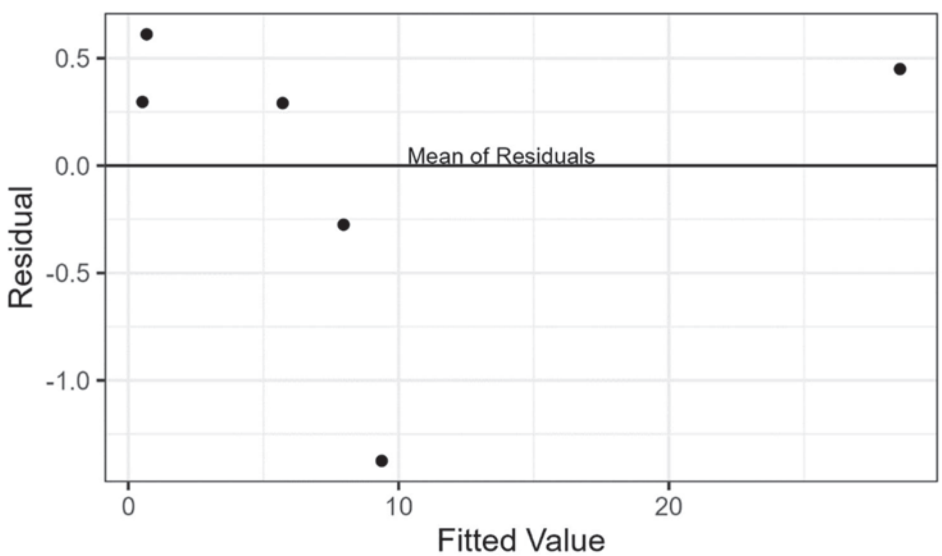

Figure B-1. Plot of residuals against fitted values for the UA solids cobalt versus manganese regression model.

[1] As reported at https://in-situ.com/us/news/orp-field-measurements-reporting-redox-potential-eh-correctly

For the regression of groundwater data, the residuals are most extreme toward the middle of the fitted values, but the mean of the residuals is zero and there is considerable scatter (**Figure B-2**). Therefore, the regression meets the assumptions relatively well.

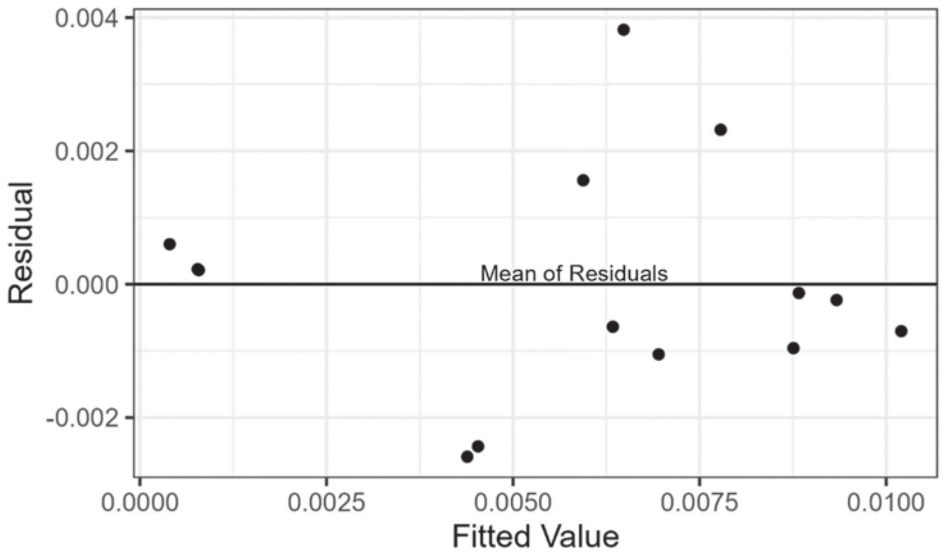

Figure B-2. Plot of residuals against fitted values for the groundwater cobalt versus manganese regression model.

3.2 Pourbaix Diagram

Figure B-3 shows the Pourbaix diagram for manganese with 2023 groundwater data plotted. Manganese is expected to exist in the reduced Mn^{2+} form at all groundwater locations (including G05), as opposed to insoluble manganese oxide mineral forms (*i.e.*, birnessite and todorokite). This indicates that reductive dissolution of manganese oxide minerals is thermodynamically favorable at G05, which supports this mechanism as a source of cobalt in the groundwater.

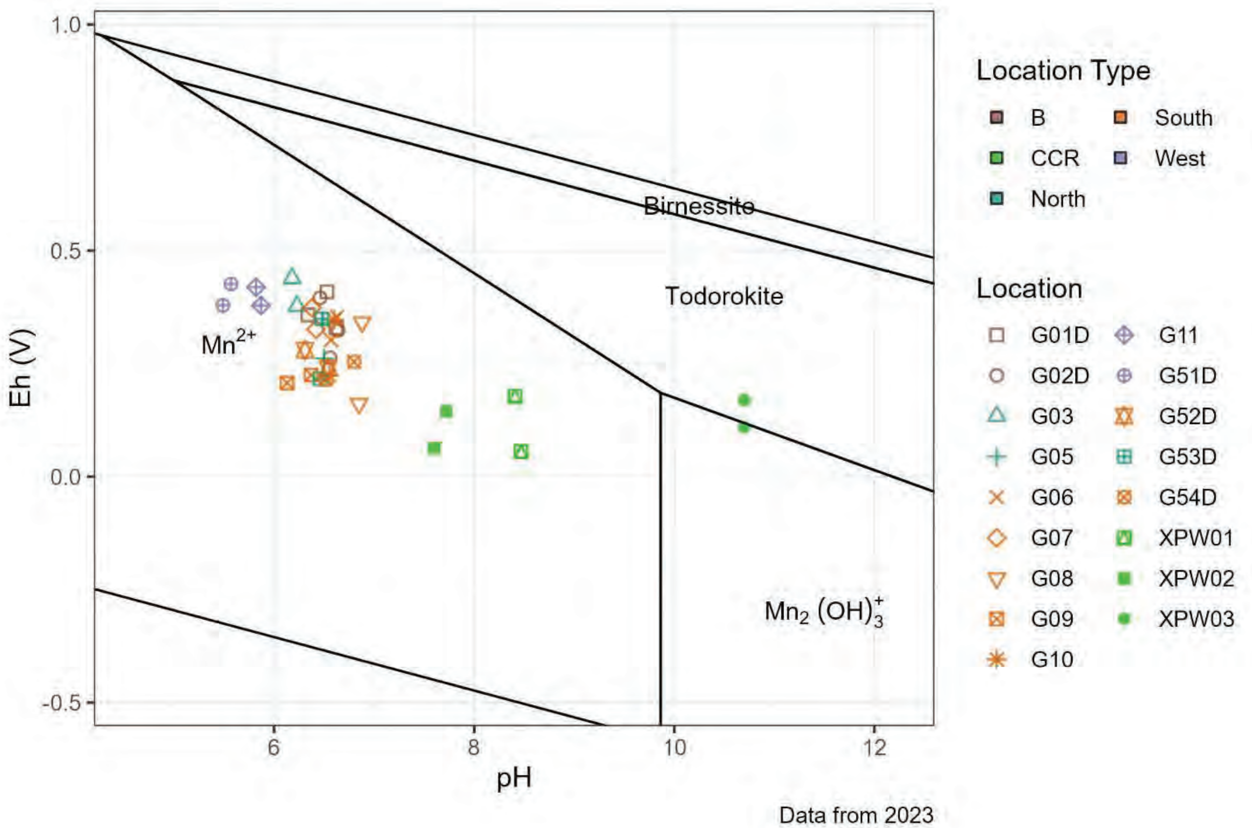

Figure B-3. Manganese Pourbaix diagram with 2023 Eh and pH data from groundwater and porewater.

3.3 PCA

The PCA biplot (**Figure B-4**) shows the results of the PCA analysis with wells colored by location type: background, CCR porewater, north of the UA stratigraphic high ("north"), south of the UA stratigraphic high ("south"), and G05 as the cobalt exceedance location. Approximately 58% of the variability in the data is encompassed in the first two principal component (PC1 explains approximately 40% of the variability in the data, and PC2 explains approximately 18%). Ninety-five % confidence ellipses for the north wells and south wells are shown in their respective location type colors. The minimal overlap of the 95% confidence ellipses shows that the groundwater compositions from the north wells and the south wells are largely distinct from one another. Well G05 plots within the 95% confidence ellipse for the north wells, indicating similarity of groundwater composition. The similarity between the north wells and dissimilarity from the south wells indicates that groundwater from these two groups of wells should be considered as distinct populations of data.

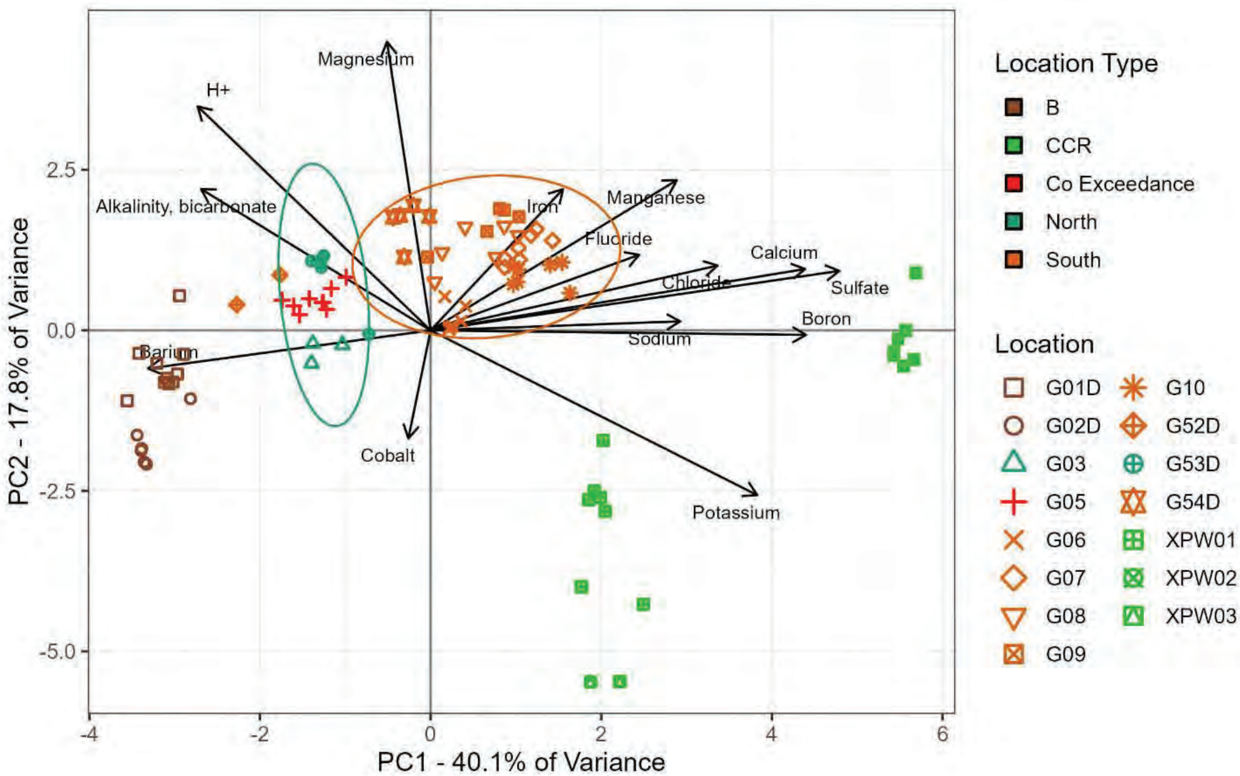

Figure B-4. Biplot of PCA results.

3.4 Redox Environment at JPP EAP

Appendix D of the associated E001 ASD, which addresses pH exceedances on the west side of the EAP, identifies a redox front west of the pond as driving iron oxidation and an associated drop in pH. The redox potential at which iron reduction/oxidation occurs is more reducing than the manganese reduction/oxidation potential. The redox potential and pH at wells G51D and G11 are consistent with an iron redox transition (Appendix D, Attachment 6-B) but all recent EAP groundwater samples fall within manganese-reducing conditions (Figure B-3). G05 is not substantially more reducing than other nearby wells without elevated cobalt. Appendix A of the E001 ASD shows that cobalt and manganese concentrations in the soil encompass 1.5 and 2.5 orders of magnitude difference, respectively, across the UA. In contrast to a redox front driving an iron speciation transition west of the EAP, local variations in solid phase cobalt and manganese concentrations appear to drive the differences in cobalt concentrations in groundwater.

4 CONCLUSIONS

The methods and results reported in this appendix support the conclusion that cobalt concentrations at G05 are consistent with mobilization due to reductive dissolution of manganese oxides. The regression analyses for cobalt and manganese correlation in solid phase material and groundwater are validated by illustrating the quality of the regressions. The Pourbaix diagram shows the manganese speciation in greater detail and concludes that reductive dissolution of manganese is thermodynamically favorable. The detailed PCA results show that the wells north and south of the UA stratigraphic high have distinct groundwater quality signatures and should be analyzed as distinct populations. Along with the strong association between cobalt and manganese in both the soil and groundwater, these results support the conclusion that the reductive dissolution of manganese oxides is a primary control on cobalt concentrations in the groundwater.

5 REFERENCES

Backes, C.A., McLaren, R.G., Rate, A.W. and Swift, R.S., 1995. Kinetics of Cadmium and Cobalt Desorption from Iron and Manganese Oxides. *Soil Sci. Soc. Am. J.*, **59**: 778-785.

McKenzie, R.M., 1967. The sorption of cobalt by manganese minerals in soils. *Aust. J. Soil Res.* **5**: 235-246.

Uren, N.C., 2013. *Heavy Metals in Soils: Trace Metals and Metalloids in Soils and their Bioavailability*. Ed. B.J. Alloway. Springer Science+Business Media. Chapter 12: Cobalt and Manganese. p 335-366.

ATTACHMENTS

Attachment A Electronic PCA Data

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G01D	3/3/2021	Alkalinity, bicarbonate	209	FALSE	FALSE
G01D	3/3/2021	Calcium	25.8	FALSE	FALSE
G01D	3/3/2021	Magnesium	7.79	FALSE	FALSE
G01D	3/3/2021	Sodium	79	FALSE	FALSE
G01D	3/3/2021	Potassium	1.24	FALSE	FALSE
G01D	3/3/2021	Chloride	10	FALSE	FALSE
G01D	3/3/2021	Sulfate	18	FALSE	FALSE
G01D	3/3/2021	Fluoride	0.2	FALSE	FALSE
G01D	3/3/2021	Barium	0.137	FALSE	FALSE
G01D	3/3/2021	Boron	0.158	FALSE	TRUE
G01D	3/3/2021	Cobalt	0.0015	FALSE	FALSE
G01D	3/3/2021	Iron	1.09	FALSE	FALSE
G01D	3/3/2021	Manganese	0.0232	FALSE	FALSE
G01D	3/3/2021	H+	0.000000251	FALSE	FALSE
G01D	3/24/2021	Alkalinity, bicarbonate	219	FALSE	FALSE
G01D	3/24/2021	Calcium	24.8	FALSE	FALSE
G01D	3/24/2021	Magnesium	7.06	FALSE	FALSE
G01D	3/24/2021	Sodium	73.9	FALSE	FALSE
G01D	3/24/2021	Potassium	1.05	FALSE	FALSE
G01D	3/24/2021	Chloride	9	FALSE	FALSE
G01D	3/24/2021	Sulfate	21	FALSE	FALSE
G01D	3/24/2021	Fluoride	0.21	FALSE	FALSE
G01D	3/24/2021	Barium	0.136	FALSE	FALSE
G01D	3/24/2021	Boron	0.158	FALSE	TRUE
G01D	3/24/2021	Cobalt	0.0316	FALSE	TRUE
G01D	3/24/2021	Iron	1.15	FALSE	FALSE
G01D	3/24/2021	Manganese	0.0181	FALSE	FALSE
G01D	3/24/2021	H+	0.000000324	FALSE	FALSE
G01D	4/14/2021	Alkalinity, bicarbonate	240	FALSE	FALSE
G01D	4/14/2021	Calcium	23.3	FALSE	FALSE
G01D	4/14/2021	Magnesium	7.56	FALSE	FALSE
G01D	4/14/2021	Sodium	94.5	FALSE	FALSE
G01D	4/14/2021	Potassium	0.979	FALSE	FALSE
G01D	4/14/2021	Chloride	6	FALSE	FALSE
G01D	4/14/2021	Sulfate	39	FALSE	FALSE
G01D	4/14/2021	Fluoride	0.23	FALSE	FALSE
G01D	4/14/2021	Barium	0.112	FALSE	FALSE
G01D	4/14/2021	Boron	0.158	FALSE	TRUE
G01D	4/14/2021	Cobalt	0.0316	FALSE	TRUE
G01D	4/14/2021	Iron	0.698	FALSE	FALSE
G01D	4/14/2021	Manganese	0.0117	FALSE	FALSE
G01D	4/14/2021	H+	0.0000002	FALSE	FALSE
G01D	5/12/2021	Alkalinity, bicarbonate	200	FALSE	FALSE
G01D	5/12/2021	Calcium	24.9	FALSE	FALSE

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G01D	5/12/2021	Magnesium	7.55	FALSE	FALSE
G01D	5/12/2021	Sodium	82.5	FALSE	FALSE
G01D	5/12/2021	Potassium	1.13	FALSE	FALSE
G01D	5/12/2021	Chloride	7	FALSE	FALSE
G01D	5/12/2021	Sulfate	20	FALSE	FALSE
G01D	5/12/2021	Fluoride	0.21	FALSE	FALSE
G01D	5/12/2021	Barium	0.133	FALSE	FALSE
G01D	5/12/2021	Boron	0.0167	FALSE	FALSE
G01D	5/12/2021	Cobalt	0.0316	FALSE	TRUE
G01D	5/12/2021	Iron	0.65	FALSE	FALSE
G01D	5/12/2021	Manganese	0.012	FALSE	FALSE
G01D	5/12/2021	H+	0.000000324	FALSE	FALSE
G01D	6/1/2021	Alkalinity, bicarbonate	198	FALSE	FALSE
G01D	6/1/2021	Calcium	24.4	FALSE	FALSE
G01D	6/1/2021	Magnesium	7.36	FALSE	FALSE
G01D	6/1/2021	Sodium	75.3	FALSE	FALSE
G01D	6/1/2021	Potassium	1.26	FALSE	FALSE
G01D	6/1/2021	Chloride	7	FALSE	FALSE
G01D	6/1/2021	Sulfate	18	FALSE	FALSE
G01D	6/1/2021	Fluoride	0.23	FALSE	FALSE
G01D	6/1/2021	Barium	0.134	FALSE	FALSE
G01D	6/1/2021	Boron	0.158	FALSE	TRUE
G01D	6/1/2021	Cobalt	0.0316	FALSE	TRUE
G01D	6/1/2021	Iron	1.92	FALSE	FALSE
G01D	6/1/2021	Manganese	0.0249	FALSE	FALSE
G01D	6/1/2021	H+	0.000000457	FALSE	FALSE
G01D	6/14/2021	Alkalinity, bicarbonate	219	FALSE	FALSE
G01D	6/14/2021	Calcium	24.4	FALSE	FALSE
G01D	6/14/2021	Magnesium	7.41	FALSE	FALSE
G01D	6/14/2021	Sodium	78.8	FALSE	FALSE
G01D	6/14/2021	Potassium	1.26	FALSE	FALSE
G01D	6/14/2021	Chloride	9	FALSE	FALSE
G01D	6/14/2021	Sulfate	20	FALSE	FALSE
G01D	6/14/2021	Fluoride	0.23	FALSE	FALSE
G01D	6/14/2021	Barium	0.136	FALSE	FALSE
G01D	6/14/2021	Boron	0.158	FALSE	TRUE
G01D	6/14/2021	Cobalt	0.0316	FALSE	TRUE
G01D	6/14/2021	Iron	0.831	FALSE	FALSE
G01D	6/14/2021	Manganese	0.0147	FALSE	FALSE
G01D	6/14/2021	H+	0.000000347	FALSE	FALSE
G01D	7/21/2021	Alkalinity, bicarbonate	204	FALSE	FALSE
G01D	7/21/2021	Calcium	26	FALSE	FALSE
G01D	7/21/2021	Magnesium	7.54	FALSE	FALSE
G01D	7/21/2021	Sodium	75.1	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G01D	7/21/2021	Potassium	1.24	FALSE	FALSE
G01D	7/21/2021	Chloride	9	FALSE	FALSE
G01D	7/21/2021	Sulfate	18	FALSE	FALSE
G01D	7/21/2021	Fluoride	0.21	FALSE	FALSE
G01D	7/21/2021	Barium	0.125	FALSE	FALSE
G01D	7/21/2021	Boron	0.158	FALSE	TRUE
G01D	7/21/2021	Cobalt	0.0316	FALSE	TRUE
G01D	7/21/2021	Iron	1.35	FALSE	FALSE
G01D	7/21/2021	Manganese	0.0121	FALSE	FALSE
G01D	7/21/2021	H+	0.000000427	FALSE	FALSE
G01D	9/20/2021	Alkalinity, bicarbonate	215	FALSE	FALSE
G01D	9/20/2021	Calcium	26	FALSE	FALSE
G01D	9/20/2021	Magnesium	7.54	TRUE	NA
G01D	9/20/2021	Sodium	75.1	TRUE	NA
G01D	9/20/2021	Potassium	1.12	TRUE	NA
G01D	9/20/2021	Chloride	9	FALSE	FALSE
G01D	9/20/2021	Sulfate	18	FALSE	FALSE
G01D	9/20/2021	Fluoride	0.21	FALSE	FALSE
G01D	9/20/2021	Barium	0.145	FALSE	FALSE
G01D	9/20/2021	Boron	0.158	FALSE	TRUE
G01D	9/20/2021	Cobalt	0.0316	FALSE	TRUE
G01D	9/20/2021	Iron	1.15	TRUE	NA
G01D	9/20/2021	Manganese	0.0147	TRUE	NA
G01D	9/20/2021	H+	0.000000309	FALSE	FALSE
G01D	9/20/2022	Alkalinity, bicarbonate	171	TRUE	NA
G01D	9/20/2022	Calcium	25.5	FALSE	FALSE
G01D	9/20/2022	Magnesium	7.79	TRUE	NA
G01D	9/20/2022	Sodium	82.5	TRUE	NA
G01D	9/20/2022	Potassium	1.13	TRUE	NA
G01D	9/20/2022	Chloride	8	FALSE	FALSE
G01D	9/20/2022	Sulfate	23	FALSE	FALSE
G01D	9/20/2022	Fluoride	0.19	FALSE	FALSE
G01D	9/20/2022	Barium	0.142	FALSE	FALSE
G01D	9/20/2022	Boron	0.014	FALSE	FALSE
G01D	9/20/2022	Cobalt	0.0007	FALSE	FALSE
G01D	9/20/2022	Iron	1.15	TRUE	NA
G01D	9/20/2022	Manganese	0.0181	TRUE	NA
G01D	9/20/2022	H+	0.000000316	FALSE	FALSE
G01D	3/7/2023	Alkalinity, bicarbonate	223	FALSE	FALSE
G01D	3/7/2023	Calcium	23	FALSE	FALSE
G01D	3/7/2023	Magnesium	7.66	FALSE	FALSE
G01D	3/7/2023	Sodium	85.8	FALSE	FALSE
G01D	3/7/2023	Potassium	1.06	FALSE	FALSE
G01D	3/7/2023	Chloride	5	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G01D	3/7/2023	Sulfate	36	FALSE	FALSE
G01D	3/7/2023	Fluoride	0.21	FALSE	FALSE
G01D	3/7/2023	Barium	0.134	FALSE	FALSE
G01D	3/7/2023	Boron	0.029	FALSE	FALSE
G01D	3/7/2023	Cobalt	0.0022	FALSE	FALSE
G01D	3/7/2023	Iron	1.09	TRUE	NA
G01D	3/7/2023	Manganese	0.0181	TRUE	NA
G01D	3/7/2023	H+	0.000000295	FALSE	FALSE
G01D	5/2/2023	Alkalinity, bicarbonate	240	FALSE	FALSE
G01D	5/2/2023	Calcium	28.8	FALSE	FALSE
G01D	5/2/2023	Magnesium	8.43	FALSE	FALSE
G01D	5/2/2023	Sodium	90.3	FALSE	FALSE
G01D	5/2/2023	Potassium	1.28	FALSE	FALSE
G01D	5/2/2023	Chloride	10	FALSE	FALSE
G01D	5/2/2023	Sulfate	26	FALSE	FALSE
G01D	5/2/2023	Fluoride	0.22	FALSE	FALSE
G01D	5/2/2023	Barium	0.213	FALSE	FALSE
G01D	5/2/2023	Boron	0.021	FALSE	FALSE
G01D	5/2/2023	Cobalt	0.0058	FALSE	FALSE
G01D	5/2/2023	Iron	4.09	FALSE	FALSE
G01D	5/2/2023	Manganese	0.345	FALSE	FALSE
G01D	5/2/2023	H+	0.000000457	FALSE	FALSE
G02D	5/12/2021	Alkalinity, bicarbonate	153	FALSE	FALSE
G02D	5/12/2021	Calcium	34.6	FALSE	FALSE
G02D	5/12/2021	Magnesium	10.4	FALSE	FALSE
G02D	5/12/2021	Sodium	53.6	FALSE	FALSE
G02D	5/12/2021	Potassium	1.17	FALSE	FALSE
G02D	5/12/2021	Chloride	18	FALSE	FALSE
G02D	5/12/2021	Sulfate	27	FALSE	FALSE
G02D	5/12/2021	Fluoride	0.18	FALSE	FALSE
G02D	5/12/2021	Barium	0.208	FALSE	FALSE
G02D	5/12/2021	Boron	0.0356	FALSE	FALSE
G02D	5/12/2021	Cobalt	0.0316	FALSE	TRUE
G02D	5/12/2021	Iron	0.316	FALSE	TRUE
G02D	5/12/2021	Manganese	0.0707	FALSE	TRUE
G02D	5/12/2021	H+	0.000000447	FALSE	FALSE
G02D	7/21/2021	Alkalinity, bicarbonate	148	FALSE	FALSE
G02D	7/21/2021	Calcium	36.6	FALSE	FALSE
G02D	7/21/2021	Magnesium	10.1	FALSE	FALSE
G02D	7/21/2021	Sodium	38.7	FALSE	FALSE
G02D	7/21/2021	Potassium	1.14	FALSE	FALSE
G02D	7/21/2021	Chloride	22	FALSE	FALSE
G02D	7/21/2021	Sulfate	20	FALSE	FALSE
G02D	7/21/2021	Fluoride	0.2	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G02D	7/21/2021	Barium	0.181	FALSE	FALSE
G02D	7/21/2021	Boron	0.0329	FALSE	FALSE
G02D	7/21/2021	Cobalt	0.0316	FALSE	TRUE
G02D	7/21/2021	Iron	0.0594	FALSE	FALSE
G02D	7/21/2021	Manganese	0.0026	FALSE	FALSE
G02D	7/21/2021	H+	0.000000661	FALSE	FALSE
G02D	9/20/2021	Alkalinity, bicarbonate	156	FALSE	FALSE
G02D	9/20/2021	Calcium	34.3	FALSE	FALSE
G02D	9/20/2021	Magnesium	10.2	TRUE	NA
G02D	9/20/2021	Sodium	38.7	TRUE	NA
G02D	9/20/2021	Potassium	1.12	TRUE	NA
G02D	9/20/2021	Chloride	20	FALSE	FALSE
G02D	9/20/2021	Sulfate	19	FALSE	FALSE
G02D	9/20/2021	Fluoride	0.18	FALSE	FALSE
G02D	9/20/2021	Barium	0.189	FALSE	FALSE
G02D	9/20/2021	Boron	0.0313	FALSE	FALSE
G02D	9/20/2021	Cobalt	0.0316	FALSE	TRUE
G02D	9/20/2021	Iron	0.158	TRUE	NA
G02D	9/20/2021	Manganese	0.0032	TRUE	NA
G02D	9/20/2021	H+	0.000000479	FALSE	FALSE
G02D	1/24/2023	Alkalinity, bicarbonate	136	FALSE	FALSE
G02D	1/24/2023	Calcium	35.9	FALSE	FALSE
G02D	1/24/2023	Magnesium	10.2	FALSE	FALSE
G02D	1/24/2023	Sodium	29	FALSE	FALSE
G02D	1/24/2023	Potassium	1.11	FALSE	FALSE
G02D	1/24/2023	Chloride	23	FALSE	FALSE
G02D	1/24/2023	Sulfate	12	FALSE	FALSE
G02D	1/24/2023	Fluoride	0.21	FALSE	FALSE
G02D	1/24/2023	Barium	0.19	FALSE	FALSE
G02D	1/24/2023	Boron	0.0311	FALSE	FALSE
G02D	1/24/2023	Cobalt	0.0316	FALSE	TRUE
G02D	1/24/2023	Iron	0.158	FALSE	TRUE
G02D	1/24/2023	Manganese	0.0014	FALSE	FALSE
G02D	1/24/2023	H+	0.000000229	FALSE	FALSE
G02D	3/8/2023	Alkalinity, bicarbonate	141	FALSE	FALSE
G02D	3/8/2023	Calcium	37.3	FALSE	FALSE
G02D	3/8/2023	Magnesium	10.3	FALSE	FALSE
G02D	3/8/2023	Sodium	28.3	FALSE	FALSE
G02D	3/8/2023	Potassium	1.12	FALSE	FALSE
G02D	3/8/2023	Chloride	21	FALSE	FALSE
G02D	3/8/2023	Sulfate	11	FALSE	FALSE
G02D	3/8/2023	Fluoride	0.2	FALSE	FALSE
G02D	3/8/2023	Barium	0.171	FALSE	FALSE
G02D	3/8/2023	Boron	0.027	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G02D	3/8/2023	Cobalt	0.0316	FALSE	TRUE
G02D	3/8/2023	Iron	0.158	TRUE	NA
G02D	3/8/2023	Manganese	0.0032	TRUE	NA
G02D	3/8/2023	H+	0.000000275	FALSE	FALSE
G02D	5/3/2023	Alkalinity, bicarbonate	140	FALSE	FALSE
G02D	5/3/2023	Calcium	38.7	FALSE	FALSE
G02D	5/3/2023	Magnesium	10.4	FALSE	FALSE
G02D	5/3/2023	Sodium	39.1	FALSE	FALSE
G02D	5/3/2023	Potassium	1.14	FALSE	FALSE
G02D	5/3/2023	Chloride	21	FALSE	FALSE
G02D	5/3/2023	Sulfate	13	FALSE	FALSE
G02D	5/3/2023	Fluoride	0.22	FALSE	FALSE
G02D	5/3/2023	Barium	0.21	FALSE	FALSE
G02D	5/3/2023	Boron	0.0412	FALSE	FALSE
G02D	5/3/2023	Cobalt	0.0316	FALSE	TRUE
G02D	5/3/2023	Iron	0.049	FALSE	FALSE
G02D	5/3/2023	Manganese	0.0032	FALSE	FALSE
G02D	5/3/2023	H+	0.000000347	FALSE	FALSE
G03	6/15/2021	Alkalinity, bicarbonate	148	FALSE	FALSE
G03	6/15/2021	Calcium	46.7	FALSE	FALSE
G03	6/15/2021	Magnesium	15.1	FALSE	FALSE
G03	6/15/2021	Sodium	40.4	FALSE	FALSE
G03	6/15/2021	Potassium	1.26	FALSE	FALSE
G03	6/15/2021	Chloride	22	FALSE	FALSE
G03	6/15/2021	Sulfate	79	FALSE	FALSE
G03	6/15/2021	Fluoride	0.22	FALSE	FALSE
G03	6/15/2021	Barium	0.0705	FALSE	FALSE
G03	6/15/2021	Boron	0.225	FALSE	FALSE
G03	6/15/2021	Cobalt	0.0316	FALSE	TRUE
G03	6/15/2021	Iron	1.69	FALSE	FALSE
G03	6/15/2021	Manganese	0.033	FALSE	FALSE
G03	6/15/2021	H+	0.000000575	FALSE	FALSE
G03	7/6/2021	Alkalinity, bicarbonate	140	FALSE	FALSE
G03	7/6/2021	Calcium	42.1	FALSE	FALSE
G03	7/6/2021	Magnesium	14	FALSE	FALSE
G03	7/6/2021	Sodium	38	FALSE	FALSE
G03	7/6/2021	Potassium	1.13	FALSE	FALSE
G03	7/6/2021	Chloride	22	FALSE	FALSE
G03	7/6/2021	Sulfate	77	FALSE	FALSE
G03	7/6/2021	Fluoride	0.22	FALSE	FALSE
G03	7/6/2021	Barium	0.0564	FALSE	FALSE
G03	7/6/2021	Boron	0.235	FALSE	FALSE
G03	7/6/2021	Cobalt	0.0316	FALSE	TRUE
G03	7/6/2021	Iron	1.06	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G03	7/6/2021	Manganese	0.0226	FALSE	FALSE
G03	7/6/2021	H+	0.000000457	FALSE	FALSE
G03	7/21/2021	Alkalinity, bicarbonate	141	FALSE	FALSE
G03	7/21/2021	Calcium	50	FALSE	FALSE
G03	7/21/2021	Magnesium	15.7	FALSE	FALSE
G03	7/21/2021	Sodium	40.2	FALSE	FALSE
G03	7/21/2021	Potassium	1.39	FALSE	FALSE
G03	7/21/2021	Chloride	24	FALSE	FALSE
G03	7/21/2021	Sulfate	92	FALSE	FALSE
G03	7/21/2021	Fluoride	0.2	FALSE	FALSE
G03	7/21/2021	Barium	0.0555	FALSE	FALSE
G03	7/21/2021	Boron	0.294	FALSE	FALSE
G03	7/21/2021	Cobalt	0.0316	FALSE	TRUE
G03	7/21/2021	Iron	2.42	FALSE	FALSE
G03	7/21/2021	Manganese	0.0334	FALSE	FALSE
G03	7/21/2021	H+	0.000000437	FALSE	FALSE
G05	3/4/2021	Alkalinity, bicarbonate	180	FALSE	FALSE
G05	3/4/2021	Calcium	55.3	FALSE	FALSE
G05	3/4/2021	Magnesium	17.2	FALSE	FALSE
G05	3/4/2021	Sodium	44.1	FALSE	FALSE
G05	3/4/2021	Potassium	1.37	FALSE	FALSE
G05	3/4/2021	Chloride	13	FALSE	FALSE
G05	3/4/2021	Sulfate	94	FALSE	FALSE
G05	3/4/2021	Fluoride	0.28	FALSE	FALSE
G05	3/4/2021	Barium	0.13	FALSE	FALSE
G05	3/4/2021	Boron	0.181	FALSE	FALSE
G05	3/4/2021	Cobalt	0.0101	FALSE	FALSE
G05	3/4/2021	Iron	0.905	FALSE	FALSE
G05	3/4/2021	Manganese	0.227	FALSE	FALSE
G05	3/4/2021	H+	0.000000316	FALSE	FALSE
G05	4/13/2021	Alkalinity, bicarbonate	206	FALSE	FALSE
G05	4/13/2021	Calcium	68.5	FALSE	FALSE
G05	4/13/2021	Magnesium	19.5	FALSE	FALSE
G05	4/13/2021	Sodium	53.7	FALSE	FALSE
G05	4/13/2021	Potassium	2.14	FALSE	FALSE
G05	4/13/2021	Chloride	21	FALSE	FALSE
G05	4/13/2021	Sulfate	95	FALSE	FALSE
G05	4/13/2021	Fluoride	0.33	FALSE	FALSE
G05	4/13/2021	Barium	0.126	FALSE	FALSE
G05	4/13/2021	Boron	0.19	FALSE	FALSE
G05	4/13/2021	Cobalt	0.0095	FALSE	FALSE
G05	4/13/2021	Iron	2	FALSE	FALSE
G05	4/13/2021	Manganese	0.294	FALSE	FALSE
G05	4/13/2021	H+	0.000000316	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G05	5/11/2021	Alkalinity, bicarbonate	193	FALSE	FALSE
G05	5/11/2021	Calcium	60.3	FALSE	FALSE
G05	5/11/2021	Magnesium	19.4	FALSE	FALSE
G05	5/11/2021	Sodium	49.6	FALSE	FALSE
G05	5/11/2021	Potassium	1.97	FALSE	FALSE
G05	5/11/2021	Chloride	19	FALSE	FALSE
G05	5/11/2021	Sulfate	109	FALSE	FALSE
G05	5/11/2021	Fluoride	0.34	FALSE	FALSE
G05	5/11/2021	Barium	0.132	FALSE	FALSE
G05	5/11/2021	Boron	0.158	FALSE	FALSE
G05	5/11/2021	Cobalt	0.0087	FALSE	FALSE
G05	5/11/2021	Iron	1.14	FALSE	FALSE
G05	5/11/2021	Manganese	0.256	FALSE	FALSE
G05	5/11/2021	H+	0.000000417	FALSE	FALSE
G05	6/1/2021	Alkalinity, bicarbonate	190	FALSE	FALSE
G05	6/1/2021	Calcium	57.1	FALSE	FALSE
G05	6/1/2021	Magnesium	18.6	FALSE	FALSE
G05	6/1/2021	Sodium	45.5	FALSE	FALSE
G05	6/1/2021	Potassium	2.18	FALSE	FALSE
G05	6/1/2021	Chloride	21	FALSE	FALSE
G05	6/1/2021	Sulfate	83	FALSE	FALSE
G05	6/1/2021	Fluoride	0.34	FALSE	FALSE
G05	6/1/2021	Barium	0.144	FALSE	FALSE
G05	6/1/2021	Boron	0.157	FALSE	FALSE
G05	6/1/2021	Cobalt	0.0078	FALSE	FALSE
G05	6/1/2021	Iron	0.81	FALSE	FALSE
G05	6/1/2021	Manganese	0.254	FALSE	FALSE
G05	6/1/2021	H+	0.000000331	FALSE	FALSE
G05	7/6/2021	Alkalinity, bicarbonate	178	FALSE	FALSE
G05	7/6/2021	Calcium	51.8	FALSE	FALSE
G05	7/6/2021	Magnesium	17.6	FALSE	FALSE
G05	7/6/2021	Sodium	45.9	FALSE	FALSE
G05	7/6/2021	Potassium	2.04	FALSE	FALSE
G05	7/6/2021	Chloride	22	FALSE	FALSE
G05	7/6/2021	Sulfate	90	FALSE	FALSE
G05	7/6/2021	Fluoride	0.34	FALSE	FALSE
G05	7/6/2021	Barium	0.139	FALSE	FALSE
G05	7/6/2021	Boron	0.148	FALSE	FALSE
G05	7/6/2021	Cobalt	0.0091	FALSE	FALSE
G05	7/6/2021	Iron	0.729	FALSE	FALSE
G05	7/6/2021	Manganese	0.27	FALSE	FALSE
G05	7/6/2021	H+	0.00000038	FALSE	FALSE
G05	7/20/2021	Alkalinity, bicarbonate	186	FALSE	FALSE
G05	7/20/2021	Calcium	55.9	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G05	7/20/2021	Magnesium	18.5	FALSE	FALSE
G05	7/20/2021	Sodium	43.4	FALSE	FALSE
G05	7/20/2021	Potassium	1.75	FALSE	FALSE
G05	7/20/2021	Chloride	20	FALSE	FALSE
G05	7/20/2021	Sulfate	87	FALSE	FALSE
G05	7/20/2021	Fluoride	0.32	FALSE	FALSE
G05	7/20/2021	Barium	0.133	FALSE	FALSE
G05	7/20/2021	Boron	0.131	FALSE	FALSE
G05	7/20/2021	Cobalt	0.0059	FALSE	FALSE
G05	7/20/2021	Iron	0.747	FALSE	FALSE
G05	7/20/2021	Manganese	0.204	FALSE	FALSE
G05	7/20/2021	H+	0.000000447	FALSE	FALSE
G05	7/26/2022	Alkalinity, bicarbonate	181	FALSE	FALSE
G05	7/26/2022	Calcium	50.6	FALSE	FALSE
G05	7/26/2022	Magnesium	17.6	FALSE	FALSE
G05	7/26/2022	Sodium	35.4	FALSE	FALSE
G05	7/26/2022	Potassium	1.07	FALSE	FALSE
G05	7/26/2022	Chloride	15	FALSE	FALSE
G05	7/26/2022	Sulfate	68	FALSE	FALSE
G05	7/26/2022	Fluoride	0.37	FALSE	FALSE
G05	7/26/2022	Barium	0.141	FALSE	FALSE
G05	7/26/2022	Boron	0.0645	FALSE	FALSE
G05	7/26/2022	Cobalt	0.0075	FALSE	FALSE
G05	7/26/2022	Iron	1.38	FALSE	FALSE
G05	7/26/2022	Manganese	0.176	FALSE	FALSE
G05	7/26/2022	H+	0.000000234	FALSE	FALSE
G05	3/9/2023	Alkalinity, bicarbonate	179	FALSE	FALSE
G05	3/9/2023	Calcium	52.6	FALSE	FALSE
G05	3/9/2023	Magnesium	19.4	FALSE	FALSE
G05	3/9/2023	Sodium	41.8	FALSE	FALSE
G05	3/9/2023	Potassium	1.59	FALSE	FALSE
G05	3/9/2023	Chloride	22	FALSE	FALSE
G05	3/9/2023	Sulfate	90	FALSE	FALSE
G05	3/9/2023	Fluoride	0.32	FALSE	FALSE
G05	3/9/2023	Barium	0.175	FALSE	FALSE
G05	3/9/2023	Boron	0.0541	FALSE	FALSE
G05	3/9/2023	Cobalt	0.0074	FALSE	FALSE
G05	3/9/2023	Iron	0.81	TRUE	NA
G05	3/9/2023	Manganese	0.204	TRUE	NA
G05	3/9/2023	H+	0.000000316	FALSE	FALSE
G05	5/3/2023	Alkalinity, bicarbonate	163	FALSE	FALSE
G05	5/3/2023	Calcium	54.4	FALSE	FALSE
G05	5/3/2023	Magnesium	19.3	FALSE	FALSE
G05	5/3/2023	Sodium	46.7	FALSE	FALSE

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G05	5/3/2023	Potassium	1.68	FALSE	FALSE
G05	5/3/2023	Chloride	24	FALSE	FALSE
G05	5/3/2023	Sulfate	112	FALSE	FALSE
G05	5/3/2023	Fluoride	0.38	FALSE	FALSE
G05	5/3/2023	Barium	0.212	FALSE	FALSE
G05	5/3/2023	Boron	0.0478	FALSE	FALSE
G05	5/3/2023	Cobalt	0.0103	FALSE	FALSE
G05	5/3/2023	Iron	1.5	FALSE	FALSE
G05	5/3/2023	Manganese	0.191	FALSE	FALSE
G05	5/3/2023	H+	0.000000324	FALSE	FALSE
G06	5/11/2021	Alkalinity, bicarbonate	156	FALSE	FALSE
G06	5/11/2021	Calcium	93.4	FALSE	FALSE
G06	5/11/2021	Magnesium	26.8	FALSE	FALSE
G06	5/11/2021	Sodium	52.8	FALSE	FALSE
G06	5/11/2021	Potassium	2.5	FALSE	FALSE
G06	5/11/2021	Chloride	22	FALSE	FALSE
G06	5/11/2021	Sulfate	219	FALSE	FALSE
G06	5/11/2021	Fluoride	0.26	FALSE	FALSE
G06	5/11/2021	Barium	0.0311	FALSE	FALSE
G06	5/11/2021	Boron	3.37	FALSE	FALSE
G06	5/11/2021	Cobalt	0.0316	FALSE	TRUE
G06	5/11/2021	Iron	0.702	FALSE	FALSE
G06	5/11/2021	Manganese	0.0957	FALSE	FALSE
G06	5/11/2021	H+	0.000000372	FALSE	FALSE
G06	6/1/2021	Alkalinity, bicarbonate	167	FALSE	FALSE
G06	6/1/2021	Calcium	92.6	FALSE	FALSE
G06	6/1/2021	Magnesium	25.3	FALSE	FALSE
G06	6/1/2021	Sodium	46.4	FALSE	FALSE
G06	6/1/2021	Potassium	2.5	FALSE	FALSE
G06	6/1/2021	Chloride	22	FALSE	FALSE
G06	6/1/2021	Sulfate	216	FALSE	FALSE
G06	6/1/2021	Fluoride	0.28	FALSE	FALSE
G06	6/1/2021	Barium	0.0323	FALSE	FALSE
G06	6/1/2021	Boron	3.56	FALSE	FALSE
G06	6/1/2021	Cobalt	0.0316	FALSE	TRUE
G06	6/1/2021	Iron	1.69	FALSE	FALSE
G06	6/1/2021	Manganese	0.0892	FALSE	FALSE
G06	6/1/2021	H+	0.000000275	FALSE	FALSE
G06	6/15/2021	Alkalinity, bicarbonate	170	FALSE	FALSE
G06	6/15/2021	Calcium	91.5	FALSE	FALSE
G06	6/15/2021	Magnesium	25.2	FALSE	FALSE
G06	6/15/2021	Sodium	50.7	FALSE	FALSE
G06	6/15/2021	Potassium	2.57	FALSE	FALSE
G06	6/15/2021	Chloride	21	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G06	6/15/2021	Sulfate	230	FALSE	FALSE
G06	6/15/2021	Fluoride	0.28	FALSE	FALSE
G06	6/15/2021	Barium	0.028	FALSE	FALSE
G06	6/15/2021	Boron	2.97	FALSE	FALSE
G06	6/15/2021	Cobalt	0.0316	FALSE	TRUE
G06	6/15/2021	Iron	0.379	FALSE	FALSE
G06	6/15/2021	Manganese	0.0682	FALSE	FALSE
G06	6/15/2021	H+	0.000000309	FALSE	FALSE
G06	7/6/2021	Alkalinity, bicarbonate	163	FALSE	FALSE
G06	7/6/2021	Calcium	86.7	FALSE	FALSE
G06	7/6/2021	Magnesium	23.7	FALSE	FALSE
G06	7/6/2021	Sodium	50	FALSE	FALSE
G06	7/6/2021	Potassium	2.57	FALSE	FALSE
G06	7/6/2021	Chloride	22	FALSE	FALSE
G06	7/6/2021	Sulfate	223	FALSE	FALSE
G06	7/6/2021	Fluoride	0.27	FALSE	FALSE
G06	7/6/2021	Barium	0.0272	FALSE	FALSE
G06	7/6/2021	Boron	3.93	FALSE	FALSE
G06	7/6/2021	Cobalt	0.0316	FALSE	TRUE
G06	7/6/2021	Iron	0.495	FALSE	FALSE
G06	7/6/2021	Manganese	0.0631	FALSE	FALSE
G06	7/6/2021	H+	0.000000479	FALSE	FALSE
G06	7/20/2021	Alkalinity, bicarbonate	162	FALSE	FALSE
G06	7/20/2021	Calcium	90.6	FALSE	FALSE
G06	7/20/2021	Magnesium	24.4	FALSE	FALSE
G06	7/20/2021	Sodium	47	FALSE	FALSE
G06	7/20/2021	Potassium	2.37	FALSE	FALSE
G06	7/20/2021	Chloride	21	FALSE	FALSE
G06	7/20/2021	Sulfate	213	FALSE	FALSE
G06	7/20/2021	Fluoride	0.26	FALSE	FALSE
G06	7/20/2021	Barium	0.0244	FALSE	FALSE
G06	7/20/2021	Boron	3.41	FALSE	FALSE
G06	7/20/2021	Cobalt	0.0316	FALSE	TRUE
G06	7/20/2021	Iron	0.613	FALSE	FALSE
G06	7/20/2021	Manganese	0.0456	FALSE	FALSE
G06	7/20/2021	H+	0.000000389	FALSE	FALSE
G06	3/9/2023	Alkalinity, bicarbonate	161	FALSE	FALSE
G06	3/9/2023	Calcium	87.6	FALSE	FALSE
G06	3/9/2023	Magnesium	24.1	FALSE	FALSE
G06	3/9/2023	Sodium	42.1	FALSE	FALSE
G06	3/9/2023	Potassium	2.2	FALSE	FALSE
G06	3/9/2023	Chloride	21	FALSE	FALSE
G06	3/9/2023	Sulfate	221	FALSE	FALSE
G06	3/9/2023	Fluoride	0.22	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G06	3/9/2023	Barium	0.0257	FALSE	FALSE
G06	3/9/2023	Boron	2.95	FALSE	FALSE
G06	3/9/2023	Cobalt	0.0006	FALSE	FALSE
G06	3/9/2023	Iron	0.537	TRUE	NA
G06	3/9/2023	Manganese	0.0682	TRUE	NA
G06	3/9/2023	H+	0.000000269	FALSE	FALSE
G07	3/24/2021	Alkalinity, bicarbonate	171	FALSE	FALSE
G07	3/24/2021	Calcium	92.8	FALSE	FALSE
G07	3/24/2021	Magnesium	24.2	FALSE	FALSE
G07	3/24/2021	Sodium	71.4	FALSE	FALSE
G07	3/24/2021	Potassium	3.87	FALSE	FALSE
G07	3/24/2021	Chloride	21	FALSE	FALSE
G07	3/24/2021	Sulfate	258	FALSE	FALSE
G07	3/24/2021	Fluoride	0.42	FALSE	FALSE
G07	3/24/2021	Barium	0.0643	FALSE	FALSE
G07	3/24/2021	Boron	4.67	FALSE	FALSE
G07	3/24/2021	Cobalt	0.0035	FALSE	FALSE
G07	3/24/2021	Iron	2.71	FALSE	FALSE
G07	3/24/2021	Manganese	4.48	FALSE	FALSE
G07	3/24/2021	H+	0.000000398	FALSE	FALSE
G07	4/13/2021	Alkalinity, bicarbonate	164	FALSE	FALSE
G07	4/13/2021	Calcium	126	FALSE	FALSE
G07	4/13/2021	Magnesium	24.4	FALSE	FALSE
G07	4/13/2021	Sodium	90.4	FALSE	FALSE
G07	4/13/2021	Potassium	3.98	FALSE	FALSE
G07	4/13/2021	Chloride	20	FALSE	FALSE
G07	4/13/2021	Sulfate	274	FALSE	FALSE
G07	4/13/2021	Fluoride	0.42	FALSE	FALSE
G07	4/13/2021	Barium	0.0497	FALSE	FALSE
G07	4/13/2021	Boron	5.04	FALSE	FALSE
G07	4/13/2021	Cobalt	0.0024	FALSE	FALSE
G07	4/13/2021	Iron	1.2	FALSE	FALSE
G07	4/13/2021	Manganese	4.56	FALSE	FALSE
G07	4/13/2021	H+	0.000000501	FALSE	FALSE
G07	5/11/2021	Alkalinity, bicarbonate	162	FALSE	FALSE
G07	5/11/2021	Calcium	90.4	FALSE	FALSE
G07	5/11/2021	Magnesium	22.9	FALSE	FALSE
G07	5/11/2021	Sodium	68.6	FALSE	FALSE
G07	5/11/2021	Potassium	3.9	FALSE	FALSE
G07	5/11/2021	Chloride	19	FALSE	FALSE
G07	5/11/2021	Sulfate	248	FALSE	FALSE
G07	5/11/2021	Fluoride	0.41	FALSE	FALSE
G07	5/11/2021	Barium	0.0448	FALSE	FALSE
G07	5/11/2021	Boron	4.55	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G07	5/11/2021	Cobalt	0.00185	FALSE	FALSE
G07	5/11/2021	Iron	0.537	FALSE	FALSE
G07	5/11/2021	Manganese	3.71	FALSE	FALSE
G07	5/11/2021	H+	0.000000525	FALSE	FALSE
G07	6/1/2021	Alkalinity, bicarbonate	173	FALSE	FALSE
G07	6/1/2021	Calcium	96.6	FALSE	FALSE
G07	6/1/2021	Magnesium	22.9	FALSE	FALSE
G07	6/1/2021	Sodium	67.5	FALSE	FALSE
G07	6/1/2021	Potassium	4.32	FALSE	FALSE
G07	6/1/2021	Chloride	22	FALSE	FALSE
G07	6/1/2021	Sulfate	257	FALSE	FALSE
G07	6/1/2021	Fluoride	0.43	FALSE	FALSE
G07	6/1/2021	Barium	0.054	FALSE	FALSE
G07	6/1/2021	Boron	5.23	FALSE	FALSE
G07	6/1/2021	Cobalt	0.0023	FALSE	FALSE
G07	6/1/2021	Iron	2.49	FALSE	FALSE
G07	6/1/2021	Manganese	3.54	FALSE	FALSE
G07	6/1/2021	H+	0.000000562	FALSE	FALSE
G07	6/15/2021	Alkalinity, bicarbonate	177	FALSE	FALSE
G07	6/15/2021	Calcium	89.3	FALSE	FALSE
G07	6/15/2021	Magnesium	21.8	FALSE	FALSE
G07	6/15/2021	Sodium	66.7	FALSE	FALSE
G07	6/15/2021	Potassium	3.97	FALSE	FALSE
G07	6/15/2021	Chloride	20	FALSE	FALSE
G07	6/15/2021	Sulfate	246	FALSE	FALSE
G07	6/15/2021	Fluoride	0.41	FALSE	FALSE
G07	6/15/2021	Barium	0.0429	FALSE	FALSE
G07	6/15/2021	Boron	3.91	FALSE	FALSE
G07	6/15/2021	Cobalt	0.0013	FALSE	FALSE
G07	6/15/2021	Iron	0.294	FALSE	FALSE
G07	6/15/2021	Manganese	3.7	FALSE	FALSE
G07	6/15/2021	H+	0.000000562	FALSE	FALSE
G07	7/6/2021	Alkalinity, bicarbonate	166	FALSE	FALSE
G07	7/6/2021	Calcium	84.8	FALSE	FALSE
G07	7/6/2021	Magnesium	20.5	FALSE	FALSE
G07	7/6/2021	Sodium	66.5	FALSE	FALSE
G07	7/6/2021	Potassium	3.87	FALSE	FALSE
G07	7/6/2021	Chloride	21	FALSE	FALSE
G07	7/6/2021	Sulfate	258	FALSE	FALSE
G07	7/6/2021	Fluoride	0.4	FALSE	FALSE
G07	7/6/2021	Barium	0.0373	FALSE	FALSE
G07	7/6/2021	Boron	4.95	FALSE	FALSE
G07	7/6/2021	Cobalt	0.0012	FALSE	FALSE
G07	7/6/2021	Iron	0.134	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G07	7/6/2021	Manganese	4.1	FALSE	FALSE
G07	7/6/2021	H+	0.00000105	FALSE	FALSE
G07	7/20/2021	Alkalinity, bicarbonate	166	FALSE	FALSE
G07	7/20/2021	Calcium	96.5	FALSE	FALSE
G07	7/20/2021	Magnesium	23	FALSE	FALSE
G07	7/20/2021	Sodium	67.4	FALSE	FALSE
G07	7/20/2021	Potassium	4.03	FALSE	FALSE
G07	7/20/2021	Chloride	21	FALSE	FALSE
G07	7/20/2021	Sulfate	252	FALSE	FALSE
G07	7/20/2021	Fluoride	0.4	FALSE	FALSE
G07	7/20/2021	Barium	0.047	FALSE	FALSE
G07	7/20/2021	Boron	4.48	FALSE	FALSE
G07	7/20/2021	Cobalt	0.0014	FALSE	FALSE
G07	7/20/2021	Iron	0.639	FALSE	FALSE
G07	7/20/2021	Manganese	3.28	FALSE	FALSE
G07	7/20/2021	H+	0.000000724	FALSE	FALSE
G08	4/13/2021	Alkalinity, bicarbonate	177	FALSE	FALSE
G08	4/13/2021	Calcium	142	FALSE	FALSE
G08	4/13/2021	Magnesium	31.9	FALSE	FALSE
G08	4/13/2021	Sodium	33.6	FALSE	FALSE
G08	4/13/2021	Potassium	1.6	FALSE	FALSE
G08	4/13/2021	Chloride	15	FALSE	FALSE
G08	4/13/2021	Sulfate	286	FALSE	FALSE
G08	4/13/2021	Fluoride	0.34	FALSE	FALSE
G08	4/13/2021	Barium	0.0772	FALSE	FALSE
G08	4/13/2021	Boron	5.25	FALSE	FALSE
G08	4/13/2021	Cobalt	0.0041	FALSE	FALSE
G08	4/13/2021	Iron	4.82	FALSE	FALSE
G08	4/13/2021	Manganese	6.03	FALSE	FALSE
G08	4/13/2021	H+	0.0000001	FALSE	FALSE
G08	5/11/2021	Alkalinity, bicarbonate	185	FALSE	FALSE
G08	5/11/2021	Calcium	101	FALSE	FALSE
G08	5/11/2021	Magnesium	25.4	FALSE	FALSE
G08	5/11/2021	Sodium	24.3	FALSE	FALSE
G08	5/11/2021	Potassium	1.45	FALSE	FALSE
G08	5/11/2021	Chloride	12	FALSE	FALSE
G08	5/11/2021	Sulfate	203	FALSE	FALSE
G08	5/11/2021	Fluoride	0.36	FALSE	FALSE
G08	5/11/2021	Barium	0.0685	FALSE	FALSE
G08	5/11/2021	Boron	3.77	FALSE	FALSE
G08	5/11/2021	Cobalt	0.0022	FALSE	FALSE
G08	5/11/2021	Iron	1.33	FALSE	FALSE
G08	5/11/2021	Manganese	3.09	FALSE	FALSE
G08	5/11/2021	H+	0.000000115	FALSE	FALSE

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G08	6/1/2021	Alkalinity, bicarbonate	201	FALSE	FALSE
G08	6/1/2021	Calcium	114	FALSE	FALSE
G08	6/1/2021	Magnesium	27.2	FALSE	FALSE
G08	6/1/2021	Sodium	25.4	FALSE	FALSE
G08	6/1/2021	Potassium	1.48	FALSE	FALSE
G08	6/1/2021	Chloride	15	FALSE	FALSE
G08	6/1/2021	Sulfate	204	FALSE	FALSE
G08	6/1/2021	Fluoride	0.34	FALSE	FALSE
G08	6/1/2021	Barium	0.0588	FALSE	FALSE
G08	6/1/2021	Boron	4.63	FALSE	FALSE
G08	6/1/2021	Cobalt	0.0041	FALSE	FALSE
G08	6/1/2021	Iron	4.43	FALSE	FALSE
G08	6/1/2021	Manganese	3.15	FALSE	FALSE
G08	6/1/2021	H+	0.00000011	FALSE	FALSE
G08	7/23/2022	Alkalinity, bicarbonate	191	FALSE	FALSE
G08	7/23/2022	Calcium	118	FALSE	FALSE
G08	7/23/2022	Magnesium	29	FALSE	FALSE
G08	7/23/2022	Sodium	30.5	FALSE	FALSE
G08	7/23/2022	Potassium	1.46	FALSE	FALSE
G08	7/23/2022	Chloride	16	FALSE	FALSE
G08	7/23/2022	Sulfate	229	FALSE	FALSE
G08	7/23/2022	Fluoride	0.3	FALSE	FALSE
G08	7/23/2022	Barium	0.0387	FALSE	FALSE
G08	7/23/2022	Boron	4.74	FALSE	FALSE
G08	7/23/2022	Cobalt	0.0028	FALSE	FALSE
G08	7/23/2022	Iron	2.25	FALSE	FALSE
G08	7/23/2022	Manganese	2.89	FALSE	FALSE
G08	7/23/2022	H+	2.57E-08	FALSE	FALSE
G08	3/9/2023	Alkalinity, bicarbonate	174	FALSE	FALSE
G08	3/9/2023	Calcium	119	FALSE	FALSE
G08	3/9/2023	Magnesium	28.9	FALSE	FALSE
G08	3/9/2023	Sodium	28.5	FALSE	FALSE
G08	3/9/2023	Potassium	1.47	FALSE	FALSE
G08	3/9/2023	Chloride	15	FALSE	FALSE
G08	3/9/2023	Sulfate	297	FALSE	FALSE
G08	3/9/2023	Fluoride	0.23	FALSE	FALSE
G08	3/9/2023	Barium	0.0495	FALSE	FALSE
G08	3/9/2023	Boron	4.33	FALSE	FALSE
G08	3/9/2023	Cobalt	0.0036	FALSE	FALSE
G08	3/9/2023	Iron	2.25	TRUE	NA
G08	3/9/2023	Manganese	0.0892	TRUE	NA
G08	3/9/2023	H+	0.000000141	FALSE	FALSE
G08	5/3/2023	Alkalinity, bicarbonate	154	FALSE	FALSE
G08	5/3/2023	Calcium	140	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G08	5/3/2023	Magnesium	32.2	FALSE	FALSE
G08	5/3/2023	Sodium	41.7	FALSE	FALSE
G08	5/3/2023	Potassium	1.67	FALSE	FALSE
G08	5/3/2023	Chloride	16	FALSE	FALSE
G08	5/3/2023	Sulfate	363	FALSE	FALSE
G08	5/3/2023	Fluoride	0.29	FALSE	FALSE
G08	5/3/2023	Barium	0.0974	FALSE	FALSE
G08	5/3/2023	Boron	5.43	FALSE	FALSE
G08	5/3/2023	Cobalt	0.0113	FALSE	FALSE
G08	5/3/2023	Iron	16.8	FALSE	FALSE
G08	5/3/2023	Manganese	2.62	FALSE	FALSE
G08	5/3/2023	H+	0.000000132	FALSE	FALSE
G09	3/4/2021	Alkalinity, bicarbonate	188	FALSE	FALSE
G09	3/4/2021	Calcium	103	FALSE	FALSE
G09	3/4/2021	Magnesium	33.8	FALSE	FALSE
G09	3/4/2021	Sodium	72	FALSE	FALSE
G09	3/4/2021	Potassium	2.78	FALSE	FALSE
G09	3/4/2021	Chloride	24	FALSE	FALSE
G09	3/4/2021	Sulfate	351	FALSE	FALSE
G09	3/4/2021	Fluoride	0.25	FALSE	FALSE
G09	3/4/2021	Barium	0.0675	FALSE	FALSE
G09	3/4/2021	Boron	3.19	FALSE	FALSE
G09	3/4/2021	Cobalt	0.0108	FALSE	FALSE
G09	3/4/2021	Iron	1.93	FALSE	FALSE
G09	3/4/2021	Manganese	4.15	FALSE	FALSE
G09	3/4/2021	H+	0.000000631	FALSE	FALSE
G09	6/1/2021	Alkalinity, bicarbonate	177	FALSE	FALSE
G09	6/1/2021	Calcium	91.3	FALSE	FALSE
G09	6/1/2021	Magnesium	31.4	FALSE	FALSE
G09	6/1/2021	Sodium	65.3	FALSE	FALSE
G09	6/1/2021	Potassium	1.87	FALSE	FALSE
G09	6/1/2021	Chloride	23	FALSE	FALSE
G09	6/1/2021	Sulfate	284	FALSE	FALSE
G09	6/1/2021	Fluoride	0.33	FALSE	FALSE
G09	6/1/2021	Barium	0.0548	FALSE	FALSE
G09	6/1/2021	Boron	3.65	FALSE	FALSE
G09	6/1/2021	Cobalt	0.0096	FALSE	FALSE
G09	6/1/2021	Iron	5.65	FALSE	FALSE
G09	6/1/2021	Manganese	3.87	FALSE	FALSE
G09	6/1/2021	H+	0.000000575	FALSE	FALSE
G09	6/15/2021	Alkalinity, bicarbonate	179	FALSE	FALSE
G09	6/15/2021	Calcium	137	FALSE	FALSE
G09	6/15/2021	Magnesium	49.3	FALSE	FALSE
G09	6/15/2021	Sodium	58.5	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G09	6/15/2021	Potassium	1.56	FALSE	FALSE
G09	6/15/2021	Chloride	21	FALSE	FALSE
G09	6/15/2021	Sulfate	294	FALSE	FALSE
G09	6/15/2021	Fluoride	0.32	FALSE	FALSE
G09	6/15/2021	Barium	0.0136	FALSE	FALSE
G09	6/15/2021	Boron	0.282	FALSE	FALSE
G09	6/15/2021	Cobalt	0.0011	FALSE	FALSE
G09	6/15/2021	Iron	0.0556	FALSE	FALSE
G09	6/15/2021	Manganese	0.104	FALSE	FALSE
G09	6/15/2021	H+	0.00000107	FALSE	FALSE
G09	7/6/2021	Alkalinity, bicarbonate	163	FALSE	FALSE
G09	7/6/2021	Calcium	79	FALSE	FALSE
G09	7/6/2021	Magnesium	28.7	FALSE	FALSE
G09	7/6/2021	Sodium	68.3	FALSE	FALSE
G09	7/6/2021	Potassium	1.65	FALSE	FALSE
G09	7/6/2021	Chloride	22	FALSE	FALSE
G09	7/6/2021	Sulfate	289	FALSE	FALSE
G09	7/6/2021	Fluoride	0.36	FALSE	FALSE
G09	7/6/2021	Barium	0.0444	FALSE	FALSE
G09	7/6/2021	Boron	4.05	FALSE	FALSE
G09	7/6/2021	Cobalt	0.0089	FALSE	FALSE
G09	7/6/2021	Iron	5.69	FALSE	FALSE
G09	7/6/2021	Manganese	4.06	FALSE	FALSE
G09	7/6/2021	H+	0.000000513	FALSE	FALSE
G09	7/21/2021	Alkalinity, bicarbonate	164	FALSE	FALSE
G09	7/21/2021	Calcium	92.1	FALSE	FALSE
G09	7/21/2021	Magnesium	32	FALSE	FALSE
G09	7/21/2021	Sodium	64.3	FALSE	FALSE
G09	7/21/2021	Potassium	1.55	FALSE	FALSE
G09	7/21/2021	Chloride	21	FALSE	FALSE
G09	7/21/2021	Sulfate	286	FALSE	FALSE
G09	7/21/2021	Fluoride	0.31	FALSE	FALSE
G09	7/21/2021	Barium	0.0454	FALSE	FALSE
G09	7/21/2021	Boron	3.75	FALSE	FALSE
G09	7/21/2021	Cobalt	0.0085	FALSE	FALSE
G09	7/21/2021	Iron	5.11	FALSE	FALSE
G09	7/21/2021	Manganese	3.17	FALSE	FALSE
G09	7/21/2021	H+	0.00000102	FALSE	FALSE
G10	3/4/2021	Alkalinity, bicarbonate	108	FALSE	FALSE
G10	3/4/2021	Calcium	107	FALSE	FALSE
G10	3/4/2021	Magnesium	35.7	FALSE	FALSE
G10	3/4/2021	Sodium	60.3	FALSE	FALSE
G10	3/4/2021	Potassium	2.54	FALSE	FALSE
G10	3/4/2021	Chloride	35	FALSE	FALSE

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G10	3/4/2021	Sulfate	391	FALSE	FALSE
G10	3/4/2021	Fluoride	0.29	FALSE	FALSE
G10	3/4/2021	Barium	0.0608	FALSE	FALSE
G10	3/4/2021	Boron	4.98	FALSE	FALSE
G10	3/4/2021	Cobalt	0.0109	FALSE	FALSE
G10	3/4/2021	Iron	2.38	FALSE	FALSE
G10	3/4/2021	Manganese	1.14	FALSE	FALSE
G10	3/4/2021	H+	0.0000002	FALSE	FALSE
G10	3/24/2021	Alkalinity, bicarbonate	132	FALSE	FALSE
G10	3/24/2021	Calcium	115	FALSE	FALSE
G10	3/24/2021	Magnesium	39.3	FALSE	FALSE
G10	3/24/2021	Sodium	62.1	FALSE	FALSE
G10	3/24/2021	Potassium	2.91	FALSE	FALSE
G10	3/24/2021	Chloride	31	FALSE	FALSE
G10	3/24/2021	Sulfate	369	FALSE	FALSE
G10	3/24/2021	Fluoride	0.3	FALSE	FALSE
G10	3/24/2021	Barium	0.0553	FALSE	FALSE
G10	3/24/2021	Boron	4.31	FALSE	FALSE
G10	3/24/2021	Cobalt	0.0122	FALSE	FALSE
G10	3/24/2021	Iron	4.61	FALSE	FALSE
G10	3/24/2021	Manganese	1.38	FALSE	FALSE
G10	3/24/2021	H+	0.0000002	FALSE	FALSE
G10	5/11/2021	Alkalinity, bicarbonate	134	FALSE	FALSE
G10	5/11/2021	Calcium	120	FALSE	FALSE
G10	5/11/2021	Magnesium	41.1	FALSE	FALSE
G10	5/11/2021	Sodium	56.8	FALSE	FALSE
G10	5/11/2021	Potassium	2.13	FALSE	FALSE
G10	5/11/2021	Chloride	25	FALSE	FALSE
G10	5/11/2021	Sulfate	364	FALSE	FALSE
G10	5/11/2021	Fluoride	0.28	FALSE	FALSE
G10	5/11/2021	Barium	0.0453	FALSE	FALSE
G10	5/11/2021	Boron	3.95	FALSE	FALSE
G10	5/11/2021	Cobalt	0.00754	FALSE	FALSE
G10	5/11/2021	Iron	1.12	FALSE	FALSE
G10	5/11/2021	Manganese	0.702	FALSE	FALSE
G10	5/11/2021	H+	0.000000457	FALSE	FALSE
G10	6/1/2021	Alkalinity, bicarbonate	127	FALSE	FALSE
G10	6/1/2021	Calcium	124	FALSE	FALSE
G10	6/1/2021	Magnesium	38.5	FALSE	FALSE
G10	6/1/2021	Sodium	55	FALSE	FALSE
G10	6/1/2021	Potassium	2.27	FALSE	FALSE
G10	6/1/2021	Chloride	29	FALSE	FALSE
G10	6/1/2021	Sulfate	401	FALSE	FALSE
G10	6/1/2021	Fluoride	0.29	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G10	6/1/2021	Barium	0.0444	FALSE	FALSE
G10	6/1/2021	Boron	4.73	FALSE	FALSE
G10	6/1/2021	Cobalt	0.0071	FALSE	FALSE
G10	6/1/2021	Iron	2.82	FALSE	FALSE
G10	6/1/2021	Manganese	0.608	FALSE	FALSE
G10	6/1/2021	H+	0.000000316	FALSE	FALSE
G10	6/15/2021	Alkalinity, bicarbonate	149	FALSE	FALSE
G10	6/15/2021	Calcium	128	FALSE	FALSE
G10	6/15/2021	Magnesium	40.8	FALSE	FALSE
G10	6/15/2021	Sodium	59.3	FALSE	FALSE
G10	6/15/2021	Potassium	2.25	FALSE	FALSE
G10	6/15/2021	Chloride	26	FALSE	FALSE
G10	6/15/2021	Sulfate	407	FALSE	FALSE
G10	6/15/2021	Fluoride	0.28	FALSE	FALSE
G10	6/15/2021	Barium	0.0439	FALSE	FALSE
G10	6/15/2021	Boron	3.74	FALSE	FALSE
G10	6/15/2021	Cobalt	0.005	FALSE	FALSE
G10	6/15/2021	Iron	0.864	FALSE	FALSE
G10	6/15/2021	Manganese	0.47	FALSE	FALSE
G10	6/15/2021	H+	0.000000347	FALSE	FALSE
G10	7/6/2021	Alkalinity, bicarbonate	144	FALSE	FALSE
G10	7/6/2021	Calcium	119	FALSE	FALSE
G10	7/6/2021	Magnesium	37.3	FALSE	FALSE
G10	7/6/2021	Sodium	57.6	FALSE	FALSE
G10	7/6/2021	Potassium	2.09	FALSE	FALSE
G10	7/6/2021	Chloride	26	FALSE	FALSE
G10	7/6/2021	Sulfate	415	FALSE	FALSE
G10	7/6/2021	Fluoride	0.27	FALSE	FALSE
G10	7/6/2021	Barium	0.0356	FALSE	FALSE
G10	7/6/2021	Boron	4.81	FALSE	FALSE
G10	7/6/2021	Cobalt	0.0049	FALSE	FALSE
G10	7/6/2021	Iron	0.556	FALSE	FALSE
G10	7/6/2021	Manganese	0.416	FALSE	FALSE
G10	7/6/2021	H+	0.000000309	FALSE	FALSE
G10	7/20/2021	Alkalinity, bicarbonate	141	FALSE	FALSE
G10	7/20/2021	Calcium	132	FALSE	FALSE
G10	7/20/2021	Magnesium	40	FALSE	FALSE
G10	7/20/2021	Sodium	56.5	FALSE	FALSE
G10	7/20/2021	Potassium	2.06	FALSE	FALSE
G10	7/20/2021	Chloride	26	FALSE	FALSE
G10	7/20/2021	Sulfate	410	FALSE	FALSE
G10	7/20/2021	Fluoride	0.26	FALSE	FALSE
G10	7/20/2021	Barium	0.0368	FALSE	FALSE
G10	7/20/2021	Boron	4.2	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G10	7/20/2021	Cobalt	0.0045	FALSE	FALSE
G10	7/20/2021	Iron	0.473	FALSE	FALSE
G10	7/20/2021	Manganese	0.348	FALSE	FALSE
G10	7/20/2021	H+	0.000000324	FALSE	FALSE
G52D	9/20/2021	Alkalinity, bicarbonate	147	FALSE	FALSE
G52D	9/20/2021	Calcium	47.8	FALSE	FALSE
G52D	9/20/2021	Magnesium	16.4	TRUE	NA
G52D	9/20/2021	Sodium	49.2	TRUE	NA
G52D	9/20/2021	Potassium	0.355	TRUE	NA
G52D	9/20/2021	Chloride	13	FALSE	FALSE
G52D	9/20/2021	Sulfate	83	FALSE	FALSE
G52D	9/20/2021	Fluoride	0.26	FALSE	FALSE
G52D	9/20/2021	Barium	0.232	FALSE	FALSE
G52D	9/20/2021	Boron	0.158	FALSE	TRUE
G52D	9/20/2021	Cobalt	0.0011	FALSE	FALSE
G52D	9/20/2021	Iron	0.537	TRUE	NA
G52D	9/20/2021	Manganese	3.71	TRUE	NA
G52D	9/20/2021	H+	0.000000513	FALSE	FALSE
G52D	3/10/2023	Alkalinity, bicarbonate	156	FALSE	FALSE
G52D	3/10/2023	Calcium	49.3	FALSE	FALSE
G52D	3/10/2023	Magnesium	15.3	FALSE	FALSE
G52D	3/10/2023	Sodium	27.7	FALSE	FALSE
G52D	3/10/2023	Potassium	0.768	FALSE	FALSE
G52D	3/10/2023	Chloride	12	FALSE	FALSE
G52D	3/10/2023	Sulfate	74	FALSE	FALSE
G52D	3/10/2023	Fluoride	0.22	FALSE	FALSE
G52D	3/10/2023	Barium	0.307	FALSE	FALSE
G52D	3/10/2023	Boron	0.0319	FALSE	FALSE
G52D	3/10/2023	Cobalt	0.0022	FALSE	FALSE
G52D	3/10/2023	Iron	0.639	TRUE	NA
G52D	3/10/2023	Manganese	3.71	TRUE	NA
G52D	3/10/2023	H+	0.000000288	FALSE	FALSE
G53D	3/25/2021	Alkalinity, bicarbonate	166	FALSE	FALSE
G53D	3/25/2021	Calcium	38.6	FALSE	FALSE
G53D	3/25/2021	Magnesium	15.7	FALSE	FALSE
G53D	3/25/2021	Sodium	50.8	FALSE	FALSE
G53D	3/25/2021	Potassium	0.278	FALSE	FALSE
G53D	3/25/2021	Chloride	19	FALSE	FALSE
G53D	3/25/2021	Sulfate	71	FALSE	FALSE
G53D	3/25/2021	Fluoride	0.71	FALSE	FALSE
G53D	3/25/2021	Barium	0.112	FALSE	FALSE
G53D	3/25/2021	Boron	0.355	FALSE	FALSE
G53D	3/25/2021	Cobalt	0.0026	FALSE	FALSE
G53D	3/25/2021	Iron	1.69	TRUE	NA

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G53D	3/25/2021	Manganese	0.0334	TRUE	NA
G53D	3/25/2021	H+	0.000000295	FALSE	FALSE
G53D	9/20/2021	Alkalinity, bicarbonate	171	FALSE	FALSE
G53D	9/20/2021	Calcium	38.5	FALSE	FALSE
G53D	9/20/2021	Magnesium	16.4	TRUE	NA
G53D	9/20/2021	Sodium	50.8	TRUE	NA
G53D	9/20/2021	Potassium	0.355	TRUE	NA
G53D	9/20/2021	Chloride	19	FALSE	FALSE
G53D	9/20/2021	Sulfate	78	FALSE	FALSE
G53D	9/20/2021	Fluoride	0.7	FALSE	FALSE
G53D	9/20/2021	Barium	0.103	FALSE	FALSE
G53D	9/20/2021	Boron	0.402	FALSE	FALSE
G53D	9/20/2021	Cobalt	0.0021	FALSE	FALSE
G53D	9/20/2021	Iron	1.69	TRUE	NA
G53D	9/20/2021	Manganese	0.0334	TRUE	NA
G53D	9/20/2021	H+	0.000000537	FALSE	FALSE
G53D	3/15/2022	Alkalinity, bicarbonate	176	FALSE	FALSE
G53D	3/15/2022	Calcium	38.1	FALSE	FALSE
G53D	3/15/2022	Magnesium	16.5	FALSE	FALSE
G53D	3/15/2022	Sodium	51.3	FALSE	FALSE
G53D	3/15/2022	Potassium	0.317	FALSE	FALSE
G53D	3/15/2022	Chloride	18	FALSE	FALSE
G53D	3/15/2022	Sulfate	74	FALSE	FALSE
G53D	3/15/2022	Fluoride	0.71	FALSE	FALSE
G53D	3/15/2022	Barium	0.0922	FALSE	FALSE
G53D	3/15/2022	Boron	0.332	FALSE	FALSE
G53D	3/15/2022	Cobalt	0.0022	FALSE	FALSE
G53D	3/15/2022	Iron	1.69	TRUE	NA
G53D	3/15/2022	Manganese	0.0334	TRUE	NA
G53D	3/15/2022	H+	0.000000316	FALSE	FALSE
G53D	7/25/2022	Alkalinity, bicarbonate	149	FALSE	FALSE
G53D	7/25/2022	Calcium	39.7	FALSE	FALSE
G53D	7/25/2022	Magnesium	17	FALSE	FALSE
G53D	7/25/2022	Sodium	49.4	FALSE	FALSE
G53D	7/25/2022	Potassium	0.3	FALSE	FALSE
G53D	7/25/2022	Chloride	19	FALSE	FALSE
G53D	7/25/2022	Sulfate	77	FALSE	FALSE
G53D	7/25/2022	Fluoride	0.72	FALSE	FALSE
G53D	7/25/2022	Barium	0.0913	FALSE	FALSE
G53D	7/25/2022	Boron	0.341	FALSE	FALSE
G53D	7/25/2022	Cobalt	0.0021	FALSE	FALSE
G53D	7/25/2022	Iron	0.281	FALSE	FALSE
G53D	7/25/2022	Manganese	0.137	FALSE	FALSE
G53D	7/25/2022	H+	1.32E-08	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G53D	3/9/2023	Alkalinity, bicarbonate	177	FALSE	FALSE
G53D	3/9/2023	Calcium	38.3	FALSE	FALSE
G53D	3/9/2023	Magnesium	16.4	FALSE	FALSE
G53D	3/9/2023	Sodium	49.2	FALSE	FALSE
G53D	3/9/2023	Potassium	0.355	FALSE	FALSE
G53D	3/9/2023	Chloride	17	FALSE	FALSE
G53D	3/9/2023	Sulfate	72	FALSE	FALSE
G53D	3/9/2023	Fluoride	0.59	FALSE	FALSE
G53D	3/9/2023	Barium	0.101	FALSE	FALSE
G53D	3/9/2023	Boron	0.37	FALSE	FALSE
G53D	3/9/2023	Cobalt	0.0022	FALSE	FALSE
G53D	3/9/2023	Iron	2.25	TRUE	NA
G53D	3/9/2023	Manganese	0.0334	TRUE	NA
G53D	3/9/2023	H+	0.000000347	FALSE	FALSE
G54D	3/24/2021	Alkalinity, bicarbonate	214	FALSE	FALSE
G54D	3/24/2021	Calcium	78.1	FALSE	FALSE
G54D	3/24/2021	Magnesium	24.2	FALSE	FALSE
G54D	3/24/2021	Sodium	62.4	FALSE	FALSE
G54D	3/24/2021	Potassium	1.12	FALSE	FALSE
G54D	3/24/2021	Chloride	23	FALSE	FALSE
G54D	3/24/2021	Sulfate	186	FALSE	FALSE
G54D	3/24/2021	Fluoride	0.32	FALSE	FALSE
G54D	3/24/2021	Barium	0.0941	FALSE	FALSE
G54D	3/24/2021	Boron	0.404	FALSE	FALSE
G54D	3/24/2021	Cobalt	0.0045	FALSE	FALSE
G54D	3/24/2021	Iron	5.11	TRUE	NA
G54D	3/24/2021	Manganese	3.87	TRUE	NA
G54D	3/24/2021	H+	0.000000275	FALSE	FALSE
G54D	9/20/2021	Alkalinity, bicarbonate	207	FALSE	FALSE
G54D	9/20/2021	Calcium	72.8	FALSE	FALSE
G54D	9/20/2021	Magnesium	24.1	TRUE	NA
G54D	9/20/2021	Sodium	49.2	TRUE	NA
G54D	9/20/2021	Potassium	1.12	TRUE	NA
G54D	9/20/2021	Chloride	24	FALSE	FALSE
G54D	9/20/2021	Sulfate	175	FALSE	FALSE
G54D	9/20/2021	Fluoride	0.29	FALSE	FALSE
G54D	9/20/2021	Barium	0.0879	FALSE	FALSE
G54D	9/20/2021	Boron	0.35	FALSE	FALSE
G54D	9/20/2021	Cobalt	0.0083	FALSE	FALSE
G54D	9/20/2021	Iron	5.11	TRUE	NA
G54D	9/20/2021	Manganese	3.87	TRUE	NA
G54D	9/20/2021	H+	0.000000331	FALSE	FALSE
G54D	3/15/2022	Alkalinity, bicarbonate	208	FALSE	FALSE
G54D	3/15/2022	Calcium	83.4	FALSE	FALSE

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
G54D	3/15/2022	Magnesium	25.8	FALSE	FALSE
G54D	3/15/2022	Sodium	54.2	FALSE	FALSE
G54D	3/15/2022	Potassium	1.21	FALSE	FALSE
G54D	3/15/2022	Chloride	21	FALSE	FALSE
G54D	3/15/2022	Sulfate	213	FALSE	FALSE
G54D	3/15/2022	Fluoride	0.31	FALSE	FALSE
G54D	3/15/2022	Barium	0.064	FALSE	FALSE
G54D	3/15/2022	Boron	0.451	FALSE	FALSE
G54D	3/15/2022	Cobalt	0.011	FALSE	FALSE
G54D	3/15/2022	Iron	5.11	TRUE	NA
G54D	3/15/2022	Manganese	3.87	TRUE	NA
G54D	3/15/2022	H+	0.000000245	FALSE	FALSE
G54D	9/20/2022	Alkalinity, bicarbonate	171	TRUE	NA
G54D	9/20/2022	Calcium	69.7	FALSE	FALSE
G54D	9/20/2022	Magnesium	19.4	TRUE	NA
G54D	9/20/2022	Sodium	49.2	TRUE	NA
G54D	9/20/2022	Potassium	0.355	TRUE	NA
G54D	9/20/2022	Chloride	22	FALSE	FALSE
G54D	9/20/2022	Sulfate	218	FALSE	FALSE
G54D	9/20/2022	Fluoride	0.27	FALSE	FALSE
G54D	9/20/2022	Barium	0.0768	FALSE	FALSE
G54D	9/20/2022	Boron	0.252	FALSE	FALSE
G54D	9/20/2022	Cobalt	0.0048	FALSE	FALSE
G54D	9/20/2022	Iron	5.11	TRUE	NA
G54D	9/20/2022	Manganese	3.87	TRUE	NA
G54D	9/20/2022	H+	0.000000316	FALSE	FALSE
G54D	5/3/2023	Alkalinity, bicarbonate	206	FALSE	FALSE
G54D	5/3/2023	Calcium	81.5	FALSE	FALSE
G54D	5/3/2023	Magnesium	26.4	FALSE	FALSE
G54D	5/3/2023	Sodium	57	FALSE	FALSE
G54D	5/3/2023	Potassium	1.21	FALSE	FALSE
G54D	5/3/2023	Chloride	22	FALSE	FALSE
G54D	5/3/2023	Sulfate	194	FALSE	FALSE
G54D	5/3/2023	Fluoride	0.3	FALSE	FALSE
G54D	5/3/2023	Barium	0.0794	FALSE	FALSE
G54D	5/3/2023	Boron	0.555	FALSE	FALSE
G54D	5/3/2023	Cobalt	0.0106	FALSE	FALSE
G54D	5/3/2023	Iron	1.39	FALSE	FALSE
G54D	5/3/2023	Manganese	1.19	FALSE	FALSE
G54D	5/3/2023	H+	0.000000158	FALSE	FALSE
XPW01	3/5/2021	Alkalinity, bicarbonate	155	FALSE	FALSE
XPW01	3/5/2021	Calcium	162	FALSE	FALSE
XPW01	3/5/2021	Magnesium	2.25	FALSE	FALSE
XPW01	3/5/2021	Sodium	35.5	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
XPW01	3/5/2021	Potassium	31.1	FALSE	FALSE
XPW01	3/5/2021	Chloride	10	FALSE	FALSE
XPW01	3/5/2021	Sulfate	345	FALSE	FALSE
XPW01	3/5/2021	Fluoride	0.67	FALSE	FALSE
XPW01	3/5/2021	Barium	0.165	FALSE	FALSE
XPW01	3/5/2021	Boron	10.4	FALSE	FALSE
XPW01	3/5/2021	Cobalt	0.0316	FALSE	TRUE
XPW01	3/5/2021	Iron	2.18	FALSE	FALSE
XPW01	3/5/2021	Manganese	1.24	FALSE	FALSE
XPW01	3/5/2021	H+	0.00000001	FALSE	FALSE
XPW01	3/24/2021	Alkalinity, bicarbonate	141	FALSE	FALSE
XPW01	3/24/2021	Calcium	158	FALSE	FALSE
XPW01	3/24/2021	Magnesium	1.7	FALSE	FALSE
XPW01	3/24/2021	Sodium	37.2	FALSE	FALSE
XPW01	3/24/2021	Potassium	38.1	FALSE	FALSE
XPW01	3/24/2021	Chloride	9	FALSE	FALSE
XPW01	3/24/2021	Sulfate	355	FALSE	FALSE
XPW01	3/24/2021	Fluoride	0.55	FALSE	FALSE
XPW01	3/24/2021	Barium	0.161	FALSE	FALSE
XPW01	3/24/2021	Boron	9.58	FALSE	FALSE
XPW01	3/24/2021	Cobalt	0.0316	FALSE	TRUE
XPW01	3/24/2021	Iron	1.18	FALSE	FALSE
XPW01	3/24/2021	Manganese	0.59	FALSE	FALSE
XPW01	3/24/2021	H+	3.98E-09	FALSE	FALSE
XPW01	4/14/2021	Alkalinity, bicarbonate	136	FALSE	FALSE
XPW01	4/14/2021	Calcium	156	FALSE	FALSE
XPW01	4/14/2021	Magnesium	1.28	FALSE	FALSE
XPW01	4/14/2021	Sodium	28.3	FALSE	FALSE
XPW01	4/14/2021	Potassium	34.7	FALSE	FALSE
XPW01	4/14/2021	Chloride	7	FALSE	FALSE
XPW01	4/14/2021	Sulfate	355	FALSE	FALSE
XPW01	4/14/2021	Fluoride	0.57	FALSE	FALSE
XPW01	4/14/2021	Barium	0.154	FALSE	FALSE
XPW01	4/14/2021	Boron	9.42	FALSE	FALSE
XPW01	4/14/2021	Cobalt	0.0316	FALSE	TRUE
XPW01	4/14/2021	Iron	1.36	FALSE	FALSE
XPW01	4/14/2021	Manganese	0.725	FALSE	FALSE
XPW01	4/14/2021	H+	6.31E-09	FALSE	FALSE
XPW01	5/12/2021	Alkalinity, bicarbonate	145	FALSE	FALSE
XPW01	5/12/2021	Calcium	166	FALSE	FALSE
XPW01	5/12/2021	Magnesium	1.31	FALSE	FALSE
XPW01	5/12/2021	Sodium	29.3	FALSE	FALSE
XPW01	5/12/2021	Potassium	36.9	FALSE	FALSE
XPW01	5/12/2021	Chloride	6	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
XPW01	5/12/2021	Sulfate	309	FALSE	FALSE
XPW01	5/12/2021	Fluoride	0.62	FALSE	FALSE
XPW01	5/12/2021	Barium	0.162	FALSE	FALSE
XPW01	5/12/2021	Boron	10.2	FALSE	FALSE
XPW01	5/12/2021	Cobalt	0.0316	FALSE	TRUE
XPW01	5/12/2021	Iron	1.98	FALSE	FALSE
XPW01	5/12/2021	Manganese	1.09	FALSE	FALSE
XPW01	5/12/2021	H+	3.98E-09	FALSE	FALSE
XPW01	3/15/2022	Alkalinity, bicarbonate	104	FALSE	FALSE
XPW01	3/15/2022	Calcium	159	FALSE	FALSE
XPW01	3/15/2022	Magnesium	0.443	FALSE	FALSE
XPW01	3/15/2022	Sodium	27.4	FALSE	FALSE
XPW01	3/15/2022	Potassium	36.9	FALSE	FALSE
XPW01	3/15/2022	Chloride	5	FALSE	FALSE
XPW01	3/15/2022	Sulfate	360	FALSE	FALSE
XPW01	3/15/2022	Fluoride	0.25	FALSE	FALSE
XPW01	3/15/2022	Barium	0.113	FALSE	FALSE
XPW01	3/15/2022	Boron	10.4	FALSE	FALSE
XPW01	3/15/2022	Cobalt	0.0316	FALSE	TRUE
XPW01	3/15/2022	Iron	1.36	TRUE	NA
XPW01	3/15/2022	Manganese	0.725	TRUE	NA
XPW01	3/15/2022	H+	4.68E-09	FALSE	FALSE
XPW01	3/8/2023	Alkalinity, bicarbonate	64	FALSE	FALSE
XPW01	3/8/2023	Calcium	164	FALSE	FALSE
XPW01	3/8/2023	Magnesium	0.254	FALSE	FALSE
XPW01	3/8/2023	Sodium	27.2	FALSE	FALSE
XPW01	3/8/2023	Potassium	37.2	FALSE	FALSE
XPW01	3/8/2023	Chloride	11	FALSE	FALSE
XPW01	3/8/2023	Sulfate	414	FALSE	FALSE
XPW01	3/8/2023	Fluoride	0.16	FALSE	FALSE
XPW01	3/8/2023	Barium	0.128	FALSE	FALSE
XPW01	3/8/2023	Boron	8.79	FALSE	FALSE
XPW01	3/8/2023	Cobalt	0.0002	FALSE	FALSE
XPW01	3/8/2023	Iron	1.36	TRUE	NA
XPW01	3/8/2023	Manganese	0.725	TRUE	NA
XPW01	3/8/2023	H+	3.39E-09	FALSE	FALSE
XPW01	5/3/2023	Alkalinity, bicarbonate	130	FALSE	FALSE
XPW01	5/3/2023	Calcium	151	FALSE	FALSE
XPW01	5/3/2023	Magnesium	0.405	FALSE	FALSE
XPW01	5/3/2023	Sodium	27	FALSE	FALSE
XPW01	5/3/2023	Potassium	38.5	FALSE	FALSE
XPW01	5/3/2023	Chloride	14	FALSE	FALSE
XPW01	5/3/2023	Sulfate	345	FALSE	FALSE
XPW01	5/3/2023	Fluoride	0.34	FALSE	FALSE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
XPW01	5/3/2023	Barium	0.137	FALSE	FALSE
XPW01	5/3/2023	Boron	10.6	FALSE	FALSE
XPW01	5/3/2023	Cobalt	0.0002	FALSE	FALSE
XPW01	5/3/2023	Iron	1	FALSE	FALSE
XPW01	5/3/2023	Manganese	0.544	FALSE	FALSE
XPW01	5/3/2023	H+	3.89E-09	FALSE	FALSE
XPW02	3/4/2021	Alkalinity, bicarbonate	121	FALSE	FALSE
XPW02	3/4/2021	Calcium	591	FALSE	FALSE
XPW02	3/4/2021	Magnesium	10.9	FALSE	FALSE
XPW02	3/4/2021	Sodium	888	FALSE	FALSE
XPW02	3/4/2021	Potassium	23.4	FALSE	FALSE
XPW02	3/4/2021	Chloride	130	FALSE	FALSE
XPW02	3/4/2021	Sulfate	2380	FALSE	FALSE
XPW02	3/4/2021	Fluoride	0.42	FALSE	FALSE
XPW02	3/4/2021	Barium	0.0342	FALSE	FALSE
XPW02	3/4/2021	Boron	12.1	FALSE	FALSE
XPW02	3/4/2021	Cobalt	0.0316	FALSE	TRUE
XPW02	3/4/2021	Iron	1.63	FALSE	FALSE
XPW02	3/4/2021	Manganese	0.47	FALSE	FALSE
XPW02	3/4/2021	H+	0.00000001	FALSE	FALSE
XPW02	3/24/2021	Alkalinity, bicarbonate	128	FALSE	FALSE
XPW02	3/24/2021	Calcium	484	FALSE	FALSE
XPW02	3/24/2021	Magnesium	11.3	FALSE	FALSE
XPW02	3/24/2021	Sodium	798	FALSE	FALSE
XPW02	3/24/2021	Potassium	26.3	FALSE	FALSE
XPW02	3/24/2021	Chloride	176	FALSE	FALSE
XPW02	3/24/2021	Sulfate	2830	FALSE	FALSE
XPW02	3/24/2021	Fluoride	0.45	FALSE	FALSE
XPW02	3/24/2021	Barium	0.0271	FALSE	FALSE
XPW02	3/24/2021	Boron	12.2	FALSE	FALSE
XPW02	3/24/2021	Cobalt	0.0316	FALSE	TRUE
XPW02	3/24/2021	Iron	1.25	FALSE	FALSE
XPW02	3/24/2021	Manganese	0.499	FALSE	FALSE
XPW02	3/24/2021	H+	0.00000001	FALSE	FALSE
XPW02	4/14/2021	Alkalinity, bicarbonate	128	FALSE	FALSE
XPW02	4/14/2021	Calcium	551	FALSE	FALSE
XPW02	4/14/2021	Magnesium	11.3	FALSE	FALSE
XPW02	4/14/2021	Sodium	705	FALSE	FALSE
XPW02	4/14/2021	Potassium	25.3	FALSE	FALSE
XPW02	4/14/2021	Chloride	110	FALSE	FALSE
XPW02	4/14/2021	Sulfate	2410	FALSE	FALSE
XPW02	4/14/2021	Fluoride	0.44	FALSE	FALSE
XPW02	4/14/2021	Barium	0.0283	FALSE	FALSE
XPW02	4/14/2021	Boron	11.5	FALSE	FALSE

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
XPW02	4/14/2021	Cobalt	0.0316	FALSE	TRUE
XPW02	4/14/2021	Iron	1.69	FALSE	FALSE
XPW02	4/14/2021	Manganese	0.583	FALSE	FALSE
XPW02	4/14/2021	H+	1.26E-08	FALSE	FALSE
XPW02	5/12/2021	Alkalinity, bicarbonate	123	FALSE	FALSE
XPW02	5/12/2021	Calcium	495	FALSE	FALSE
XPW02	5/12/2021	Magnesium	11.8	FALSE	FALSE
XPW02	5/12/2021	Sodium	641	FALSE	FALSE
XPW02	5/12/2021	Potassium	24.5	FALSE	FALSE
XPW02	5/12/2021	Chloride	134	FALSE	FALSE
XPW02	5/12/2021	Sulfate	2410	FALSE	FALSE
XPW02	5/12/2021	Fluoride	0.41	FALSE	FALSE
XPW02	5/12/2021	Barium	0.0287	FALSE	FALSE
XPW02	5/12/2021	Boron	10.8	FALSE	FALSE
XPW02	5/12/2021	Cobalt	0.0316	FALSE	TRUE
XPW02	5/12/2021	Iron	2.15	FALSE	FALSE
XPW02	5/12/2021	Manganese	0.632	FALSE	FALSE
XPW02	5/12/2021	H+	1.41E-08	FALSE	FALSE
XPW02	7/21/2021	Alkalinity, bicarbonate	139	FALSE	FALSE
XPW02	7/21/2021	Calcium	494	FALSE	FALSE
XPW02	7/21/2021	Magnesium	11.1	FALSE	FALSE
XPW02	7/21/2021	Sodium	762	FALSE	FALSE
XPW02	7/21/2021	Potassium	24.7	FALSE	FALSE
XPW02	7/21/2021	Chloride	179	FALSE	FALSE
XPW02	7/21/2021	Sulfate	2330	FALSE	FALSE
XPW02	7/21/2021	Fluoride	0.4	FALSE	FALSE
XPW02	7/21/2021	Barium	0.0226	FALSE	FALSE
XPW02	7/21/2021	Boron	12	FALSE	FALSE
XPW02	7/21/2021	Cobalt	0.0316	FALSE	TRUE
XPW02	7/21/2021	Iron	2.7	FALSE	FALSE
XPW02	7/21/2021	Manganese	0.744	FALSE	FALSE
XPW02	7/21/2021	H+	1.74E-08	FALSE	FALSE
XPW02	3/15/2022	Alkalinity, bicarbonate	144	FALSE	FALSE
XPW02	3/15/2022	Calcium	483	FALSE	FALSE
XPW02	3/15/2022	Magnesium	10.7	FALSE	FALSE
XPW02	3/15/2022	Sodium	828	FALSE	FALSE
XPW02	3/15/2022	Potassium	27.1	FALSE	FALSE
XPW02	3/15/2022	Chloride	115	FALSE	FALSE
XPW02	3/15/2022	Sulfate	2590	FALSE	FALSE
XPW02	3/15/2022	Fluoride	0.48	FALSE	FALSE
XPW02	3/15/2022	Barium	0.023	FALSE	FALSE
XPW02	3/15/2022	Boron	16	FALSE	FALSE
XPW02	3/15/2022	Cobalt	0.0316	FALSE	TRUE

Attachment A.
ELECTRONIC PCA DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
XPW02	3/15/2022	Iron	1.69	TRUE	NA
XPW02	3/15/2022	Manganese	0.583	TRUE	NA
XPW02	3/15/2022	H+	1.82E-08	FALSE	FALSE
XPW02	5/3/2023	Alkalinity, bicarbonate	139	FALSE	FALSE
XPW02	5/3/2023	Calcium	451	FALSE	FALSE
XPW02	5/3/2023	Magnesium	12.3	FALSE	FALSE
XPW02	5/3/2023	Sodium	953	FALSE	FALSE
XPW02	5/3/2023	Potassium	27.4	FALSE	FALSE
XPW02	5/3/2023	Chloride	104	FALSE	FALSE
XPW02	5/3/2023	Sulfate	2650	FALSE	FALSE
XPW02	5/3/2023	Fluoride	0.48	FALSE	FALSE
XPW02	5/3/2023	Barium	0.0212	FALSE	FALSE
XPW02	5/3/2023	Boron	13.4	FALSE	FALSE
XPW02	5/3/2023	Cobalt	0.0002	FALSE	FALSE
XPW02	5/3/2023	Iron	3.49	FALSE	FALSE
XPW02	5/3/2023	Manganese	0.748	FALSE	FALSE
XPW02	5/3/2023	H+	1.91E-08	FALSE	FALSE
XPW03	5/12/2021	Alkalinity, bicarbonate	141	TRUE	FALSE
XPW03	5/12/2021	Calcium	16.4	FALSE	FALSE
XPW03	5/12/2021	Magnesium	0.316	FALSE	TRUE
XPW03	5/12/2021	Sodium	113	FALSE	FALSE
XPW03	5/12/2021	Potassium	27.5	FALSE	FALSE
XPW03	5/12/2021	Chloride	25	FALSE	FALSE
XPW03	5/12/2021	Sulfate	155	FALSE	FALSE
XPW03	5/12/2021	Fluoride	0.25	FALSE	FALSE
XPW03	5/12/2021	Barium	0.012	FALSE	FALSE
XPW03	5/12/2021	Boron	11.7	FALSE	FALSE
XPW03	5/12/2021	Cobalt	0.0316	FALSE	TRUE
XPW03	5/12/2021	Iron	0.316	FALSE	TRUE
XPW03	5/12/2021	Manganese	0.0707	FALSE	TRUE
XPW03	5/12/2021	H+	2E-11	FALSE	FALSE
XPW03	7/21/2021	Alkalinity, bicarbonate	141	TRUE	FALSE
XPW03	7/21/2021	Calcium	15.3	FALSE	FALSE
XPW03	7/21/2021	Magnesium	0.224	FALSE	TRUE
XPW03	7/21/2021	Sodium	104	FALSE	FALSE
XPW03	7/21/2021	Potassium	26.9	FALSE	FALSE
XPW03	7/21/2021	Chloride	26	FALSE	FALSE
XPW03	7/21/2021	Sulfate	148	FALSE	FALSE
XPW03	7/21/2021	Fluoride	0.26	FALSE	FALSE
XPW03	7/21/2021	Barium	0.0114	FALSE	FALSE
XPW03	7/21/2021	Boron	11.6	FALSE	FALSE
XPW03	7/21/2021	Cobalt	0.0316	FALSE	TRUE
XPW03	7/21/2021	Iron	0.158	FALSE	TRUE
XPW03	7/21/2021	Manganese	0.0447	FALSE	TRUE

Attachment A.

ELECTRONIC PCA DATA

35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION

JOPPA POWER PLANT

EAST ASH POND

JOPPA, IL

Well ID	Date	Parameter	Result (mg/L)	Imputed Value	Half RL Used
XPW03	7/21/2021	H+	1.07E-10	FALSE	FALSE

Note:

mg/L = milligrams per liter

RL = reporting limit

APPENDIX C
SUPPORTING GROUNDWATER AND POREWATER ANALYTICAL DATA

APPENDIX C.
SUPPORTING GROUNDWATER AND POREWATER ANALYTICAL DATA
35 I.A.C. § 845: ALTERNATIVE SOURCE DEMONSTRATION
JOPPA POWER PLANT
EAST ASH POND
JOPPA, IL

Well ID	Well Type	Date	Parameter	Result	Unit
G03	Compliance	06/15/2021	Cobalt, total	0.001 U	mg/L
G03	Compliance	07/06/2021	Cobalt, total	0.001 U	mg/L
G03	Compliance	07/21/2021	Cobalt, total	0.001 U	mg/L
G03	Compliance	06/15/2021	Manganese, total	0.0330	mg/L
G03	Compliance	07/06/2021	Manganese, total	0.0226	mg/L
G03	Compliance	07/21/2021	Manganese, total	0.0334	mg/L
G05	Compliance	03/04/2021	Boron, total	0.181	mg/L
G05	Compliance	03/24/2021	Boron, total	0.195	mg/L
G05	Compliance	04/13/2021	Boron, total	0.190	mg/L
G05	Compliance	05/11/2021	Boron, total	0.158	mg/L
G05	Compliance	06/01/2021	Boron, total	0.157	mg/L
G05	Compliance	06/15/2021	Boron, total	0.140	mg/L
G05	Compliance	07/06/2021	Boron, total	0.148	mg/L
G05	Compliance	07/20/2021	Boron, total	0.131	mg/L
G05	Compliance	07/26/2022	Boron, total	0.0645	mg/L
G05	Compliance	03/09/2023	Boron, total	0.0541	mg/L
G05	Compliance	05/03/2023	Boron, total	0.0478	mg/L
G05	Compliance	03/04/2021	Cobalt, total	0.0101	mg/L
G05	Compliance	03/24/2021	Cobalt, total	0.00960	mg/L
G05	Compliance	04/13/2021	Cobalt, total	0.00950	mg/L
G05	Compliance	05/11/2021	Cobalt, total	0.00870	mg/L
G05	Compliance	06/01/2021	Cobalt, total	0.00780	mg/L
G05	Compliance	06/15/2021	Cobalt, total	0.00570	mg/L
G05	Compliance	07/06/2021	Cobalt, total	0.00910	mg/L
G05	Compliance	07/20/2021	Cobalt, total	0.00590	mg/L
G05	Compliance	07/26/2022	Cobalt, total	0.00750	mg/L
G05	Compliance	03/09/2023	Cobalt, total	0.00740	mg/L
G05	Compliance	05/03/2023	Cobalt, total	0.0103	mg/L
G05	Compliance	03/04/2021	Manganese, total	0.227	mg/L
G05	Compliance	04/13/2021	Manganese, total	0.294	mg/L
G05	Compliance	05/11/2021	Manganese, total	0.256	mg/L
G05	Compliance	06/01/2021	Manganese, total	0.254	mg/L
G05	Compliance	06/15/2021	Manganese, total	0.187	mg/L
G05	Compliance	07/06/2021	Manganese, total	0.270	mg/L
G05	Compliance	07/20/2021	Manganese, total	0.204	mg/L
G05	Compliance	07/26/2022	Manganese, total	0.176	mg/L
G05	Compliance	05/03/2023	Manganese, total	0.191	mg/L
G05	Compliance	03/04/2021	Sulfate, total	94.0	mg/L
G05	Compliance	03/24/2021	Sulfate, total	92.0	mg/L
G05	Compliance	04/13/2021	Sulfate, total	95.0	mg/L
G05	Compliance	05/11/2021	Sulfate, total	109	mg/L
G05	Compliance	06/01/2021	Sulfate, total	83.0	mg/L
G05	Compliance	06/15/2021	Sulfate, total	91.0	mg/L
G05	Compliance	07/06/2021	Sulfate, total	90.0	mg/L
G05	Compliance	07/20/2021	Sulfate, total	87.0	mg/L
G05	Compliance	07/26/2022	Sulfate, total	68.0	mg/L

APPENDIX C.
SUPPORTING GROUNDWATER AND POREWATER ANALYTICAL DATA
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JOPPA POWER PLANT
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JOPPA, IL

Well ID	Well Type	Date	Parameter	Result	Unit
G05	Compliance	03/09/2023	Sulfate, total	90.0	mg/L
G05	Compliance	05/03/2023	Sulfate, total	112	mg/L
G53D	Compliance	07/25/2022	Cobalt, total	0.00210	mg/L
G53D	Compliance	05/03/2023	Cobalt, total	0.00180	mg/L
G53D	Compliance	07/25/2022	Manganese, total	0.137	mg/L
G53D	Compliance	05/03/2023	Manganese, total	0.133	mg/L
XPW01	Porewater	03/05/2021	Boron, total	10.4	mg/L
XPW01	Porewater	03/24/2021	Boron, total	9.58	mg/L
XPW01	Porewater	04/14/2021	Boron, total	9.42	mg/L
XPW01	Porewater	05/12/2021	Boron, total	10.2	mg/L
XPW01	Porewater	07/21/2021	Boron, total	10.1	mg/L
XPW01	Porewater	03/15/2022	Boron, total	10.4	mg/L
XPW01	Porewater	03/08/2023	Boron, total	8.79	mg/L
XPW01	Porewater	05/03/2023	Boron, total	10.6	mg/L
XPW01	Porewater	03/05/2021	Cobalt, total	0.001 U	mg/L
XPW01	Porewater	03/24/2021	Cobalt, total	0.001 U	mg/L
XPW01	Porewater	04/14/2021	Cobalt, total	0.001 U	mg/L
XPW01	Porewater	05/12/2021	Cobalt, total	0.001 U	mg/L
XPW01	Porewater	07/21/2021	Cobalt, total	0.001 U	mg/L
XPW01	Porewater	03/15/2022	Cobalt, total	0.001 U	mg/L
XPW01	Porewater	03/08/2023	Cobalt, total	0.0002 J	mg/L
XPW01	Porewater	05/03/2023	Cobalt, total	0.0002 J	mg/L
XPW01	Porewater	03/05/2021	Sulfate, total	345	mg/L
XPW01	Porewater	03/24/2021	Sulfate, total	355	mg/L
XPW01	Porewater	04/14/2021	Sulfate, total	355	mg/L
XPW01	Porewater	05/12/2021	Sulfate, total	309	mg/L
XPW01	Porewater	07/21/2021	Sulfate, total	328	mg/L
XPW01	Porewater	03/15/2022	Sulfate, total	360	mg/L
XPW01	Porewater	03/08/2023	Sulfate, total	414	mg/L
XPW01	Porewater	05/03/2023	Sulfate, total	345	mg/L
XPW02	Porewater	03/04/2021	Boron, total	12.1	mg/L
XPW02	Porewater	03/24/2021	Boron, total	12.2	mg/L
XPW02	Porewater	04/14/2021	Boron, total	11.5	mg/L
XPW02	Porewater	05/12/2021	Boron, total	10.8	mg/L
XPW02	Porewater	07/21/2021	Boron, total	12.0	mg/L
XPW02	Porewater	03/15/2022	Boron, total	16.0	mg/L
XPW02	Porewater	03/08/2023	Boron, total	10.8	mg/L
XPW02	Porewater	05/03/2023	Boron, total	13.4	mg/L
XPW02	Porewater	03/04/2021	Cobalt, total	0.001 U	mg/L
XPW02	Porewater	03/24/2021	Cobalt, total	0.001 U	mg/L
XPW02	Porewater	04/14/2021	Cobalt, total	0.001 U	mg/L
XPW02	Porewater	05/12/2021	Cobalt, total	0.001 U	mg/L
XPW02	Porewater	07/21/2021	Cobalt, total	0.001 U	mg/L
XPW02	Porewater	03/15/2022	Cobalt, total	0.001 U	mg/L
XPW02	Porewater	03/08/2023	Cobalt, total	0.0003 J	mg/L
XPW02	Porewater	05/03/2023	Cobalt, total	0.0002 J	mg/L

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Well ID	Well Type	Date	Parameter	Result	Unit
XPW02	Porewater	03/04/2021	Sulfate, total	2,380	mg/L
XPW02	Porewater	03/24/2021	Sulfate, total	2,830	mg/L
XPW02	Porewater	04/14/2021	Sulfate, total	2,410	mg/L
XPW02	Porewater	05/12/2021	Sulfate, total	2,410	mg/L
XPW02	Porewater	07/21/2021	Sulfate, total	2,330	mg/L
XPW02	Porewater	03/15/2022	Sulfate, total	2,590	mg/L
XPW02	Porewater	03/08/2023	Sulfate, total	2,450	mg/L
XPW02	Porewater	05/03/2023	Sulfate, total	2,650	mg/L
XPW03	Porewater	03/04/2021	Boron, total	12.2	mg/L
XPW03	Porewater	03/24/2021	Boron, total	11.6	mg/L
XPW03	Porewater	04/14/2021	Boron, total	9.30	mg/L
XPW03	Porewater	05/12/2021	Boron, total	11.7	mg/L
XPW03	Porewater	07/21/2021	Boron, total	11.6	mg/L
XPW03	Porewater	03/15/2022	Boron, total	11.1	mg/L
XPW03	Porewater	03/09/2023	Boron, total	8.06	mg/L
XPW03	Porewater	05/03/2023	Boron, total	9.22	mg/L
XPW03	Porewater	03/04/2021	Cobalt, total	0.001 U	mg/L
XPW03	Porewater	03/24/2021	Cobalt, total	0.001 U	mg/L
XPW03	Porewater	04/14/2021	Cobalt, total	0.001 U	mg/L
XPW03	Porewater	05/12/2021	Cobalt, total	0.001 U	mg/L
XPW03	Porewater	07/21/2021	Cobalt, total	0.001 U	mg/L
XPW03	Porewater	03/15/2022	Cobalt, total	0.001 U	mg/L
XPW03	Porewater	03/09/2023	Cobalt, total	0.0001 U	mg/L
XPW03	Porewater	05/03/2023	Cobalt, total	0.0001 U	mg/L
XPW03	Porewater	03/04/2021	Sulfate, total	133	mg/L
XPW03	Porewater	03/24/2021	Sulfate, total	138	mg/L
XPW03	Porewater	04/14/2021	Sulfate, total	152	mg/L
XPW03	Porewater	05/12/2021	Sulfate, total	155	mg/L
XPW03	Porewater	07/21/2021	Sulfate, total	148	mg/L
XPW03	Porewater	03/15/2022	Sulfate, total	152	mg/L
XPW03	Porewater	03/09/2023	Sulfate, total	142	mg/L
XPW03	Porewater	05/03/2023	Sulfate, total	144	mg/L

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Notes:
mg/L = milligrams per liter
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
U = The analyte was analyzed for, but was not detected above the level of the adjusted detection limit or quantitation limit, as appropriate.

APPENDIX D
GEOCHEMICAL ANALYSIS OF JOPPA EAST ASH POND GROUNDWATER IN SUPPORT OF AN ALTERNATIVE SOURCE DEMONSTRATION (LIFE CYCLE GEO, LLC, 2023)

TECHNICAL MEMORANDUM

DATE October 21, 2023 **Reference No.** 23RAM01-1

TO Brian G. Hennings – Ramboll
Frances Ackerman – Ramboll
Allison Kreinberg - Geosyntec

CC Stu Cravens - Vistra

FROM Shannon Zahuranec, Allie Wyman, Tom Meuzelaar **EMAIL:** shannon@lifecyclegeo.com

GEOCHEMICAL ANALYSIS OF JOPPA EAST ASH POND GROUNDWATER IN SUPPORT OF AN ALTERNATIVE SOURCE DEMONSTRATION

1.0 EXECUTIVE SUMMARY

This document serves as an Appendix to the October 21, 2023, Alternative Source Demonstration (ASD) for Joppa (JOP) Power Plant East Ash Pond (EAP) for monitoring Event 1 (E001) (referred to as the E001 ASD), completed to fulfill the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.650(e). Life Cycle Geo, LLC (LCG) has completed a review of geochemical conditions to evaluate the feasibility of an ASD at monitoring wells G11 and G51D associated with the JOP EAP. Compliance wells G11 and G51D monitor conditions in the Uppermost Aquifer (UA) to the west of the EAP and currently exhibit pH levels lower than the groundwater protection standard (GWPS) range for pH. This technical evaluation considered all available groundwater and solid-phase chemical analyses and utilized multivariate statistical analysis to conclude that low pH levels at G11 and G51D are not attributed to influence from the EAP. Further, observed pH levels are likely the result of the oxidation of dissolved iron released from chemically reducing conditions in the upgradient area to the north and west of the G11 and G51D monitoring wells (also referred to in this document as exceedance wells). Oxidation of dissolved ferrous iron and subsequent precipitation of solid-phase iron generates acidity through fundamentally established geochemical reactions discussed in Section 4.0. This scope of work was executed by subcontract to Ramboll Americas Engineering Solutions, Inc. (Ramboll) on behalf of Electric Energy, Inc.

2.0 HYDROGEOLOGY AND GROUNDWATER CONDITION

Monitoring wells G11 and G51D are screened in the UA. The UA is composed predominantly of sand and is overlain by the upper confining unit (UCU), a clay-rich, low permeability stratigraphic unit (Ramboll, 2021). Monitoring wells G11 and G51D are on the western border of the EAP, hydraulically upgradient of the EAP and the other EAP monitoring wells (Attachment 1). Monitoring wells G11 and G51D are downgradient of the northernmost part of the JOP West Ash Pond (WAP), and the sewage treatment pond (Attachment 2) situated on the northwest corner of the WAP.

Table 1: Concentration Ranges for Select Constituents in Joppa Groundwater and CCR Ponds.

	pH	Boron (mg/L)	Magnesium (mg/L)
G11	5.78-6.33	0.25-0.42	27.8-72.4
G51D	5.30-6.92	0.03-0.96	12.3-14.4
CCR porewater	6.76-11.1	4.02-34.3	ND-27.8
Western Groundwater*	5.04-7.4	ND-24.7	4.0-126
Eastern Groundwater	5.62-7.88	ND-5.43	7.1-49.3
TPZ120	2.77-3.63	2.08-3.55	52.4-63.5

ND=Not Detected
Data provided in Appendix D-1
*Western groundwater ranges presented do not include TPZ120, which is listed separately.

From March 2021 through May 2023, pH at G11 and G51D is generally below the GWPS lower limit of 6.0 standard pH units (SU) (Attachment 3). Groundwater pH elsewhere at the site has been measured as low as 5.0 SU (Table 1) but is typically between 6 and 8 SU (Attachment 3; Appendix D-1). The UCU monitoring well TPZ120 is an exception with a much lower groundwater pH (less than 4.0 SU).

This analysis focused predominantly on assessing the source of acidity in G11 and G51D as originating from either east or west of the exceedance wells to determine if the EAP (east of the exceedance wells) is the source of the low pH levels observed. To this end, monitoring wells to the east of the exceedance wells are discussed as the Eastern Wells and the monitoring wells to the west are discussed as the Western Wells. The Eastern Wells include the EAP porewater wells [XPW01, XPW02, and XPW03] as an endmember for evaluation, EAP compliance-based groundwater wells [G03, G05, G06, G07, G08, G09, G10, G52D, G53D, and G54D], and two EAP monitoring wells [G04 and G06S] that are not included in the regulatory network but are in close proximity to the compliance EAP monitoring wells. While most of these wells are downgradient of G11 and G51D, they provide a necessary comparison for assessing potential EAP impacts to G11 and G51D. The Western Wells are hydraulically upgradient or side-gradient of G11 and G51D and are used to evaluate potential alternate sources for the pH exceedances originating to the west. Western Wells included in this analysis are installed in the UA [TPZ118D, TPZ118DD, TPZ119D, TPZ119DD, TPZ120D, TPZ123, and TPZ124D] and UCU [TPZ118, TPZ120, and TPZ124], as well as the WAP porewater wells [XTPW01, XTPW02, XTPW03, and XTPW04]. The upgradient background wells G01D and G02D are assessed as the upgradient endmember reflective of groundwater uninfluenced by activity at the JOP site. This selection of Eastern and Western wells provides the best analysis of geochemical conditions and potential sources in the immediate area of G11 and G51D. Potential sources of acidity (which could drive the observed low pH levels at G11 and G51D) are assessed through comprehensive geochemical analysis, including time series analysis, correlation plots (scatterplot comparisons), Principal Components Analysis (PCA), and spatial and chemical distribution of iron.

3.0 GEOCHEMICAL ANALYSIS

3.1 CCR INDICATOR CONSTITUENT BORON

Boron is commonly used as an indicator parameter for contaminant transport of CCR because: (i) it is commonly present at elevated concentrations in coal ash leachate; (ii) it is mobile and typically not very reactive but conservative (i.e., low rates of sorption or degradation) in groundwater; and (iii) it is less likely than other constituents to be present at elevated concentrations in background groundwater from natural or other anthropogenic sources. Boron is often assessed in groundwater to identify possible end-member sources of influence in downgradient areas that could be attributed to CCR. Porewater samples collected from both the EAP and WAP exhibit elevated concentrations of boron, whereas boron concentrations in monitoring wells G11 and G51D are low relative to CCR porewater and most groundwater monitoring wells located both to the east and west (Attachment 3). While boron concentrations suggest no immediate influence from either of the CCR units, it is not otherwise relied upon for distinguishing influence as originating from either the east (i.e., EAP) or west.

3.2 OTHER PERTINENT CHEMICAL TRACERS OF INFLUENCE

Magnesium is not commonly used as a CCR indicator, yet the substantial range in magnesium concentrations observed in groundwater to the west relative to east makes it a particularly useful tracer of influence (Attachment 3). Table 1 presents the range in magnesium measured for several different endmember components assessed for influence in relation to exceedance wells G11 and G51D.

Magnesium concentrations are notably elevated in several of the western groundwater monitoring wells, both within the UA and UCU stratigraphic units. Magnesium concentrations in G11 are similarly elevated when contrasted with groundwater concentrations measured to the east. Concentrations of magnesium at G51D are more similar to background (i.e., overall low). While some Eastern Wells do exhibit magnesium concentrations above background, the range is substantially lower than G11 and the Western Wells overall. The low magnesium concentrations observed in background groundwater, eastern groundwater, and CCR porewater lead in the direction of the western groundwater as a source of high magnesium to, and therefore a dominant influence on, the exceedance wells (G11 in particular).

A strong linear relationship is observed between sulfate and magnesium in groundwater (Attachment 4; Appendix D-1), except TPZ120, which appears as an outlier for the JOP groundwater. The linear relationship between magnesium and sulfate is observed in both western and eastern groundwaters, though the magnitude of measured concentrations in the Western Wells extends beyond that of the Eastern Wells, as discussed in the previous paragraph. Concentrations from monitoring well G11 plot among the Western Wells and are distinctly separate from Eastern Wells. Furthermore, the G11 magnesium-sulfate relationship is similar to Western UCU wells. This data suggests that G11 groundwater chemistry is more similar to western groundwater chemistry than eastern groundwater chemistry. Conditions at G51D are suspected to be under the same influence from the western groundwater chemistry, but are simultaneously influenced from upgradient background groundwater, discussed further in Section 4.0. This mixing of groundwaters produces a lower magnesium concentration in G51D relative to G11.

3.3 MULTIVARIATE DATA ANALYSIS

3.3.1 METHOD

Groundwater chemistry data are by nature multivariate datasets given the high number of parameters observed per sampling location and within a given timeframe. With such a large number of variables, advanced statistical analysis of multivariate groundwater data can provide important insights into spatial,

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temporal, and chemical relationships influencing constituent distribution and compliance in groundwater. The multivariate technique Principal Component Analysis (PCA) is used to interrogate the groundwater chemistry around the exceedance wells.

PCA is a multivariate technique that reduces dataset dimensionality to its principal, independent components thereby revealing the inner structure of the dataset. Multivariate techniques such as PCA are valuable because they identify variables that are highly dependent on each other but do not inherently provide insights into water origin, type, or evolution. Reducing multivariate data dimensionality reduces redundant information, revealing inner structures in the data that might otherwise be obscured by these dependencies. These structures might include groups of related variables, chemical evolution through time, or spatial locations with similar chemical signatures.

PCA results are most easily viewed on a biplot (such as those provided in Attachment 5), which depicts the sample population plotted on two axes, each representing a principal component. The principal components are created from a linear combination of the original variables in the dataset and variance in the data. For natural compositional datasets, approximately 70% of the population variance can often be expressed in the first three or four principal components (in some cases less and in others, more), each representing decreasing amounts of variance in the data while remaining uncorrelated to previous principal components. The first two principal components often represent the majority of the dataset and are visualized using biplots with the variables expressed as vectors; the location of groups of samples (i.e., factor scores) relative to component vectors provides insight into geochemical relationships among groups of variables and samples.

3.3.2 DATA PREPARATION

When conducting multivariate analysis, it is first necessary to prepare the dataset. Raw chemical data requires preparation prior to analysis because the data often contains values in two forms unsuitable for advanced analytics: 1) measurements reported below a method detection limit (MDL), referred to as censored data, and 2) missing values. For this work, any sample or analyte with a high percentage (≥40%) of missing and/or censored data was assessed for meaningful statistical variance. If overall analyte variance was determined to be low, the analyte was removed, otherwise the data was included in the analysis. Any remaining censored data was converted to half the MDL. Remaining missing values were imputed, a method of assigning an estimated value that accounts for the entire distribution of the material's composition (Sanford et al., 1993) and also takes into consideration the values associated with samples of similar composition. Imputation was done with a nearest neighbor algorithm (Troyanskaya, 2001) and resulting values were checked against the overall data distribution for both the analyte and sample to ensure representative results. Imputed data represents 1.9% or less of the overall dataset in the PCA biplots presented here. Processed data for the PCA are presented in Electronic Attachment 1 and 2.

PCA also requires transformation of the dataset to address the numeric closure problem inherent within chemical compositional datasets (Aitchison, 1986). Numeric closure can often occur in water quality data since water quality concentrations are not completely independent. To address this issue, all data was converted to the same units (mg/L) and the centered-log ratio transformation (CLR; Aitchison 1986; Egozcue et al. 2011) was applied to the cleaned dataset. In practice, closure only significantly affects elements present in large concentrations (e.g., major ions in typical water quality samples), but for consistency the entire dataset (i.e., including trace metals) was CLR-transformed.

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The resulting dataset includes both compliance wells and other monitoring wells and spans sampling events from 2017 through 2023. The dataset contains 18 measured analytes, including the hydrogen ion (H+), which represents acidity in groundwater and is proportional to pH. This data represents both the most recent data measured at JOP as well as the most complete set of regularly measured and detectable analytes. All data preparation was conducted using python programming language. Only total concentrations of major ions and metals were used in this analysis as those data are both relatively complete and consistent across the wells on site and are the parameters of interest for regulatory purposes.

3.3.3 RESULTS

Biplots showing principal components 1 and 2 (PC1 and PC2) are provided in Attachment 5. The PC1 and PC2 are represented on the X and Y axis and explain approximately 30% and 25% of the statistical variance in the water quality dataset, respectively. For each biplot, the first three components explain over 65% variance in the dataset, while the first four explain over 70%. Constituent variables are expressed as vectors. The grouping of samples relative to the component vectors is useful for providing immediate insight into geochemical relationships among groups of variables and samples.

Two iterations of biplots are provided; Attachment 5a depicts all Western and Eastern Wells and porewater locations with sufficient data. Attachment 5b depicts all potential endmember influences on the pH exceedances at G11 and G51D, as represented by background groundwater, EAP porewater, WAP porewater, and hydraulically upgradient groundwater wells (all of which exist to the north and west). Side-gradient western well TPZ120 is also included as it represents a geochemical endmember. While constituent vectors are arranged in a similar orientation across both biplots, biplot 5A which includes the downgradient eastern groundwater contains more noise in the dataset making it difficult to decipher meaningful inter-well trends. This biplot is provided as a reference but is not discussed further. The remaining analysis focuses on biplot 5B which contains hydraulically upgradient wells, background wells, and porewater wells as geochemical endmembers of G11 and G51D (Attachment 5b). This biplot exhibits the following key features:

- Exceedance wells G51D and G11 exhibit a high degree of similarity with the Western Wells screened in the UA.
- Groundwater samples are distributed linearly from the bottom right to the middle of the upper left quadrant, with clear separation between stratigraphic units within the spread of data. Background data plots as an endmember in the lower right quadrant, transitions into UA wells in the lower left quadrant, and continues through the UCU wells in the middle upper left quadrant.
- The EAP and WAP porewaters dominate the upper right quadrant and are distinctly separate from the groundwater samples. There is also a clear separation between EAP and WAP porewaters. The WAP porewater has a strong association with the boron and lithium vectors whereas the EAP porewater is more closely associated with arsenic, potassium, molybdenum, and selenium.
- The WAP UCU monitoring well TPZ120 plots alone in the upper left corner of the plot at the far end of the iron vector, indicating (a) iron is a key contributor to the variance associated with this location and (b) TPZ120 has a distinct chemical composition relative to the other groundwater compositions considered.

The linear spread of groundwater data suggests chemical evolution and/or communication within the aquifer system. The western UCU groundwater composition is dominated by redox sensitive vectors such as manganese, iron, and sulfate. The UA groundwater is observed to undergo a gradual chemical evolution from the UCU redox-sensitive composition endmember back to background conditions, which are dominated by alkalinity, sodium, chloride, and fluoride. The exceedance wells plot among the western UA groundwater, suggesting geochemistry is broadly similar in these wells. Furthermore, the exceedance wells plot in near association with the background groundwater wells, also indicating some multi-variate geochemical similarity to background. This positioning may indicate potential mixing between reduced upgradient groundwaters from the northwest with oxidized background water from the north, discussed further in Section 4.0. Exceedance wells G51D and G11 do not demonstrate association with the EAP porewater composition, supporting the conclusion that the EAP porewater is not a primary influence on the groundwater composition observed at G51D and G11, and is therefore not found to be responsible for the pH exceedances.

4.0 POTENTIAL ALTERNATE SOURCES

This technical review identified the likely source of acidity contributing to the low pH levels at G11 and G51D is dissolved iron in groundwater under reducing conditions and the redox transition that occurs in groundwater immediately upgradient of the G11 and G51D monitoring wells. This is demonstrated in Attachment 6, which includes figures depicting the redox condition at the site. The map included in Attachment 6A (Appendix D-2) demonstrates a distinct redox transition from more reducing conditions in upgradient waters and more oxidizing conditions near the exceedance wells. The reducing upgradient waters are characterized by lower oxidation reduction potential (ORP) and higher iron concentrations, while downgradient waters are largely the opposite with higher ORP and lower iron concentrations. This spatial gradient in redox conditions is also reflected in the Pourbaix diagram for the upgradient western groundwater network (Attachment 6B; Appendix D-3). This diagram demonstrates the predominant iron species and mineral forms under changing pH and Eh conditions (Eh is calculated from field measurements of ORP using the AquaTROLL conversion rate). There is a clear gradient from more reducing conditions in the north and west to more oxidized conditions in G11 and G51D with dissolved iron (Fe^{++}) and iron hydroxide ($Fe(OH)_3$) as the dominant forms of iron. Simultaneously, there is a drop in pH as conditions become more oxidizing.

The source of the dissolved iron and reducing condition could be attributed to three possible upgradient influences existing to the west and north of the two exceedance wells: 1) low pH and relatively high dissolved iron existing in the general area around Western Well TPZ120, 2) the WAP, and 3) the sewage treatment pond. Results of the PCA suggest groundwater monitored in the area of Western Well TPZ120 and the WAP are both potential geochemical endmembers of the chemical evolution observed upgradient and to the west (Attachment 5). Monitoring well TPZ120 has an average iron concentration of 1.2 mg/L (determined from samples with turbidity <10 NTU) and is near enough in proximity to the exceedance wells to suggest cross-gradient flow between these wells may be possible (Attachment 2). The WAP and the sewage treatment pond are both upgradient sources of reduced groundwater, though high turbidity in field samples limits the use of existing iron data for full understanding of transport and speciation of dissolved iron in response to the redox gradient. These three locations represent possible alternate sources of reduced iron to the exceedance wells.

This change in redox condition is the likely source of acidity in G11 and G51D. It is interpreted that dissolved iron is released from the sediments through the process of reductive dissolution by upgradient waters, in response to the reducing conditions (as observed by low ORP). The dissolved iron is transported downgradient with groundwater and subsequently oxidizes and precipitates when it moves into an area with sufficient dissolved oxygen to drive the oxidation reaction.

The oxidation of dissolved iron to iron hydroxide is known to produce acidity via the following reactions:

$$Fe^{2+} + \frac{1}{4}O_2 + H^+ \rightarrow Fe^{3+} + \frac{1}{2}H_2O$$

$$Fe^{3+} + 3H_2O \rightarrow Fe(OH)_3 + 3H^+$$

Acidity is highlighted in red, and the equations demonstrate a net increase in acidity through iron oxidation and precipitation. In this way, reduced upgradient waters from the north and west provides the constituent (i.e., reduced iron) necessary to cause a drop in pH (i.e., through iron oxidation) in G11 and G51D. The oxidized environment near the exceedance wells results from sufficient mixing with the upgradient oxidized background groundwater. This is particularly evident in G51D, which has a more immediate influence of dissolved iron from reduced upgradient wells and has a compositional similarity to background wells (as seen in PCA and magnesium concentrations) resulting in the lowest pH in the JOP EAP groundwater network.

5.0 CONCLUSIONS

This technical review presents evidence that demonstrates the EAP is not the source of pH exceedances at compliance wells G11 and G51D. Results of the geochemical and multivariate analysis (i.e., PCA) demonstrate that groundwater associated with monitoring wells G11 and G51D are more similar to upgradient groundwater to the north and west than the EAP porewater. This analysis was supported by examination of magnesium concentrations and the magnesium-sulfate relationship, both of which indicate G11 and G51D have a chemical signature indicative of western groundwater and background groundwater. The pH exceedances are found to be the result of chemically reduced upgradient waters carrying dissolved iron (released from the aquifer solids through the geochemical process of reductive dissolution) subsequently mixing with oxidized background groundwater in the area of G51D and G11. Further analysis revealed three potential sources of dissolved iron to the north and west of the exceedance locations; however, this investigation did not attempt to identify the primary or singular source of dissolved iron driving the pH exceedances. Upon mixing, the dissolved iron originating from more reducing groundwater subsequently oxidizes and precipitates as iron hydroxide, consequently generating acidity and lowering the groundwater pH in this specific area. The information and analysis presented thus rules out the EAP as the source of the acidity, and therefore pH exceedances, in this area.

6.0 ABBREVIATIONS

Alk	Total Alkalinity
As	Arsenic
B	Boron
Ca	Calcium
CCR	Coal combustion residual
Cl	Chloride
Co	Cobalt
Cr	Chromium
EAP	East Ash Pond
F	Fluoride
Fe	Iron
H+	Hydrogen ion, represents acidity in groundwater
JOP	Joppa
K	Potassium
Li	Lithium
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
Na	Sodium
ORP	Oxidation reduction potential
PCA	Principal components analysis
Redox	Oxidation-Reduction
Se	Selenium
SO4	Sulfate
UA	Upper Aquifer
UCU	Upper confining unit
WAP	West Ash Pond

7.0 REFERENCES

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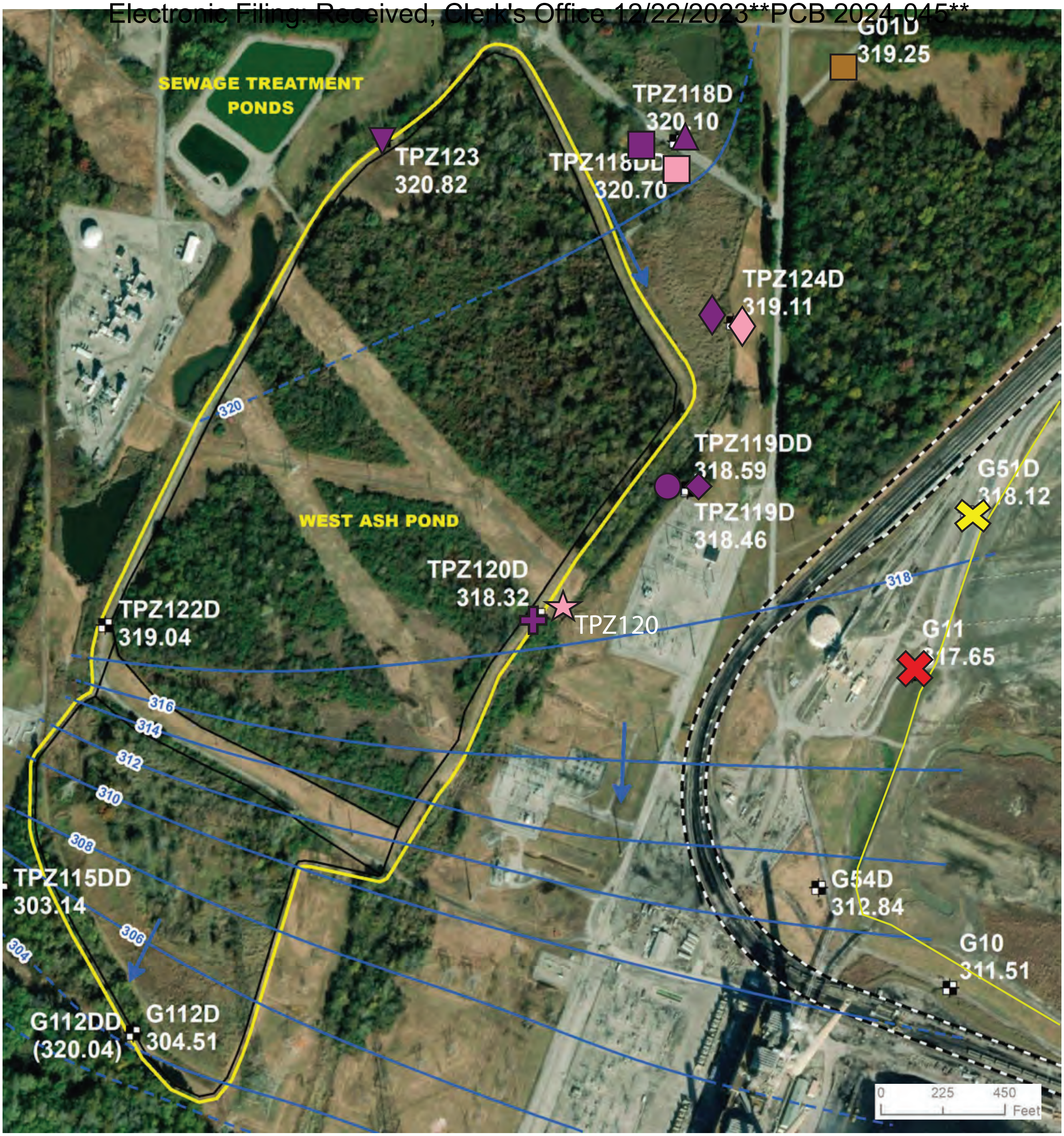
Olga Troyanskaya, Michael Cantor, Gavin Sherlock, Pat Brown, Trevor Hastie, Robert Tibshirani, David Botstein and Russ B. Altman, Missing value estimation methods for DNA microarrays, BIOINFORMATICS Vol. 17 no. 6, 2001 Pages 520-525.

Sanford, R. F., C.T. Pierson, and R.A. Crovelli. 1993. An objective replacement method for censored geochemical data: Math. Geol., 25(1), p. 59–80.

Notes:
Wells with pH exceedances are shown with an X.
East ash pond compliance wells are light blue and monitoring wells are dark blue.
Western monitoring wells are purple (UA) and pink (UCU).
Background wells are brown. Ash ponds are outlined in yellow.
Contours are from March 2023.

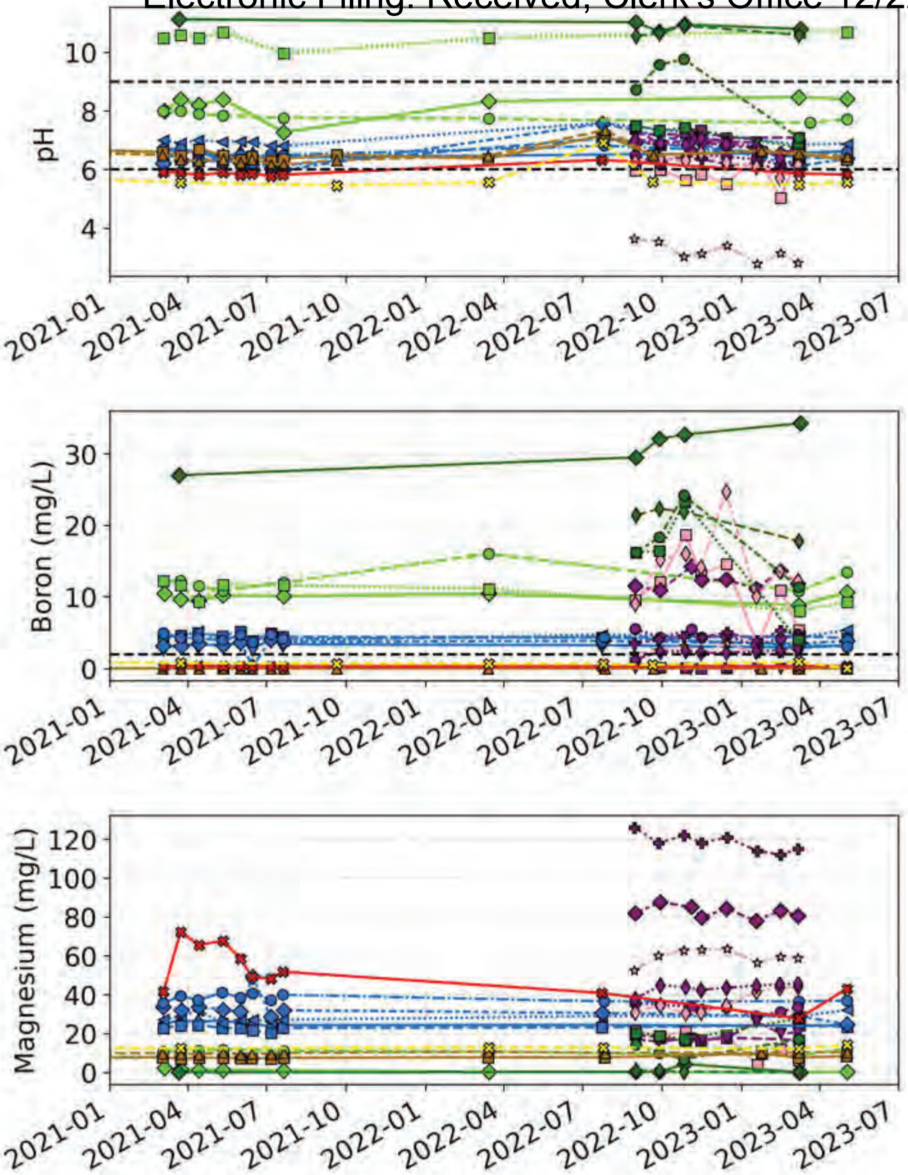
LIFECYCLEGEO	Title Joppa East Ash Pond Well Locations and Hydrology		
	Project Name Joppa- East Ash Pond Evaluation	Project Number [23RAM01-1] Vistra CCR	Attachment 1
	Client Name Ramboll Americas Engineering Solutions, Inc.	Date 10/21/2023	

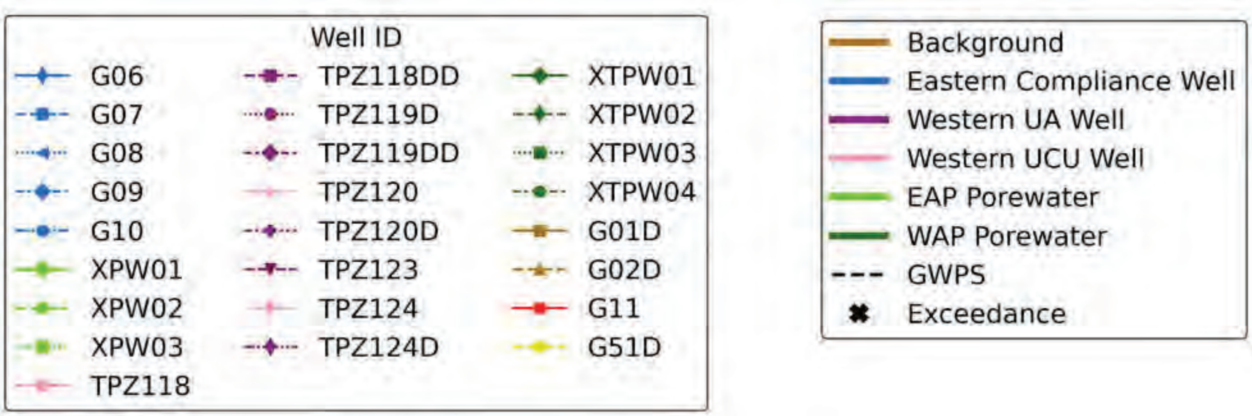


Notes:
Wells with pH exceedances are shown with an X.
Western wells are purple (UA) and pink (UCU).
Background wells are brown. Ash ponds are outlined in yellow.
Contours are from September 2022.

LIFECYCLEGEO

Title	Joppa West Ash Pond Well Locations and Upper Aquifer Groundwater Elevation
Project Name	Joppa- East Ash Pond Evaluation
Project Number	[23RAM01-1] Vistra CCR
Client Name	Ramboll Americas Engineering Solutions, Inc.
Date	10/21/2023
Attachment	2

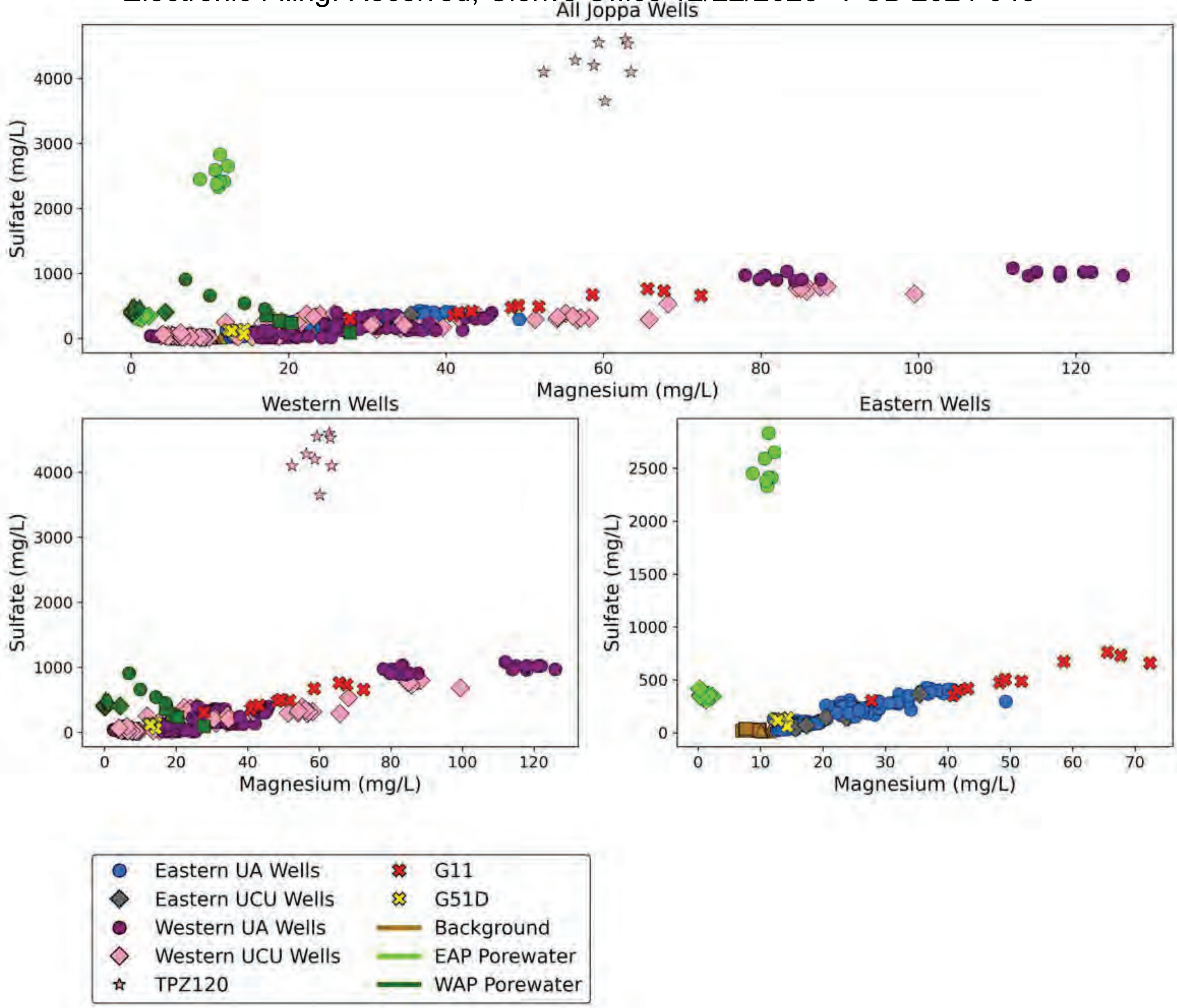




Notes:
Data is colored according to well classification.
All data shown is for eastern compliance wells, upgradient western upgradient wells, background, and porewaters

LIFECYCLEGEO

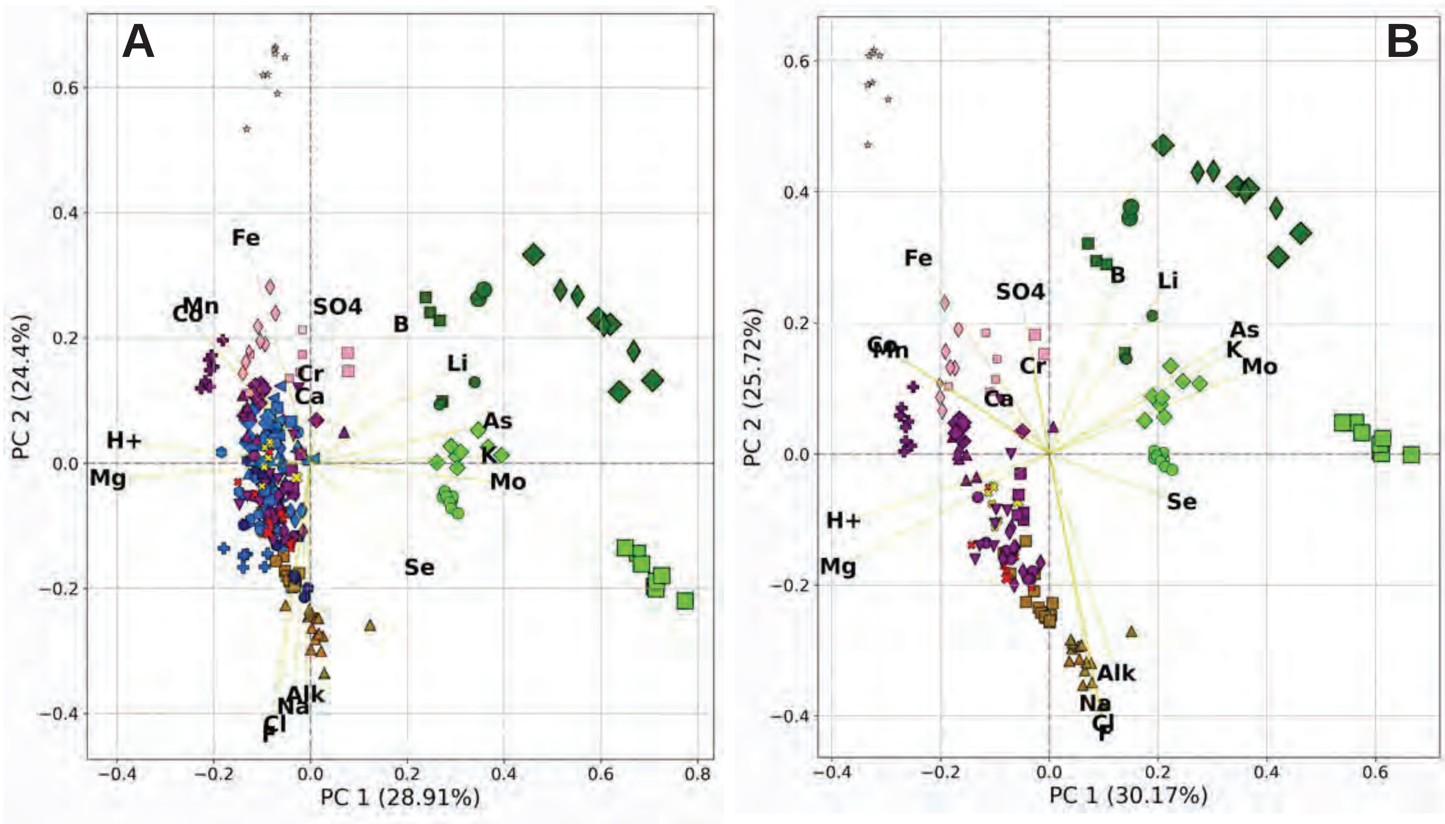
Title	Time Series for pH, Boron, and Magnesium
Project Name	Joppa- East Ash Pond Evaluation
Project Number	[23RAM01-1] Vistra CCR
Client Name	Ramboll Americas Engineering Solutions, Inc.
Date	10/21/2023
Attachment	3

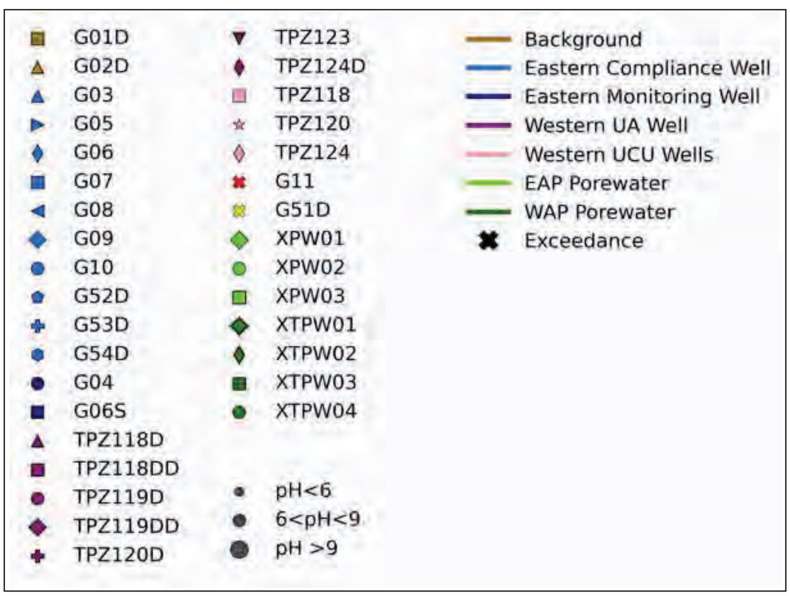


Scatterplots of magnesium and sulfate for all Joppa wells (top), the western wells (bottom left) and eastern wells (bottom right).

LIFECYCLEGEO

Title		
Joppa Magnesium-Sulfate Scatterplot		
Project Name Joppa- East Ash Pond Evaluation	**Project Number** [23RAM01-1] Vistra CCR	**Attachment** 4
Client Name Ramboll Americas Engineering Solutions, Inc.	**Date** 10/21/2023	

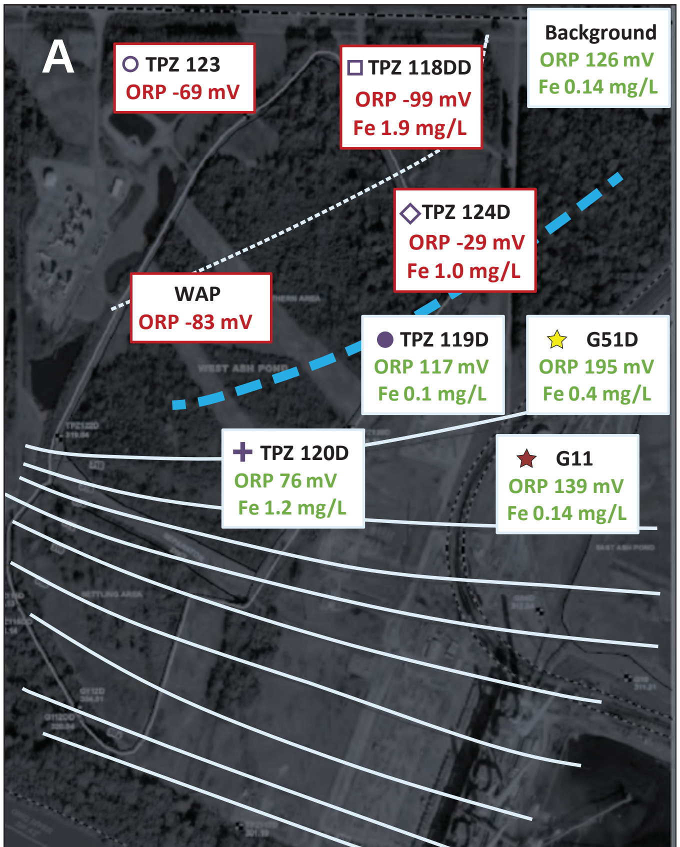




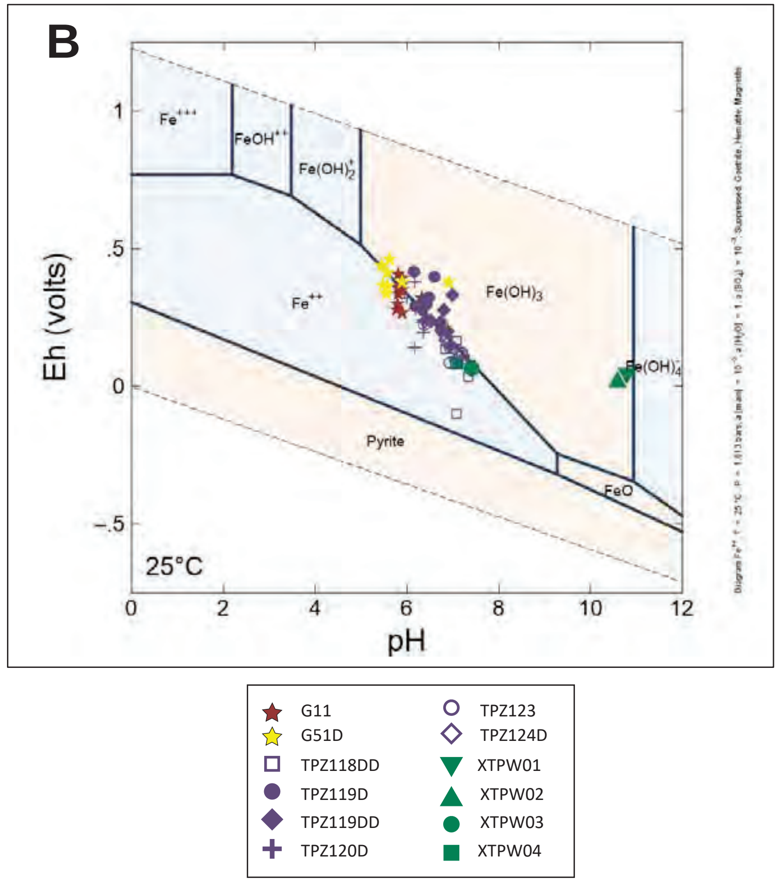
Notes:
Data is colored according to well classification and sized according to pH. See abbreviations list for complete analyte and unit names.
A) PCA with all eastern and western wells, including porewater.
B) PCA with only western wells, background, and porewater.

LIFECYCLEGEO

Title	Joppa Principal Components Analysis Results
Project Name	Joppa- East Ash Pond Evaluation
Project Number	[23RAM01-1] Vistra CCR
Client Name	Ramboll Americas Engineering Solutions, Inc.
Date	10/21/2023
Attachment	5



Iron concentration averaged for samples with turbidity <10 NTU



Notes:

A) Redox conditions upgradient of G11 and G51D. White lines are upper aquifer groundwater contours, blue line indicates where conditions change from reducing to oxidizing. Contours from September 2022. Iron concentration not shown where turbidity >10 NTU.

B) Pourbaix diagram depicting iron solubility upgradient of G11 and G51D. WAP porewater is shown in green, western monitoring wells are shown in purple, G11 is red, and G51D is yellow. Blue areas are indicate aqueous phase iron; brown areas indicate solid phase iron.

LIFECYCLEGEO	Title: Joppa Oxidation Reduction Conditions		
	Project Name: Joppa- East Ash Pond Evaluation	Project Number: [23RAM01-1] Vistra CCR	Attachment 6
	Client Name: Ramboll Americas Engineering Solutions, Inc.	Date: 10/21/2023	

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G01D	12/3/2015	Background	6.7	<0.025	--	20
G01D	3/15/2016	Background	6.7	0.036	--	126
G01D	6/15/2016	Background	6.9	0.0296	--	157
G01D	9/14/2016	Background	6.8	0.0416	--	129
G01D	12/14/2016	Background	6.8	<0.025	--	53
G01D	3/7/2017	Background	6.2	<0.025	--	72
G01D	6/15/2017	Background	6.7	<0.025	--	56
G01D	7/20/2017	Background	6.8	<0.025	9.87	31
G01D	11/30/2017	Background	6.8	<0.025	--	117
G01D	6/19/2018	Background	6.8	<0.025	--	70
G01D	9/5/2018	Background	7	<0.025	--	94
G01D	3/27/2019	Background	6.7	<0.025	--	30
G01D	9/9/2019	Background	6.4	<0.025	--	37
G01D	3/30/2020	Background	6.8	<0.025	7.6	35
G01D	9/23/2020	Background	6.72	<0.025	--	34
G02D	7/6/2021	Background	6.17	0.0431	9.77	22
G02D	7/21/2021	Background	6.18	0.0329	10.1	20
G02D	6/1/2021	Background	6.23	0.0433	9.39	23
G02D	4/14/2021	Background	6.3	0.0318	9.39	19
G02D	9/20/2021	Background	6.32	0.0313	--	19
G01D	7/6/2021	Background	6.33	<0.025	7.18	20
G01D	6/1/2021	Background	6.34	<0.025	7.36	18
G01D	5/2/2023	Background	6.34	0.021	8.43	26
G02D	3/24/2021	Background	6.35	0.033	9.76	18
G02D	5/12/2021	Background	6.35	0.0356	10.4	27
G02D	6/14/2021	Background	6.36	0.0352	9.84	23
G01D	7/21/2021	Background	6.37	<0.025	7.54	18
G01D	3/14/2022	Background	6.37	<0.025	7.77	22
G02D	5/3/2023	Background	6.46	0.0412	10.4	13
G01D	6/14/2021	Background	6.46	<0.025	7.41	20
G02D	12/3/2015	Background	6.7	0.0536	--	16
G02D	3/15/2016	Background	6.6	0.0494	--	17
G02D	6/15/2016	Background	6.8	0.0508	--	15
G02D	9/14/2016	Background	6.6	0.0534	--	22
G02D	12/14/2016	Background	6.3	0.0552	--	22
G02D	7/20/2017	Background	6.7	0.044	11.4	12
G02D	11/30/2017	Background	6.9	0.0496	--	17
G02D	6/19/2018	Background	6.7	0.0404	--	17
G02D	9/5/2018	Background	6.6	0.0468	--	19

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G02D	3/27/2019	Background	6.6	0.0473	--	20
G02D	9/9/2019	Background	6.5	0.0429	--	20
G02D	3/30/2020	Background	6.59	0.0449	9.96	22
G02D	9/23/2020	Background	6.62	0.0442	--	22
G02D	3/14/2022	Background	6.47	0.0283	10.6	11
G02D	9/21/2022	Background	6.48	0.0266	--	15
G01D	5/12/2021	Background	6.49	0.0167	7.55	20
G01D	3/24/2021	Background	6.49	<0.025	7.06	21
G02D	3/3/2021	Background	6.5	0.0296	9.98	21
G01D	9/20/2022	Background	6.5	<0.014	--	23
G01D	9/20/2021	Background	6.51	<0.025	--	18
G01D	3/7/2023	Background	6.53	0.029	7.66	36
G02D	3/8/2023	Background	6.56	0.027	10.3	11
G01D	3/3/2021	Background	6.6	<0.025	7.79	18
G01D	1/24/2023	Background	6.62	<0.022	9.75	24
G02D	3/8/2017	Background	6.9	0.0546	--	18
G02D	6/14/2017	Background	6.3	0.0467	--	20
G02D	1/24/2023	Background	6.64	0.0311	10.2	12
G01D	4/14/2021	Background	6.7	<0.025	7.56	39
G01D	7/26/2022	Background	7.17	<0.015	7.74	36
G02D	7/27/2022	Background	7.35	0.0322	10.1	19
G03	3/24/2021	Eastern Compliance	6.3	0.343	17.6	104
G03	4/14/2021	Eastern Compliance	6.2	0.603	28.3	168
G03	5/12/2021	Eastern Compliance	6.39	0.26	15.8	112
G03	6/1/2021	Eastern Compliance	6.35	0.232	14.9	73
G03	7/6/2021	Eastern Compliance	6.34	0.235	14	77
G03	7/21/2021	Eastern Compliance	6.36	0.294	15.7	92
G03	7/26/2022	Eastern Compliance	6.51	0.532	22.9	164
G03	5/3/2023	Eastern Compliance	6.18	0.38	16.6	97
G03	3/5/2021	Eastern Compliance	6.4	0.213	15.1	66
G03	6/15/2021	Eastern Compliance	6.24	0.225	15.1	79
G03	3/9/2023	Eastern Compliance	6.23	0.33	15.2	82
G04	3/24/2021	Eastern Monitoring	6.5	<0.025	14.6	41
G04	7/26/2022	Eastern Monitoring	6.82	<0.0092	34.1	216
G04	3/4/2021	Eastern Monitoring	6.5	<0.025	12.6	21
G04	4/13/2021	Eastern Monitoring	6.5	<0.025	17.3	63
G04	5/11/2021	Eastern Monitoring	6.28	0.0157	17.6	73
G04	7/20/2021	Eastern Monitoring	6.33	<0.025	20.6	131
G05	3/24/2021	Eastern Compliance	6.4	0.195	18.8	92

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G05	6/1/2021	Eastern Compliance	6.48	0.157	18.6	83
G05	7/6/2021	Eastern Compliance	6.42	0.148	17.6	90
G05	7/26/2022	Eastern Compliance	6.63	0.0645	17.6	68
G05	5/3/2023	Eastern Compliance	6.49	0.0478	19.3	112
G05	6/15/2021	Eastern Compliance	6.34	0.14	18.4	91
G05	3/9/2023	Eastern Compliance	6.5	0.0541	19.4	90
G05	3/4/2021	Eastern Compliance	6.5	0.181	17.2	94
G05	4/13/2021	Eastern Compliance	6.5	0.19	19.5	95
G05	5/11/2021	Eastern Compliance	6.38	0.158	19.4	109
G05	7/20/2021	Eastern Compliance	6.35	0.131	18.5	87
G06	3/24/2021	Eastern Compliance	6.6	3.4	26.6	215
G06	6/1/2021	Eastern Compliance	6.56	3.56	25.3	216
G06	7/6/2021	Eastern Compliance	6.32	3.93	23.7	223
G06	5/3/2023	Eastern Compliance	6.63	3.28	24.4	208
G06	6/15/2021	Eastern Compliance	6.51	2.97	25.2	230
G06	3/9/2023	Eastern Compliance	6.57	2.95	24.1	221
G06	3/4/2021	Eastern Compliance	6.7	2.9	25.1	250
G06	4/13/2021	Eastern Compliance	6.6	3.27	26	229
G06	5/11/2021	Eastern Compliance	6.43	3.37	26.8	219
G06	7/20/2021	Eastern Compliance	6.41	3.41	24.4	213
G06	7/23/2022	Eastern Compliance	--	3.29	24.5	216
G06S	3/24/2021	Eastern Monitoring	5.8	0.253	13.5	31
G06S	3/4/2021	Eastern Monitoring	6.2	0.229	12.9	35
G06S	4/13/2021	Eastern Monitoring	5.8	0.265	14.3	30
G06S	5/11/2021	Eastern Monitoring	5.62	0.245	15.6	31
G06S	7/20/2021	Eastern Monitoring	5.73	0.248	13	30
G06S	7/23/2022	Eastern Monitoring	6.54	0.269	13.5	30
G07	3/24/2021	Eastern Compliance	6.4	4.67	24.2	258
G07	6/1/2021	Eastern Compliance	6.25	5.23	22.9	257
G07	7/6/2021	Eastern Compliance	5.98	4.95	20.5	258
G07	5/3/2023	Eastern Compliance	6.38	4.27	23.4	260
G07	6/15/2021	Eastern Compliance	6.25	3.91	21.8	246
G07	3/9/2023	Eastern Compliance	6.42	4.55	24.3	308
G07	3/4/2021	Eastern Compliance	6.5	4.37	22.9	285
G07	4/13/2021	Eastern Compliance	6.3	5.04	24.4	274
G07	5/11/2021	Eastern Compliance	6.28	4.55	22.9	248
G07	7/20/2021	Eastern Compliance	6.14	4.48	23	252
G07	7/23/2022	Eastern Compliance	7.06	4.35	23.2	246
G08	3/24/2021	Eastern Compliance	6.9	4.39	29	225

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G08	6/1/2021	Eastern Compliance	6.96	4.63	27.2	204
G08	7/6/2021	Eastern Compliance	6.81	4.56	26.2	227
G08	5/3/2023	Eastern Compliance	6.88	5.43	32.2	363
G08	6/15/2021	Eastern Compliance	6.94	3.97	27.2	226
G08	3/9/2023	Eastern Compliance	6.85	4.33	28.9	297
G08	3/4/2021	Eastern Compliance	7	4.53	27.2	241
G08	4/13/2021	Eastern Compliance	7	5.25	31.9	286
G08	5/11/2021	Eastern Compliance	6.94	3.77	25.4	203
G08	7/20/2021	Eastern Compliance	6.81	3.98	27.1	227
G08	7/23/2022	Eastern Compliance	7.59	4.74	29	229
G09	4/14/2021	Eastern Compliance	6.3	3.48	33.7	297
G09	5/12/2021	Eastern Compliance	6.45	3.26	32.1	272
G09	6/1/2021	Eastern Compliance	6.24	3.65	31.4	284
G09	7/6/2021	Eastern Compliance	6.29	4.05	28.7	289
G09	7/21/2021	Eastern Compliance	5.99	3.75	32	286
G09	5/3/2023	Eastern Compliance	6.37	3.87	24.7	241
G09	6/15/2021	Eastern Compliance	5.97	0.282	49.3	294
G09	3/9/2023	Eastern Compliance	6.13	3.49	28.9	295
G09	3/4/2021	Eastern Compliance	6.2	3.19	33.8	351
G09	3/25/2021	Eastern Compliance	6.3	3.15	32	286
G09	7/24/2022	Eastern Compliance	7.57	3.89	30.6	278
G10	3/24/2021	Eastern Compliance	6.7	4.31	39.3	369
G10	6/1/2021	Eastern Compliance	6.5	4.73	38.5	401
G10	7/6/2021	Eastern Compliance	6.51	4.81	37.3	415
G10	7/26/2022	Eastern Compliance	6.81	4.4	36.6	388
G10	3/8/2023	Eastern Compliance	6.55	3.28	36.6	425
G10	5/3/2023	Eastern Compliance	6.6	3.08	36.9	365
G10	6/15/2021	Eastern Compliance	6.46	3.74	40.8	407
G10	3/4/2021	Eastern Compliance	6.7	4.98	35.7	391
G10	4/13/2021	Eastern Compliance	6.6	4.26	37.2	382
G10	5/11/2021	Eastern Compliance	6.34	3.95	41.1	364
G10	7/20/2021	Eastern Compliance	6.49	4.2	40	410
G11	3/8/2023	Exceedance	5.87	0.327	27.8	303
G11	7/23/2022	Exceedance	6.33	0.31	40.9	352
G11	3/4/2021	Exceedance	5.9	0.247	41.6	400
G11	5/3/2023	Exceedance	5.82	0.373	43.2	416
G11	7/6/2021	Exceedance	5.78	0.358	48.3	474
G11	7/20/2021	Exceedance	5.82	0.302	51.8	487
G11	6/14/2021	Exceedance	5.86	0.266	49.2	505

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G11	3/24/2021	Exceedance	5.9	0.42	72.4	658
G11	6/1/2021	Exceedance	5.82	0.309	58.6	671
G11	5/12/2021	Exceedance	5.9	0.321	67.7	730
G11	4/14/2021	Exceedance	5.8	0.411	65.6	761
G51D	12/3/2015	Exceedance	6.2	0.117	--	117
G51D	3/15/2016	Exceedance	5.9	0.184	--	145
G51D	6/15/2016	Exceedance	5.8	0.213	--	139
G51D	9/14/2016	Exceedance	5.6	0.263	--	136
G51D	12/14/2016	Exceedance	5.9	0.171	--	101
G51D	6/15/2017	Exceedance	5.6	0.58	--	149
G51D	7/20/2017	Exceedance	5.9	0.332	14.4	140
G51D	11/30/2017	Exceedance	5.6	0.302	--	138
G51D	6/19/2018	Exceedance	5.7	0.337	--	124
G51D	9/5/2018	Exceedance	6	0.263	--	134
G51D	3/27/2019	Exceedance	5.7	0.778	--	125
G51D	9/9/2019	Exceedance	5.3	0.501	--	109
G51D	3/30/2020	Exceedance	5.62	0.697	13.4	130
G51D	9/23/2020	Exceedance	5.72	0.863	--	121
G51D	9/20/2021	Exceedance	5.46	0.689	--	131
G51D	3/8/2023	Exceedance	5.49	0.963	12.3	131
G51D	3/24/2021	Exceedance	5.56	0.786	12.5	122
G51D	3/8/2017	Exceedance	6.2	0.309	--	146
G51D	5/3/2023	Exceedance	5.57	0.0297	14.3	59
G51D	3/15/2022	Exceedance	5.57	0.689	12.9	123
G51D	9/20/2022	Exceedance	5.58	0.551	--	125
G51D	7/25/2022	Exceedance	6.92	0.663	12.8	116
G52D	12/3/2015	Eastern Compliance	6.5	<0.025	--	65
G52D	3/15/2016	Eastern Compliance	6.3	<0.025	--	99
G52D	6/15/2016	Eastern Compliance	6.6	<0.025	--	88
G52D	9/14/2016	Eastern Compliance	6.4	<0.025	--	84
G52D	12/14/2016	Eastern Compliance	6.7	<0.025	--	82
G52D	3/7/2017	Eastern Compliance	5.9	<0.025	--	115
G52D	11/30/2017	Eastern Compliance	6	<0.025	--	97
G52D	6/19/2018	Eastern Compliance	6.4	<0.025	--	97
G52D	9/5/2018	Eastern Compliance	6.3	<0.025	--	101
G52D	3/27/2019	Eastern Compliance	6.4	<0.025	--	81
G52D	9/9/2019	Eastern Compliance	6	<0.025	--	78
G52D	3/30/2020	Eastern Compliance	6.38	<0.025	15.3	84
G52D	9/23/2020	Eastern Compliance	6.54	<0.025	--	84

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G52D	9/20/2021	Eastern Compliance	6.29	<0.025	--	83
G52D	6/14/2017	Eastern Compliance	6.2	<0.025	--	112
G52D	9/21/2022	Eastern Compliance	6.26	<0.011	--	72
G52D	5/3/2023	Eastern Compliance	6.31	0.682	12.1	129
G52D	3/25/2021	Eastern Compliance	6.25	<0.025	14.6	75
G52D	3/15/2022	Eastern Compliance	6.22	<0.025	15.1	68
G52D	3/10/2023	Eastern Compliance	6.54	0.0319	15.3	74
G52D	7/19/2017	Eastern Compliance	6.4	<0.025	17	108
G53D	12/3/2015	Eastern Compliance	6.8	0.332	--	103
G53D	3/15/2016	Eastern Compliance	6.7	0.334	--	107
G53D	6/15/2016	Eastern Compliance	6.6	0.342	--	107
G53D	9/14/2016	Eastern Compliance	6.5	0.368	--	104
G53D	12/14/2016	Eastern Compliance	6.8	0.364	--	106
G53D	6/15/2017	Eastern Compliance	6.6	0.309	--	79
G53D	7/20/2017	Eastern Compliance	6.8	0.366	19.2	94
G53D	11/30/2017	Eastern Compliance	6.6	0.427	--	98
G53D	6/19/2018	Eastern Compliance	6.6	0.361	--	84
G53D	9/5/2018	Eastern Compliance	6.8	0.392	--	81
G53D	3/27/2019	Eastern Compliance	6.6	0.269	--	54
G53D	9/9/2019	Eastern Compliance	6.2	0.385	--	80
G53D	3/30/2020	Eastern Compliance	6.7	0.334	15.7	66
G53D	9/23/2020	Eastern Compliance	6.67	0.411	--	79
G53D	9/20/2021	Eastern Compliance	6.27	0.402	--	78
G53D	9/20/2022	Eastern Compliance	6.48	0.431	--	79
G53D	3/8/2017	Eastern Compliance	7.2	0.138	--	35
G53D	5/3/2023	Eastern Compliance	6.48	0.367	15.3	68
G53D	3/9/2023	Eastern Compliance	6.46	0.37	16.4	72
G53D	3/25/2021	Eastern Compliance	6.53	0.355	15.7	71
G53D	7/25/2022	Eastern Compliance	7.88	0.341	17	77
G53D	3/15/2022	Eastern Compliance	6.5	0.332	16.5	74
G54D	12/3/2015	Eastern Compliance	7	0.663	--	191
G54D	3/15/2016	Eastern Compliance	6.8	0.513	--	176
G54D	6/15/2016	Eastern Compliance	6.6	0.508	--	160
G54D	9/14/2016	Eastern Compliance	6.6	0.557	--	149
G54D	12/14/2016	Eastern Compliance	6.7	0.564	--	144
G54D	6/15/2017	Eastern Compliance	6.8	0.685	--	170
G54D	7/20/2017	Eastern Compliance	6.8	0.58	25.2	151
G54D	11/30/2017	Eastern Compliance	6.7	0.646	--	136
G54D	6/19/2018	Eastern Compliance	6.7	0.631	--	146

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G54D	9/5/2018	Eastern Compliance	6.5	0.66	--	152
G54D	3/27/2019	Eastern Compliance	6.8	1.03	--	142
G54D	9/9/2019	Eastern Compliance	6.4	0.614	--	136
G54D	3/30/2020	Eastern Compliance	6.78	0.766	27.1	184
G54D	9/23/2020	Eastern Compliance	6.7	0.819	--	173
G54D	3/24/2021	Eastern Compliance	6.56	0.404	24.2	186
G54D	9/20/2021	Eastern Compliance	6.48	0.35	--	175
G54D	7/26/2022	Eastern Compliance	7.09	0.178	22.3	188
G54D	9/20/2022	Eastern Compliance	6.5	0.252	--	218
G54D	3/8/2017	Eastern Compliance	7.1	0.499	--	131
G54D	5/3/2023	Eastern Compliance	6.8	0.555	26.4	194
G54D	3/9/2023	Eastern Compliance	6.52	0.555	26.4	231
G54D	3/15/2022	Eastern Compliance	6.61	0.451	25.8	213
G101	7/26/2022	Other	7.31	<0.0092	5.09	30
G101	3/7/2023	Other	6.58	0.0294	5.4	28
G101	3/22/2021	Other	6.99	<0.02	7.65	39
G101	8/31/2022	Other	6.64	<0.0092	5.88	37
G101	9/28/2022	Other	6.49	<0.019	5.77	30
G101	10/26/2022	Other	6.9	0.0366	5.21	56
G101	11/15/2022	Other	6.85	<0.0092	5.51	37
G101	12/14/2022	Other	6.63	<0.0092	5.19	37
G101	1/18/2023	Other	6.58	<0.0092	5.01	32
G101	2/14/2023	Other	6.24	<0.0092	5.29	41
G101	12/14/2016	Other	6.7	<0.025	--	35
G101	3/7/2017	Other	6	<0.025	--	37
G101	11/30/2017	Other	6.6	<0.025	--	35
G101	6/19/2018	Other	6.7	<0.025	--	49
G101	3/27/2019	Other	6.7	<0.025	--	46
G101	9/9/2019	Other	6.3	<0.025	--	35
G101	3/30/2020	Other	6.76	<0.025	3.79	41
G101	9/23/2020	Other	6.51	<0.025	--	37
G101	9/20/2021	Other	6.4	<0.025	--	36
G101	3/14/2022	Other	6.48	<0.025	4.34	38
G101	9/20/2022	Other	6.58	<0.0092	--	38
G101	6/14/2017	Other	6.4	<0.025	--	51
G101	3/25/2021	Other	6.51	<0.025	4.36	37
G101	7/19/2017	Other	6.7	<0.025	4.68	52
G101	12/22/2015	Other	6.5	<0.025	--	33
G101	3/16/2016	Other	6.6	<0.025	--	86

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G101	6/14/2016	Other	6.3	<0.025	--	53
G101	9/13/2016	Other	6.4	<0.025	--	47
G101	12/6/2018	Other	6.7	<0.025	--	54
G101	3/21/2023	Other	6.59	0.0525	13.2	49
G102	3/7/2017	Other	5.8	<0.025	--	22
G102	11/30/2017	Other	6.3	<0.025	--	20
G102	6/19/2018	Other	6.5	<0.025	--	50
G102	3/27/2019	Other	6.5	<0.025	--	44
G102	9/9/2019	Other	6.1	<0.025	--	34
G102	3/30/2020	Other	6.48	<0.025	2.5	38
G102	9/23/2020	Other	6.24	<0.025	--	34
G102	9/20/2021	Other	6.38	<0.025	--	38
G102	3/14/2022	Other	6.37	<0.025	3.21	30
G102	9/20/2022	Other	6.44	<0.0092	--	41
G102	6/14/2017	Other	6.1	<0.025	--	27
G102	3/25/2021	Other	6.46	<0.025	2.64	35
G102	3/10/2023	Other	6.31	<0.02	3.6	40
G102	7/19/2017	Other	6.4	<0.025	3.3	28
G102	12/22/2015	Other	6.9	<0.025	--	15
G102	3/16/2016	Other	6.4	<0.025	--	58
G102	6/14/2016	Other	6.1	<0.025	--	65
G102	9/13/2016	Other	5.8	<0.025	--	49
G102	12/6/2018	Other	6.4	<0.025	--	28
G102	12/15/2016	Other	6.2	<0.025	--	24
G103	12/23/2015	Other	7.25	--	--	--
G104	6/23/2014	Other	6.8	<0.02	--	<50.0
G104	9/9/2014	Other	6.89	<0.02	--	<50.0
G104	12/9/2014	Other	6.9	0.0837	--	<50.0
G104	3/20/2015	Other	6.29	<0.02	--	--
G105	3/7/2017	Other	5.7	<0.025	--	12
G105	11/30/2017	Other	6.3	<0.025	--	12
G105	6/19/2018	Other	6.3	<0.025	--	12
G105	3/27/2019	Other	6.3	<0.025	--	11
G105	9/9/2019	Other	6.1	<0.025	--	12
G105	3/30/2020	Other	6.32	<0.025	9.11	13
G105	9/23/2020	Other	6.22	<0.025	--	16
G105	9/20/2021	Other	6.06	<0.025	--	13
G105	3/14/2022	Other	6.18	<0.025	8.95	12
G105	9/20/2022	Other	6.14	<0.0092	--	11

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G105	6/14/2017	Other	6.1	<0.025	--	16
G105	3/25/2021	Other	6.13	<0.025	8.53	12
G105	3/10/2023	Other	6.03	<0.011	8.78	12
G105	7/19/2017	Other	6.4	<0.025	8.8	13
G105	12/22/2015	Other	6.6	<0.025	--	12
G105	3/16/2016	Other	6.4	<0.025	--	11
G105	6/14/2016	Other	6.4	<0.025	--	12
G105	9/13/2016	Other	6.4	<0.025	--	13
G105	12/6/2018	Other	6.2	<0.025	--	11
G105	12/15/2016	Other	6.2	<0.025	--	11
G106	12/23/2015	Other	6.34	--	--	--
G107	3/7/2017	Other	6.1	<0.025	--	93
G107	11/30/2017	Other	6.5	0.0295	--	88
G107	6/19/2018	Other	6.6	<0.025	--	77
G107	3/27/2019	Other	6.4	<0.025	--	30
G107	9/9/2019	Other	6.5	0.0373	--	112
G107	3/30/2020	Other	6.68	<0.025	24.8	89
G107	9/23/2020	Other	6.73	0.0353	--	101
G107	9/20/2021	Other	6.64	0.0282	--	67
G107	3/14/2022	Other	6.42	<0.025	21.3	40
G107	9/20/2022	Other	6.59	<0.023	--	49
G107	6/14/2017	Other	6.4	<0.025	--	50
G107	3/25/2021	Other	6.48	0.0291	19.5	54
G107	3/10/2023	Other	6.42	<0.023	20.6	42
G107	7/19/2017	Other	6.8	<0.025	26.7	123
G107	12/22/2015	Other	6.9	0.0365	--	29
G107	3/16/2016	Other	6.3	<0.025	--	11
G107	6/14/2016	Other	6.9	0.0311	--	58
G107	9/13/2016	Other	6.7	<0.025	--	127
G107	12/6/2018	Other	6.6	0.027	--	72
G107	12/15/2016	Other	6.6	<0.025	--	67
G108	12/23/2015	Other	7.04	--	--	--
G109	3/7/2017	Other	6	<0.025	--	37
G109	11/30/2017	Other	6.5	<0.025	--	48
G109	6/19/2018	Other	6.9	0.0277	--	100
G109	9/5/2018	Other	7	--	--	77
G109	3/27/2019	Other	6.7	0.0309	--	55
G109	9/9/2019	Other	6.5	0.0255	--	59
G109	3/30/2020	Other	6.76	0.0272	8.21	41

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G109	9/23/2020	Other	6.6	<0.025	--	42
G109	9/20/2021	Other	6.54	<0.025	--	27
G109	3/14/2022	Other	6.55	<0.025	7.91	30
G109	9/20/2022	Other	6.49	<0.014	--	21
G109	6/14/2017	Other	6.5	<0.025	--	68
G109	3/25/2021	Other	6.35	<0.025	6.16	32
G109	3/10/2023	Other	6.32	<0.018	7.7	37
G109	7/19/2017	Other	6.7	<0.025	7.34	65
G109	12/22/2015	Other	6.7	0.0315	--	23
G109	3/16/2016	Other	6.5	<0.025	--	22
G109	6/14/2016	Other	6.4	<0.025	--	29
G109	9/13/2016	Other	6.5	<0.025	--	41
G109	12/6/2018	Other	6.7	<0.025	--	68
G109	12/15/2016	Other	6.5	<0.025	--	33
G110	12/23/2015	Other	6.87	--	--	--
G111	3/7/2023	Other	7.05	<0.0092	8.94	16
G111	3/22/2021	Other	7.34	<0.02	9.48	17
G111	1/18/2023	Other	6.88	<0.0092	8.76	14
G111	9/1/2022	Other	7.02	0.0873	9.92	16
G111	9/27/2022	Other	7.03	0.0341	9	14
G111	10/28/2022	Other	6.9	0.0389	9.32	13
G111	11/16/2022	Other	7.11	<0.0092	8.67	16
G111	12/15/2022	Other	6.89	<0.0092	8.89	15
G111	2/15/2023	Other	6.48	<0.0092	9.14	16
G111	3/7/2017	Other	6.2	0.0308	--	29
G111	11/30/2017	Other	6.7	<0.025	--	<10.0
G111	6/19/2018	Other	6.8	<0.025	--	40
G111	3/27/2019	Other	6.8	0.0256	--	46
G111	9/9/2019	Other	5.9	0.0258	--	33
G111	3/30/2020	Other	6.68	0.03	7.49	44
G111	9/23/2020	Other	6.63	<0.025	--	31
G111	9/20/2021	Other	6.51	<0.025	--	21
G111	3/14/2022	Other	6.49	<0.025	6.03	29
G111	9/20/2022	Other	6.53	<0.013	--	19
G111	6/14/2017	Other	6.6	<0.025	--	37
G111	3/25/2021	Other	6.4	<0.025	6.06	33
G111	7/19/2017	Other	6.8	<0.025	5.97	29
G111	12/22/2015	Other	6.5	<0.025	--	27
G111	3/16/2016	Other	6.5	<0.025	--	37

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
G111	6/14/2016	Other	6.7	0.0265	--	39
G111	9/13/2016	Other	6.8	0.0251	--	23
G111	12/6/2018	Other	6.5	0.0404	--	32
G111	3/21/2023	Other	6.56	0.047	4.71	23
G111	12/15/2016	Other	6.8	<0.025	--	13
G112C	3/8/2023	Other	6.41	4.8	85.6	822
G112C	3/22/2021	Other	6.85	4.25	68.2	532
G112C	9/28/2022	Other	6.31	4.82	99.5	682
G112C	10/26/2022	Other	6.69	4.86	84.7	820
G112C	12/14/2022	Other	6.63	4.99	87.5	791
G112C	1/18/2023	Other	6.49	4.31	84.6	769
G112C	2/15/2023	Other	6.26	5.04	88.4	797
G112C	8/30/2022	Other	6.62	4.26	85.8	726
G112C	11/17/2022	Other	6.76	4.6	85.1	764
G112D	3/8/2023	Other	6.62	0.0464	24.3	13
G112D	9/28/2022	Other	6.8	0.101	26	<8.0
G112D	10/26/2022	Other	6.97	0.0457	24.3	<8.0
G112D	12/14/2022	Other	6.81	<0.0092	24.7	<6.0
G112D	1/18/2023	Other	6.71	0.0268	24.3	11
G112D	2/15/2023	Other	6.49	<0.0092	25.4	13
G112D	8/30/2022	Other	6.89	0.0367	24.8	<9.0
G112D	11/17/2022	Other	6.95	<0.012	24	<8.0
G112DD	3/8/2023	Other	7.03	0.104	17.7	10
G112DD	9/28/2022	Other	7.24	0.162	21	12
G112DD	10/26/2022	Other	7.42	0.12	18.6	13
G112DD	12/14/2022	Other	8.06	0.116	18.3	10
G112DD	8/30/2022	Other	7.31	0.109	19.9	12
G112DD	11/17/2022	Other	7.41	0.135	17.5	11
G113	3/7/2023	Other	6.53	<0.013	55.2	386
G113	3/22/2021	Other	6.86	<0.02	51.3	292
G113	9/28/2022	Other	6.36	0.0258	65.8	289
G113	10/26/2022	Other	6.57	0.0919	56.7	288
G113	9/1/2022	Other	6.6	<0.022	58.2	316
G113	11/16/2022	Other	6.58	<0.014	54.1	296
G113	12/15/2022	Other	6.38	<0.0092	57.1	314
G113	2/15/2023	Other	6.21	<0.0092	56.1	346
G113	1/19/2023	Other	6.32	<0.0092	54.2	327
TPZ114	3/10/2023	Other	6.15	<0.024	6.82	20
TPZ114	3/22/2021	Other	7.42	0.177	15.4	19

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
TPZ114	9/1/2022	Other	6.32	0.0746	7.86	13
TPZ114	9/27/2022	Other	6.02	0.0451	7.95	19
TPZ114	11/16/2022	Other	6.51	0.0269	8.71	21
TPZ114	12/15/2022	Other	6.22	<0.0092	7.5	24
TPZ114	2/15/2023	Other	6.09	0.0254	6.36	24
TPZ114	1/19/2023	Other	6.26	<0.0092	6.42	19
TPZ114	10/27/2022	Other	6.21	0.0251	6.52	21
TPZ115	3/8/2023	Other	6.96	<0.015	38.4	197
TPZ115	1/18/2023	Other	6.93	<0.0092	36.6	178
TPZ115	9/27/2022	Other	6.91	0.0383	34.2	147
TPZ115	12/15/2022	Other	6.87	<0.0092	38.1	180
TPZ115	2/15/2023	Other	6.68	<0.0092	37.6	179
TPZ115	8/30/2022	Other	7.12	0.0354	31.2	135
TPZ115	11/17/2022	Other	7.16	<0.013	35.5	181
TPZ115	10/27/2022	Other	6.93	0.0267	39.6	170
TPZ115D	3/8/2023	Other	7.11	0.356	21.8	37
TPZ115D	1/18/2023	Other	7.13	0.349	20.8	37
TPZ115D	9/27/2022	Other	7.24	0.467	22.5	35
TPZ115D	12/15/2022	Other	7.1	0.387	22.4	39
TPZ115D	2/15/2023	Other	6.79	0.4	22.3	37
TPZ115D	8/30/2022	Other	7.13	0.382	21.9	38
TPZ115D	11/17/2022	Other	7.37	0.387	20.9	37
TPZ115D	10/27/2022	Other	7.13	0.421	22.6	36
TPZ115DD	3/8/2023	Other	7.18	0.0915	17	13
TPZ115DD	9/27/2022	Other	7.34	0.0563	17.6	11
TPZ115DD	12/15/2022	Other	7.2	0.0657	19.2	12
TPZ115DD	8/30/2022	Other	7.36	0.0423	17.7	<8.0
TPZ115DD	11/17/2022	Other	7.36	0.0684	16.4	11
TPZ115DD	10/27/2022	Other	7.24	0.0847	18.3	11
TPZ116	3/22/2021	Other	6.99	<0.02	13.6	24
TPZ117	3/22/2021	Other	6.67	<0.02	18.8	32
TPZ117D	3/7/2023	Other	6.54	0.724	29.3	228
TPZ117D	7/27/2022	Other	7.56	0.409	36.3	134
TPZ117D	3/22/2021	Other	7.09	0.0763	19.3	187
TPZ117D	11/15/2022	Other	6.7	0.36	35.6	133
TPZ117D	12/14/2022	Other	6.53	0.353	37	127
TPZ117D	1/18/2023	Other	6.48	0.495	29.8	186
TPZ117D	9/1/2022	Other	6.62	0.41	38.7	124
TPZ117D	2/15/2023	Other	6.29	0.331	35.1	126

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
TPZ117D	9/29/2022	Other	6.57	0.394	42.1	130
TPZ117D	11/4/2022	Other	6.69	0.423	35.2	135
TPZ118	3/8/2023	Western UCU	6.56	5.44	6.3	88
TPZ118	8/31/2022	Western UCU	5.97	9.54	21.6	242
TPZ118	11/15/2022	Western UCU	5.84	13.1	16.7	233
TPZ118	12/14/2022	Western UCU	5.52	14.6	19.1	263
TPZ118	10/28/2022	Western UCU	5.65	18.7	21.1	259
TPZ118	2/15/2023	Western UCU	5.04	10.9	12	250
TPZ118	1/19/2023	Western UCU	6.41	3.35	4.04	63
TPZ118	9/29/2022	Western UCU	5.99	12.1	18.6	215
TPZ118D	3/8/2023	Western UA	6.28	7.44	30.7	358
TPZ118D	8/31/2022	Western UA	6.3	5.41	32.7	351
TPZ118D	11/15/2022	Western UA	6.55	6.13	29.8	332
TPZ118D	12/14/2022	Western UA	6.6	5.85	27.1	300
TPZ118D	10/28/2022	Western UA	6.35	7.08	31.3	352
TPZ118D	2/15/2023	Western UA	6.07	7.56	30.8	329
TPZ118D	1/19/2023	Western UA	6.31	6.35	28.7	329
TPZ118D	9/29/2022	Western UA	6.17	5.74	33.6	357
TPZ118DD	3/8/2023	Western UA	7.09	0.0776	16.8	10
TPZ118DD	8/31/2022	Western UA	7.4	0.831	19.5	73
TPZ118DD	11/15/2022	Western UA	7.34	0.054	16.4	12
TPZ118DD	12/14/2022	Western UA	7.08	0.122	17.9	12
TPZ118DD	10/28/2022	Western UA	7.26	0.112	16.5	10
TPZ118DD	9/29/2022	Western UA	6.84	0.146	17.9	17
TPZ119D	3/7/2023	Western UA	6.34	4.76	33.7	175
TPZ119D	8/31/2022	Western UA	6.49	5.58	35.5	192
TPZ119D	12/14/2022	Western UA	6.44	4.59	33.6	156
TPZ119D	1/18/2023	Western UA	6.35	3.32	29	142
TPZ119D	11/16/2022	Western UA	6.48	4.35	32.4	159
TPZ119D	2/15/2023	Western UA	6.16	4.22	31.2	154
TPZ119D	9/29/2022	Western UA	6.19	4.37	35	186
TPZ119D	11/4/2022	Western UA	6.61	5.48	33.7	156
TPZ119DD	3/7/2023	Western UA	6.76	11.8	80.5	969
TPZ119DD	8/31/2022	Western UA	6.9	11.5	82	899
TPZ119DD	12/14/2022	Western UA	6.81	12.4	84.3	886
TPZ119DD	1/18/2023	Western UA	6.74	11.1	78	972
TPZ119DD	11/16/2022	Western UA	6.94	12.3	79.8	906
TPZ119DD	2/15/2023	Western UA	6.54	13.6	83.3	1030
TPZ119DD	9/29/2022	Western UA	6.88	10.9	87.6	907

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
TPZ119DD	11/4/2022	Western UA	7	14.2	85.2	906
TPZ120	3/7/2023	Western UCU	2.8	2.36	58.8	4200
TPZ120	10/26/2022	Western UCU	3.02	3.13	62.8	4600
TPZ120	9/27/2022	Western UCU	3.53	2.53	60.2	3650
TPZ120	11/16/2022	Western UCU	3.13	2.21	63.1	4530
TPZ120	12/15/2022	Western UCU	3.4	3.55	63.5	4100
TPZ120	2/15/2023	Western UCU	3.14	2.1	59.4	4550
TPZ120	8/30/2022	Western UCU	3.63	2.08	52.4	4100
TPZ120	1/19/2023	Western UCU	2.77	2.1	56.4	4280
TPZ120D	3/7/2023	Western UA	6.2	4.77	115	1020
TPZ120D	10/26/2022	Western UA	6.35	4.51	122	1020
TPZ120D	9/27/2022	Western UA	6.37	4.14	118	960
TPZ120D	11/16/2022	Western UA	6.37	4.39	118	1020
TPZ120D	12/15/2022	Western UA	6.16	5.09	121	1020
TPZ120D	2/15/2023	Western UA	6.01	5.31	112	1080
TPZ120D	8/30/2022	Western UA	6.18	3.52	126	967
TPZ120D	1/19/2023	Western UA	6.17	3.9	114	964
TPZ122	3/7/2023	Other	6.77	5.15	27	214
TPZ122	8/31/2022	Other	6.52	0.806	19.7	234
TPZ122	1/18/2023	Other	6.12	1.17	22.3	379
TPZ122	9/27/2022	Other	6.46	1.16	18.2	270
TPZ122	11/16/2022	Other	6.35	0.945	23.4	332
TPZ122	12/15/2022	Other	6.2	1.32	24	367
TPZ122	2/15/2023	Other	5.73	1.34	25.8	381
TPZ122	10/27/2022	Other	6.24	0.988	23.2	325
TPZ122D	3/7/2023	Other	6.11	1.32	26.1	395
TPZ122D	8/31/2022	Other	6.95	4.66	26.4	193
TPZ122D	1/18/2023	Other	6.77	4.36	24.7	225
TPZ122D	9/27/2022	Other	6.65	5.43	25.7	193
TPZ122D	11/16/2022	Other	6.94	5.25	25.4	193
TPZ122D	12/15/2022	Other	6.76	4.92	25.9	213
TPZ122D	2/15/2023	Other	6.46	5.54	26.8	215
TPZ122D	10/27/2022	Other	6.78	6.6	27.7	191
TPZ123	3/7/2023	Western UA	6.84	<0.023	20.5	156
TPZ123	11/3/2022	Western UA	7.2	0.027	17.6	102
TPZ123	8/31/2022	Western UA	7.21	0.0691	17.1	85
TPZ123	1/18/2023	Western UA	6.93	0.0384	26	163
TPZ123	9/27/2022	Western UA	7.2	0.0934	15.9	89
TPZ123	11/16/2022	Western UA	7.11	<0.015	16.8	121

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
TPZ123	12/15/2022	Western UA	6.95	0.0457	17.8	122
TPZ123	2/15/2023	Western UA	6.38	0.0337	20.2	166
TPZ124	3/7/2023	Western UCU	6.17	12.2	44	357
TPZ124	8/31/2022	Western UCU	6.27	8.99	30.8	219
TPZ124	11/15/2022	Western UCU	6.57	14.1	30.8	221
TPZ124	12/14/2022	Western UCU	6.25	24.7	34.4	257
TPZ124	1/18/2023	Western UCU	6.09	10	41.6	311
TPZ124	2/14/2023	Western UCU	5.71	13.6	43.6	331
TPZ124	10/28/2022	Western UCU	6.31	16	30.5	205
TPZ124	9/29/2022	Western UCU	6.35	15.2	34.7	202
TPZ124D	3/7/2023	Western UA	6.77	2.88	45.8	394
TPZ124D	8/31/2022	Western UA	7.04	1.31	37.8	238
TPZ124D	11/15/2022	Western UA	7.07	2.21	42.5	321
TPZ124D	12/14/2022	Western UA	6.88	2.22	43.6	314
TPZ124D	1/18/2023	Western UA	6.8	2.41	44.7	313
TPZ124D	2/14/2023	Western UA	6.4	2.59	45.4	341
TPZ124D	10/28/2022	Western UA	6.84	2.46	43.9	306
TPZ124D	9/29/2022	Western UA	6.91	2.34	44.9	303
XPW01	7/21/2021	Eastern Porewater	7.27	10.1	0.917	328
XPW02	3/21/2023	Eastern Porewater	7.6	--	--	--
XPW02	5/3/2023	Eastern Porewater	7.72	13.4	12.3	2650
XPW02	3/15/2022	Eastern Porewater	7.74	16	10.7	2590
XPW02	7/21/2021	Eastern Porewater	7.76	12	11.1	2330
XPW02	5/12/2021	Eastern Porewater	7.85	10.8	11.8	2410
XPW02	4/14/2021	Eastern Porewater	7.9	11.5	11.3	2410
XPW01	3/5/2021	Eastern Porewater	8	10.4	2.25	345
XPW02	3/4/2021	Eastern Porewater	8	12.1	10.9	2380
XPW02	3/24/2021	Eastern Porewater	8	12.2	11.3	2830
XPW01	4/14/2021	Eastern Porewater	8.2	9.42	1.28	355
XPW01	3/15/2022	Eastern Porewater	8.33	10.4	0.443	360
XPW01	5/12/2021	Eastern Porewater	8.4	10.2	1.31	309
XPW01	3/24/2021	Eastern Porewater	8.4	9.58	1.7	355
XPW01	5/3/2023	Eastern Porewater	8.41	10.6	0.405	345
XPW01	3/8/2023	Eastern Porewater	8.47	8.79	0.254	414
XPW03	7/21/2021	Eastern Porewater	9.97	11.6	<0.05	148
XPW03	3/4/2021	Eastern Porewater	10.5	12.2	<0.05	133
XPW03	3/15/2022	Eastern Porewater	10.5	11.1	<0.05	152
XPW03	4/14/2021	Eastern Porewater	10.5	9.3	<0.05	152
XPW03	3/24/2021	Eastern Porewater	10.6	11.6	<0.05	138

Appendix D-1. Supporting groundwater analytical data for Table 1 and Attachments 3 and 4.

Well ID	Date	Well Type	pH (field) (SU)	Boron, total (mg/L)	Magnesium, total (mg/L)	Sulfate, total (mg/L)
XPW03	3/9/2023	Eastern Porewater	10.7	8.06	<0.021	142
XPW03	5/3/2023	Eastern Porewater	10.7	9.22	<0.03	144
XPW03	5/12/2021	Eastern Porewater	10.7	11.7	<0.1	155
XPW02	3/8/2023	Eastern Porewater	--	10.8	8.75	2450
XTPW01	3/10/2023	Western Porewater	10.8	34.3	0.0986	420
XTPW01	3/22/2021	Western Porewater	11.13	27	0.122	387
XTPW01	9/28/2022	Western Porewater	10.71	32.1	0.29	395
XTPW01	9/1/2022	Western Porewater	11.03	29.5	0.292	402
XTPW01	10/27/2022	Western Porewater	10.95	32.7	4.36	403
XTPW02	3/8/2023	Western Porewater	10.6	17.8	0.123	462
XTPW02	9/28/2022	Western Porewater	10.65	22.3	0.7	427
XTPW02	10/26/2022	Western Porewater	10.91	21.9	0.381	478
XTPW02	9/1/2022	Western Porewater	10.56	21.4	1.1	461
XTPW03	3/7/2023	Western Porewater	6.76	4.02	27.8	89
XTPW03	9/28/2022	Western Porewater	7.33	16.4	18.9	269
XTPW03	9/1/2022	Western Porewater	7.5	16.2	20.4	234
XTPW03	10/27/2022	Western Porewater	7.42	23.3	17.2	356
XTPW04	3/8/2023	Western Porewater	7.09	11.3	17	452
XTPW04	9/28/2022	Western Porewater	9.58	18.3	10	658
XTPW04	10/26/2022	Western Porewater	9.77	24.2	6.91	907
XTPW04	9/1/2022	Western Porewater	8.73	16.2	14.4	539

Notes:
mg/L = milligrams per liter
SU= standard units
< = less than analytical detection limit; data not included in Attachment 3 and 4 analyses.
-- = data not measured
Well Type: Western and Eastern as defined in main text, UA=uppermost aquifer, UCU= upper confining unit
Attachment 3: pH, boron, and magnesium data from March 2021 to May 2023. See Attachment 3 legend for full list of included wells.
Attachment 4: Magnesium and sulfate data for all sampling dates and all wells listed here.
Table 1: Inline Table 1 presents pH, boron, and magnesium data for G11, G51D, CCR Porewater, Western Groundwater, Eastern Groundwater, and TPZ120. G11, G51D, and TPZ120 data are from from March 2021 to May 2023 for those individual wells. For the same time frame, CCR Porewater includes both eastern and western porewater; Western Groundwater includes all Western UA and UCU wells except TPZ120; Eastern Groundwater includes all Eastern Compliance and Background Wells.

Appendix D- . Supporting groundwater analytical data for Attachment A.

Well ID	Date	Iron (mg/L)	xidation eduction otential (m)
G11	2021/07/06	0.071	78
G11	2021/04/14	0.084	100
G11	2021/07/20	0.036	135
G11	2023/05/03	*3.35*	207
G11	2021/06/01	0.086	159
G11	2021/06/14	0.052	149
G11	2023/03/08	--	166
G11	2021/03/04	0.51	69.0
G11	2021/03/24	<0.025	154
G11	2021/05/12	<0.1	194
G11	2022/07/23	0.16	122
G51D	2023/03/08	--	167
G51D	2021/03/24	--	136
G51D	2022/07/25	0.41	178
G51D	2022/03/15	--	165
G51D	2020/03/30	--	261
G51D	2023/05/03	*0.82*	214
G51D	2017/07/20	--	180
G51D	2019/09/09	--	157
G51D	2021/09/20	--	238
G51D	2022/09/20	--	215
G51D	2016/09/14	--	231
G51D	2017/06/15	--	168
G51D	2017/11/30	--	168
G51D	2018/06/19	--	247
G51D	2019/03/27	--	130
G51D	2020/09/23	--	292
G51D	2016/06/15	--	213
G51D	2016/12/14	--	134
G51D	2016/03/15	--	122
G51D	2018/09/05	--	217
G51D	2015/12/03	--	133
G51D	2017/03/08	--	282
TPZ118DD	2022/09/29	*0.97*	-65.5
TPZ118DD	2022/12/14	2.07	<-300.0
TPZ118DD	2023/03/08	*2.11*	-36.2
TPZ118DD	2022/10/28	1.88	-103
TPZ118DD	2022/11/15	1.60	-168

Appendix D- . Supporting groundwater analytical data for Attachment A.

Well ID	Date	Iron (mg/L)	xidation eduction otential (m)
TPZ118DD	2022/08/31	*1.70*	-124
TPZ119D	2023/02/15	0.10	217
TPZ119D	2022/09/29	0.12	90.1
TPZ119D	2023/03/07	0.051	104
TPZ119D	2023/01/18	0.12	76.0
TPZ119D	2022/12/14	0.095	96.0
TPZ119D	2022/11/16	*0.086*	38.0
TPZ119D	2022/08/31	*0.80*	123
TPZ119D	2022/11/04	--	196
TPZ120D	2023/02/15	0.89	123
TPZ120D	2022/12/15	1.30	212
TPZ120D	2023/01/19	1.30	178
TPZ120D	2022/08/30	*16.5*	-59.2
TPZ120D	2023/03/07	*1.30*	83.1
TPZ120D	2022/10/26	1.51	32.0
TPZ120D	2022/11/16	1.32	-3.20
TPZ120D	2022/09/27	2.68	43.2
TPZ123	2022/08/31	*31.9*	-78.4
TPZ123	2022/11/03	--	-89.2
TPZ123	2022/09/27	*5.11*	-81.7
TPZ123	2023/03/07	*2.74*	-24.2
TPZ123	2023/01/18	*102*	-116
TPZ123	2022/11/16	*2.46*	-116
TPZ123	2022/12/15	*5.56*	-64.0
TPZ123	2023/02/15	*2.17*	21.0
TPZ124D	2023/02/14	0.40	35.0
TPZ124D	2023/03/07	0.32	11.6
TPZ124D	2023/01/18	0.32	-8.00
TPZ124D	2022/10/28	1.13	-32.9
TPZ124D	2022/12/14	0.76	-24.0
TPZ124D	2022/09/29	*1.71*	-42.7
TPZ124D	2022/08/31	3.14	-63.7
TPZ124D	2022/11/15	0.82	-106
G01D	2017/03/07	--	80.0
G01D	2021/07/06	*1.79*	139
G01D	2023/05/02	*4.09*	145

Appendix D- . Supporting groundwater analytical data for Attachment A.

Well ID	Date	Iron (mg/L)	xidation eduction otential (m)
G01D	2021/06/01	*1.92*	164
G01D	2021/07/21	*1.35*	122
G01D	2022/03/14	--	117
G01D	2019/09/09	--	193
G01D	2021/06/14	*0.83*	160
G01D	2021/03/24	*1.15*	160
G01D	2021/05/12	*0.65*	180
G01D	2022/09/20	--	173
G01D	2021/09/20	--	170
G01D	2023/03/07	--	195
G01D	2021/03/03	*1.09*	145
G01D	2023/01/24	*7.38*	114
G01D	2016/03/15	--	-103
G01D	2017/06/15	--	123
G01D	2015/12/03	--	60.0
G01D	2019/03/27	--	118
G01D	2021/04/14	0.70	134
G01D	2020/09/23	--	202
G01D	2016/09/14	--	-26.0
G01D	2017/11/30	--	21.0
G01D	2016/12/14	--	113
G01D	2018/06/19	--	29.0
G01D	2017/07/20	--	102
G01D	2020/03/30	--	138
G01D	2016/06/15	--	-110
G01D	2018/09/05	--	131
G01D	2022/07/26	*1.85*	15.5
G02D	2021/07/06	<0.025	128
G02D	2021/07/21	0.059	100
G02D	2021/06/01	0.043	140
G02D	2017/06/14	--	95.0
G02D	2021/04/14	<0.025	151
G02D	2016/12/14	--	218
G02D	2021/09/20	--	191
G02D	2021/03/24	0.026	175
G02D	2021/05/12	<0.1	183

Appendix D- . Supporting groundwater analytical data for Attachment A.

Well ID	Date	Iron (mg/L)	xidation eduction otential (m)
G02D	2021/06/14	0.071	169
G02D	2023/05/03	0.049	182
G02D	2022/03/14	--	138
G02D	2022/09/21	--	199
G02D	2021/03/03	0.11	151
G02D	2019/09/09	--	186
G02D	2023/03/08	--	49.1
G02D	2020/03/30	--	179
G02D	2016/03/15	--	28.0
G02D	2016/09/14	--	69.0
G02D	2018/09/05	--	169
G02D	2019/03/27	--	130
G02D	2020/09/23	--	246
G02D	2023/01/24	<0.0115	109.8
G02D	2015/12/03	--	146
G02D	2018/06/19	--	187
G02D	2017/07/20	--	132
G02D	2016/06/15	--	82.0
G02D	2017/03/08	--	254
G02D	2017/11/30	--	70.0
G02D	2022/07/27	0.03	97.3
XTPW03	2023/03/07	*0.49*	50.0
XTPW03	2022/09/28	*12.8*	-69.5
XTPW03	2022/10/27	*5.64*	-136
XTPW03	2022/09/01	*18.7*	-174

Notes:
mg/L = milligrams per liter
mV = millivolts ; V = volts
Italicized samples not included in average iron presented in Attachment 6a due to turbidity >10NTU
WAP: West ash pond, represented by data from XTPW03
Backgroud: Represented by data from G01D and G02D

Appendix D-3. Supporting groundwater analytical data for Attachment B.

Well ID	Date	pH (SU)	Temperature (elcius)	xidation eduction otential (m)	h ( )
G11	3/4/2021	5.90	16.30	69.0	0.276
G11	3/24/2021	5.90	16.50	154	0.361
G11	4/14/2021	5.80	16.10	100	0.307
G11	5/12/2021	5.90	16.50	194	0.401
G11	6/1/2021	5.82	16.40	159	0.366
G11	6/14/2021	5.86	16.60	149	0.355
G11	7/6/2021	5.78	16.70	78.0	0.284
G11	7/20/2021	5.82	16.90	135	0.341
G11	7/23/2022	6.33	17.32	122	0.328
G11	3/8/2023	5.87	16.00	166	0.373
G11	5/3/2023	5.82	16.50	207	0.414
G51D	7/20/2017	5.90	18.92	180	0.384
G51D	3/30/2020	5.62	16.40	261	0.468
G51D	3/24/2021	5.56	17.00	136	0.342
G51D	9/20/2021	5.46	17.70	238	0.443
G51D	3/15/2022	5.57	16.10	165	0.372
G51D	7/25/2022	6.92	18.07	178	0.383
G51D	3/8/2023	5.49	15.90	167	0.374
G51D	5/3/2023	5.57	16.30	214	0.421
TPZ118DD	8/31/2022	7.40	15.94	-124	0.083
TPZ118DD	9/29/2022	6.84	15.83	-65.5	0.142
TPZ118DD	10/28/2022	7.26	15.70	-103	0.104
TPZ118DD	11/15/2022	7.34	14.77	-168	0.040
TPZ118DD	12/14/2022	7.08	14.80	-300	-0.092
TPZ118DD	3/8/2023	7.09	14.70	-36.2	0.172
TPZ119D	8/31/2022	6.49	16.55	123	0.329
TPZ119D	9/29/2022	6.19	16.92	90.1	0.296
TPZ119D	11/4/2022	6.61	16.12	196	0.403
TPZ119D	11/16/2022	6.48	14.41	38.0	0.246
TPZ119D	12/14/2022	6.44	14.80	96.0	0.304
TPZ119D	1/18/2023	6.35	14.30	76.0	0.285
TPZ119D	2/15/2023	6.16	15.10	217	0.425
TPZ119D	3/7/2023	6.34	14.90	104	0.312
TPZ119DD	8/31/2022	6.90	17.25	-1.3	0.205
TPZ119DD	9/29/2022	6.88	18.56	-3.0	0.202
TPZ119DD	11/4/2022	7.00	17.05	131	0.337
TPZ119DD	11/16/2022	6.94	12.75	-54.0	0.156
TPZ119DD	12/14/2022	6.81	14.60	76.0	0.284
TPZ119DD	1/18/2023	6.74	14.00	32.0	0.241

Appendix D-3. Supporting groundwater analytical data for Attachment B.

Well ID	Date	pH (SU)	Temperature (elcius)	xidation eduction otential (m)	h ( )
TPZ119DD	2/15/2023	6.54	14.90	36.0	0.244
TPZ119DD	3/7/2023	6.76	14.60	2.0	0.210
TPZ120D	8/30/2022	6.18	16.31	-59.2	0.148
TPZ120D	9/27/2022	6.37	17.00	43.2	0.249
TPZ120D	10/26/2022	6.35	17.60	32.0	0.238
TPZ120D	11/16/2022	6.37	15.23	-3.2	0.204
TPZ120D	12/15/2022	6.16	14.70	212	0.420
TPZ120D	1/19/2023	6.17	14.80	178	0.386
TPZ120D	2/15/2023	6.01	15.50	123	0.330
TPZ120D	3/7/2023	6.20	14.90	83.1	0.291
TPZ123	8/31/2022	7.21	17.13	-78.4	0.128
TPZ123	9/27/2022	7.20	16.42	-81.7	0.125
TPZ123	11/3/2022	7.20	19.43	-89.2	0.115
TPZ123	11/16/2022	7.11	13.87	-116	0.093
TPZ123	12/15/2022	6.95	14.70	-64.0	0.144
TPZ123	1/18/2023	6.93	14.30	-116	0.093
TPZ123	2/15/2023	6.38	14.70	21.0	0.229
TPZ123	3/7/2023	6.84	14.60	-24.2	0.184
TPZ124D	8/31/2022	7.04	16.98	-63.7	0.142
TPZ124D	9/29/2022	6.91	16.40	-42.7	0.164
TPZ124D	10/28/2022	6.84	14.80	-32.9	0.175
TPZ124D	11/15/2022	7.07	13.82	-106	0.103
TPZ124D	12/14/2022	6.88	14.50	-24.0	0.184
TPZ124D	1/18/2023	6.80	14.00	-8.0	0.201
TPZ124D	2/14/2023	6.40	14.00	35.0	0.244
TPZ124D	3/7/2023	6.77	14.40	11.6	0.220
XTPW01	3/10/2023	10.80	14.00	-156	0.053
XTPW02	3/8/2023	10.60	13.90	-182	0.027
XTPW03	10/27/2022	7.42	14.40	-136	0.072
XTPW04	3/8/2023	7.09	13.50	-118	0.091

Notes:

SU= standard units

mV = millivolts ; V = volts

Exhibit C

Luminant

Electric Energy, Inc.
1500 Eastport Plaza Drive
Collinsville, IL 62234

November 6, 2023

VIA E-MAIL
Lauren.Martin@epa.gov
EPA.CCR.PART845.COORDINATOR@ILLINOIS.GOV
EPA.CCR.Part845.Notify@Illinois.gov

Re: Alternative Source Demonstration ("ASD") for Joppa Power Plant East Ash Pond

To Whom It May Concern:

On October 21, 2023, Electric Energy, Inc. ("EEI") submitted an ASD for the Joppa Power Plant East Ash Pond ("Joppa EAP") to the Illinois Environmental Protection Agency ("IEPA") pursuant to 35 Ill. Admin. Code 845.650(e). On October 23, 2023, IEPA provided notice to its listserve regarding the posting of the ASD submittal, triggering a 14-day period for written comments on the ASD submittal pursuant to 35 Ill Admin. Code 845.650(e)(3). After submittal of the Joppa EAP ASD, EEI and IEPA engaged in communications regarding the Joppa EAP ASD submittal. EEI submits this letter and its attachments, within the 14-day period for written comments, to provide additional information to IEPA in response to those communications. As explained below and in the attached materials, EEI's October 21 ASD submittal was comprehensive in scope and used scientifically supported, industry standard methodologies.

IEPA requested certain additional data as part of its communications with EEI. While EEI does not agree that any additional data is necessary in support of the ASD submittal, EEI has compiled and is providing, as Attachment 1 to this letter, the hydraulic conductivity and boring log data requested by IEPA. No specific boring locations were referenced by IEPA in its request, therefore, boring logs for subject wells G05, G11, and G151/G51D and borings from which solid samples were collected (G03, G07, G08, G09M, and G11) have been included. Attachment 1 also includes hydraulic conductivity data referenced and provided in the October 2017 Hydrogeologic Monitoring Plan for the Joppa EAP. All of the information in Attachment 1 was previously provided or referenced in the Joppa EAP operating permit application and/or construction permit application. Additional site characterization data can also be found in the previously provided April 2023 supplemental site investigation report for the Joppa EAP. Because the supplemental site investigation report, operating permit application and construction permit application were used and relied upon in preparing the Joppa EAP ASD and all contain information IEPA has sought in connection with its review of the ASD, EEI (with this letter) is incorporating by reference the entirety of its April 2023 supplemental site investigation report, October 25, 2021 operating permit application and July 28, 2022 construction permit application for the Joppa EAP into its Joppa EAP ASD submittal.

In its communications with EEI, IEPA also requested (1) source characterization of CCR that includes total solids sampling, analysis and reporting in accordance with SW-846 leach testing methods and (2) sampling and analysis in accordance with 35 Ill. Admin. Code 845.640 of the alternative source. Collecting this information would be a considerable undertaking that EEI would not be able to complete prior to the decision deadline or within the comment period for the Joppa EAP ASD. Additionally, this information is not required by law and is unnecessary to support the Joppa EAP ASD. First, there is no requirement under Part 845 that source characterization of CCR be conducted in accordance with SW-846. While Part 845.150 incorporates by reference SW-846, that incorporation does not create an affirmative obligation to analyze all samples in accordance with SW-846. As set forth in Chapter 2 of SW-846, the methods are not "mandatory" unless specifically specified in the regulation. Groundwater samples taken under Part 845 are the only samples specifically required by Part 845 to be analyzed using SW-846. In particular, Part 845.640(e) requires groundwater samples taken under a groundwater monitoring program be analyzed in accordance with SW-846. Notably, samples collected under the Joppa EAP's groundwater monitoring program have been analyzed in accordance with SW-846 (and were otherwise collected and analyzed in accordance with 35 Ill. Admin. Code 845.640). Attachment 2 to this letter explains how CCR source characterization was conducted for the Joppa EAP ASD and explains why the methodology used is more appropriate than SW-846 leach testing methods for characterizing the source material.

Second, there is no requirement under 35 Ill Admin. Code 845.640, 35 Ill. Admin. Code 845.650 or elsewhere in Part 845 to identify, sample or analyze an alternative source. Section 845.650(e), which governs alternative source demonstrations, simply requires a determination that a source other than the CCR surface impoundment caused the contamination and that the CCR surface impoundment did not contribute to the contamination. As described in Attachment 2, this demonstration is made through a multiple lines of evidence analysis in the Joppa EAP ASD submittal. The multiple lines of evidence analysis for the Joppa EAP ASD demonstrates, among other findings, that the cobalt contamination in well G05 is likely from naturally occurring cobalt in soil and that pH exceedances in wells G11 and G51D are consistent with iron oxidization. However, identification and a full characterization of an alternative source is not required for the ASD or necessary to determine that a source other than the Joppa EAP caused the cobalt contamination in well G05 and pH contamination in wells G11 and G51D, and that the Joppa EAP did not contribute to that contamination.

Finally, given that this submittal responds to questions and requests raised by IEPA regarding the Joppa EAP ASD, EEI hereby incorporates this letter and its attachments (including the references set forth in those attachments) into its Joppa EAP submittal.

Should you have any questions regarding the information contained in this letter or its attachments, please feel free to reach out.

Sincerely,

Dianna Tickner
Sr. Director – Decommission and Demolition

Attachments

ATTACHMENT 1
ADDITIONAL INFORMATION REQUESTED BY IEPA

FIELD HYDRAULIC CONDUCTIVITY TABLE AND SOFTWARE REPORTS

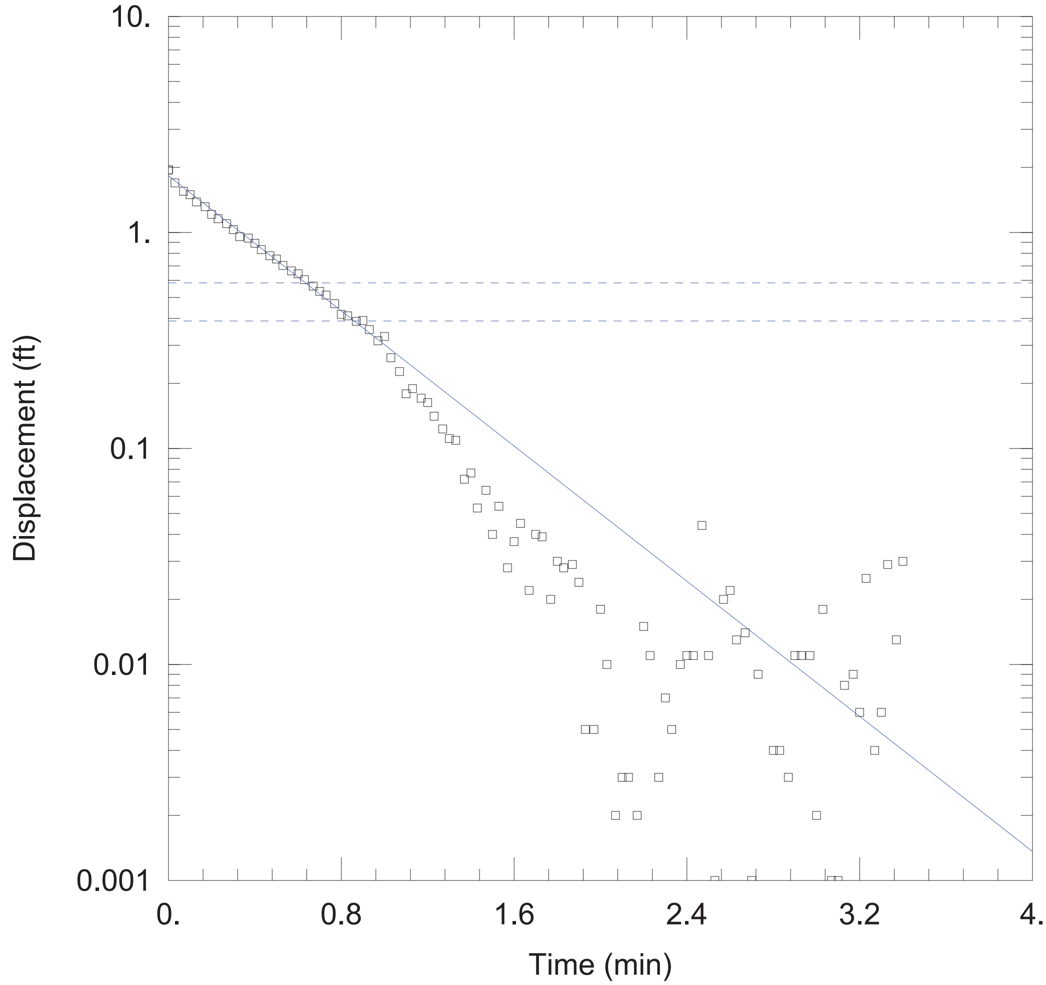
TABLE 3-3. FIELD HYDRAULIC CONDUCTIVITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
JOPPA POWER PLANT
EAST ASH POND
JOPPA, ILLINOIS

Well ID	Gradient Position	Bottom of Screen Elevation (ft NAVD88)	Screen Length[1] (ft)	Field Identified Screened Material	Slug Type	Analysis Method	Falling Head (Slug In) K (cm/s)			Rising Head (Slug Out) K (cm/s)			Average Hydraulic Conductivity (cm/s)	Minimum Hydraulic Conductivity (cm/s)	Maximum Hydraulic Conductivity (cm/s)	Hydraulic Conductivity Geometric Mean (cm/s)
							1	2	3	1	2	3				
Uppermost Aquifer																
G06	D	267.60	10.0	Gravely Silty Clay	Solid	Bouwer-Rice	1.20E-03	1.02E-03	---	1.03E-03	8.14E-04	---	1.02E-03	4.84E-04	1.18E-02	3.10E-03
G07	D	290.34	10.0	Sand	Solid	Bouwer-Rice	6.96E-03	1.18E-02	8.98E-03	8.22E-03	1.05E-02	1.02E-02	9.45E-03			
G08	D	256.72	10.0	Sand	Solid	Bouwer-Rice	5.51E-03	5.82E-03	---	2.92E-03	3.69E-03	---	4.49E-03			
G09	D	279.19	10.0	Sandy Gravel	Solid	Bouwer-Rice	2.62E-03	---	---	1.55E-03	---	---	2.08E-03			
G10	D	280.45	10.0	Sand and Sandy Gravel	Solid	Bouwer-Rice	1.36E-03	8.69E-04	---	4.84E-04	5.25E-04	---	8.08E-04			
G11	U	297.68	10.0	Sand	Solid	Bouwer-Rice	7.15E-03	6.36E-03	---	6.72E-03	7.23E-03	---	6.86E-03			
Lower Aquifer Unit																
G09M	D	193.60	10.0	Bedrock	Solid	Bouwer-Rice	2.73E-04	5.82E-04	---	3.78E-04	4.16E-04	---	4.12E-04	2.73E-04	5.82E-04	3.97E-04
CCR Fill																
XPW-02	NA	343.53	5.0	Ash	Solid	Bouwer-Rice	9.82E-03	9.25E-03	---	4.46E-03	5.39E-03	---	7.23E-03	4.46E-03	1.65E-01	1.29E-02
XPW-03	NA	341.95	5.0	Ash	Solid	Springer-Gelhar	---	---	---	1.65E-01	---	---	1.65E-01			

Notes:
[1] All wells are constructed from 2 inch PVC with 0.01 inch slotted screens.
--- = Test not analyzed/performed
CCR = coal combustion residuals
cm/s = centimeters per second
D = downgradient
ft = foot/feet
NA = Not Applicable
NAVD88 = North American Vertical Datum of 1988
U = upgradient

[O: XXX MM/DD/YY; U: CJC 08/24/21; C: LDC 08/30/21]

RAMBOLL



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-06 test 1 (slug-in) BR.aqt
Date: 03/31/21 Time: 11:36:29

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-06

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 0.1

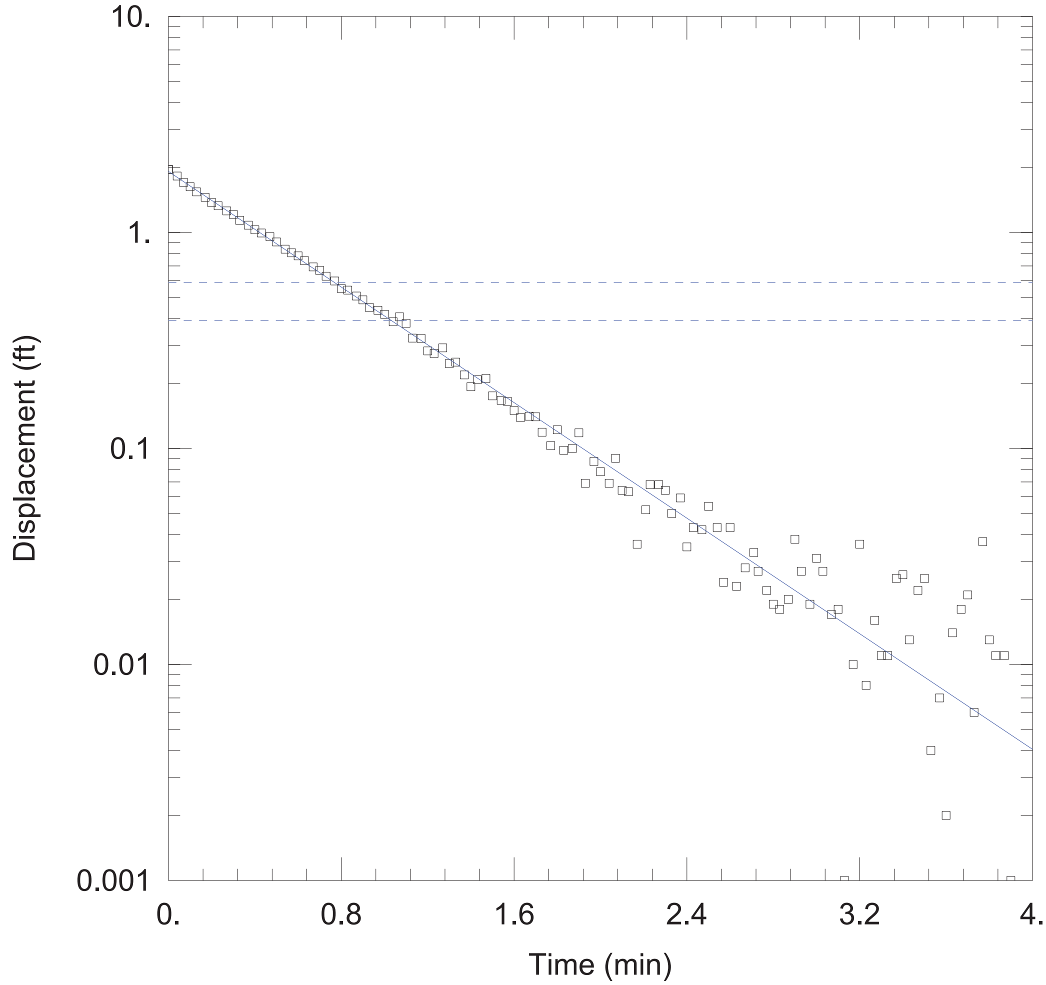
WELL DATA (G-06 (test 1 slug in))

Initial Displacement: 1.945 ft Static Water Column Height: 52.85 ft
Total Well Penetration Depth: 52.85 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.001199 cm/sec y0 = 1.829 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-06 test 2 (slug-out) BR.aqt
Date: 03/31/21 Time: 11:37:34

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-06

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 0.1

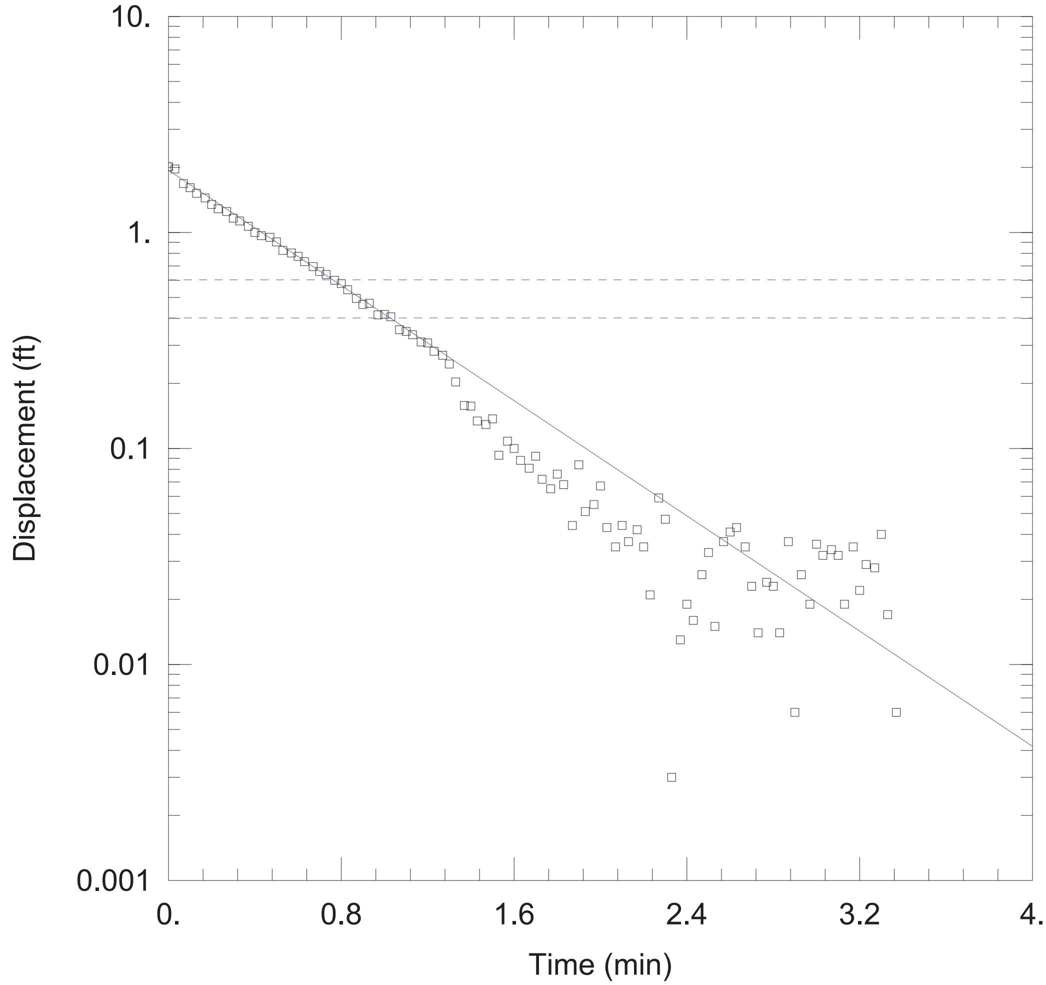
WELL DATA (G-06 (test 2 slug out))

Initial Displacement: 1.956 ft
Total Well Penetration Depth: 52.85 ft
Casing Radius: 0.083 ft
Static Water Column Height: 52.85 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.001025 cm/sec y0 = 1.915 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-06 test 3 (slug-in) BR.aqt
Date: 03/31/21 Time: 11:38:16

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-06

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 0.1

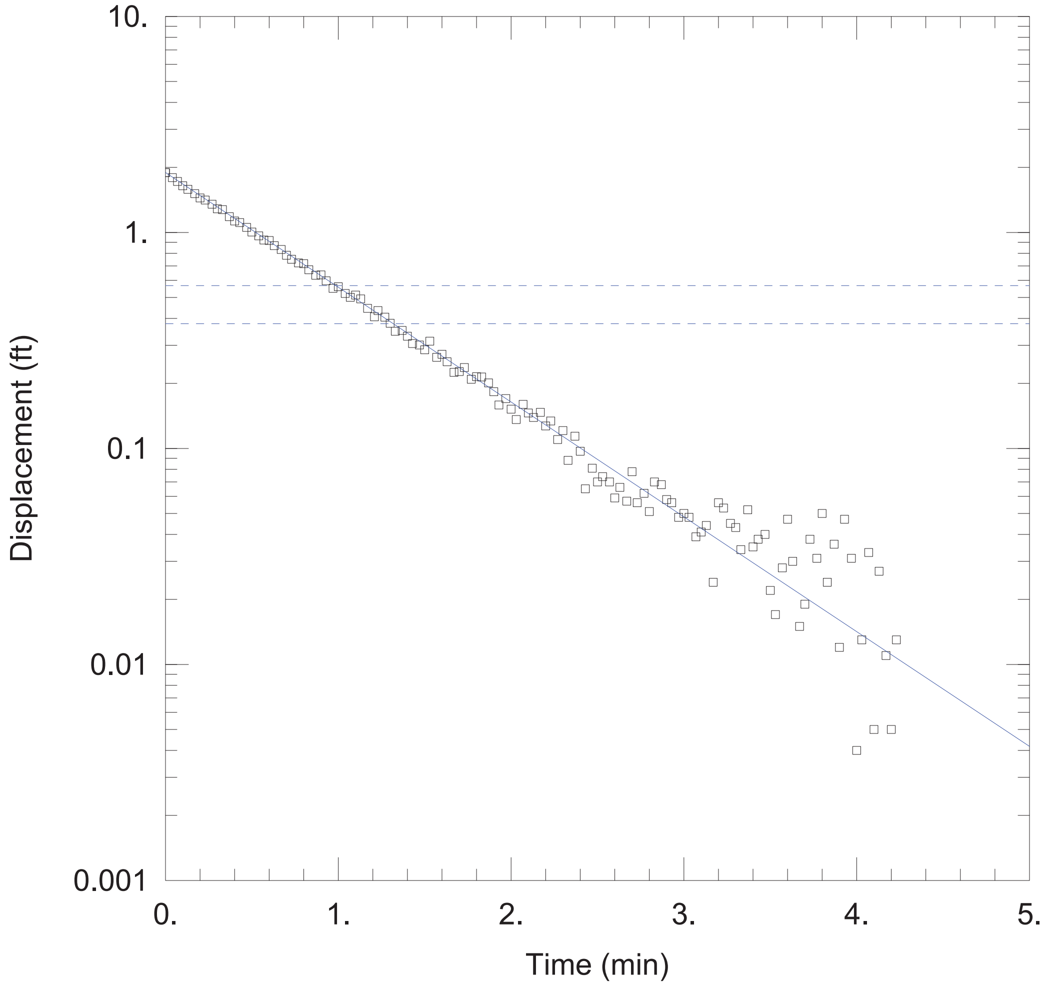
WELL DATA (G-06 (test 3 slug in))

Initial Displacement: 2.01 ft
Total Well Penetration Depth: 52.85 ft
Casing Radius: 0.083 ft
Static Water Column Height: 52.85 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.001022 cm/sec
y0 = 1.941 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-06 test 4 (slug-out) BR.aqt
Date: 03/31/21 Time: 11:38:53

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-06

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 0.1

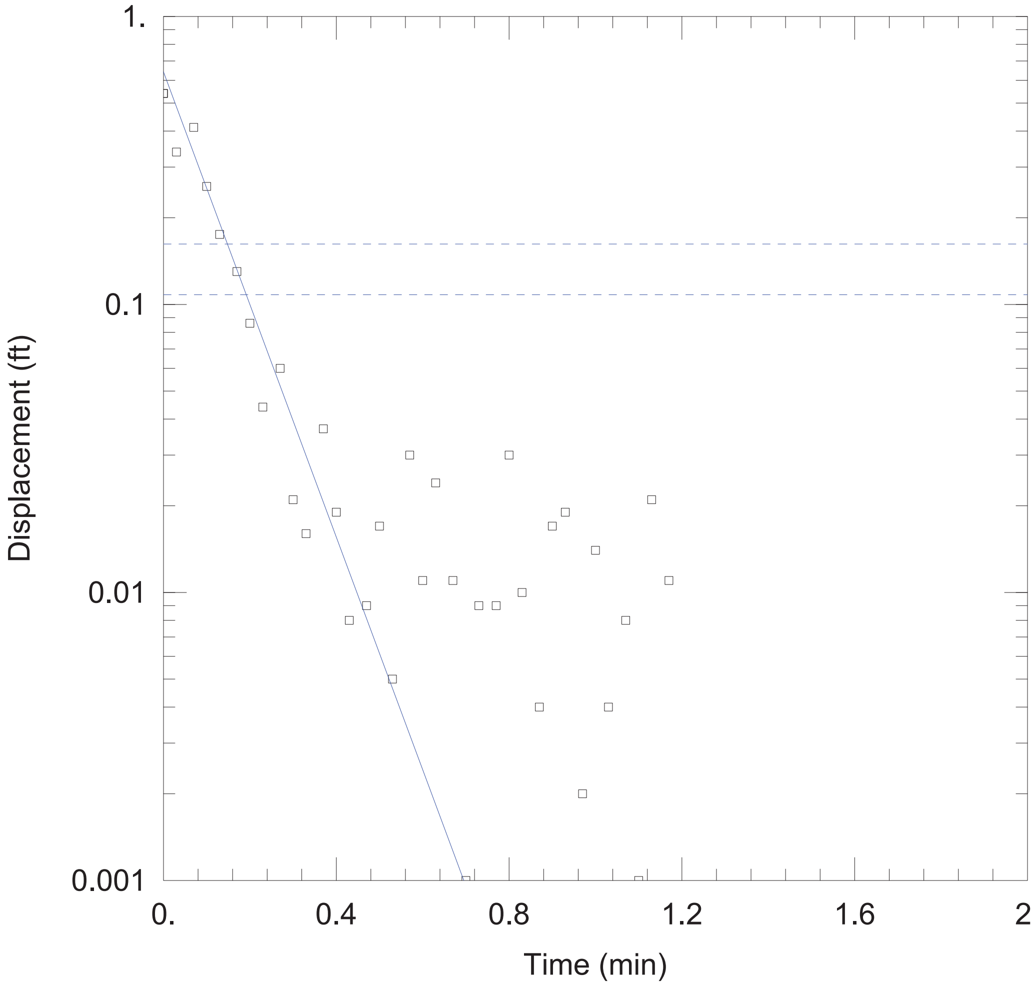
WELL DATA (G-06 (test 4 slug out))

Initial Displacement: 1.89 ft
Total Well Penetration Depth: 52.85 ft
Casing Radius: 0.083 ft
Static Water Column Height: 52.85 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0008143 cm/sec
y0 = 1.895 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-07 test 1 (slug-in) BR.aqt
Date: 03/31/21 Time: 11:41:12

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-07

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 0.1

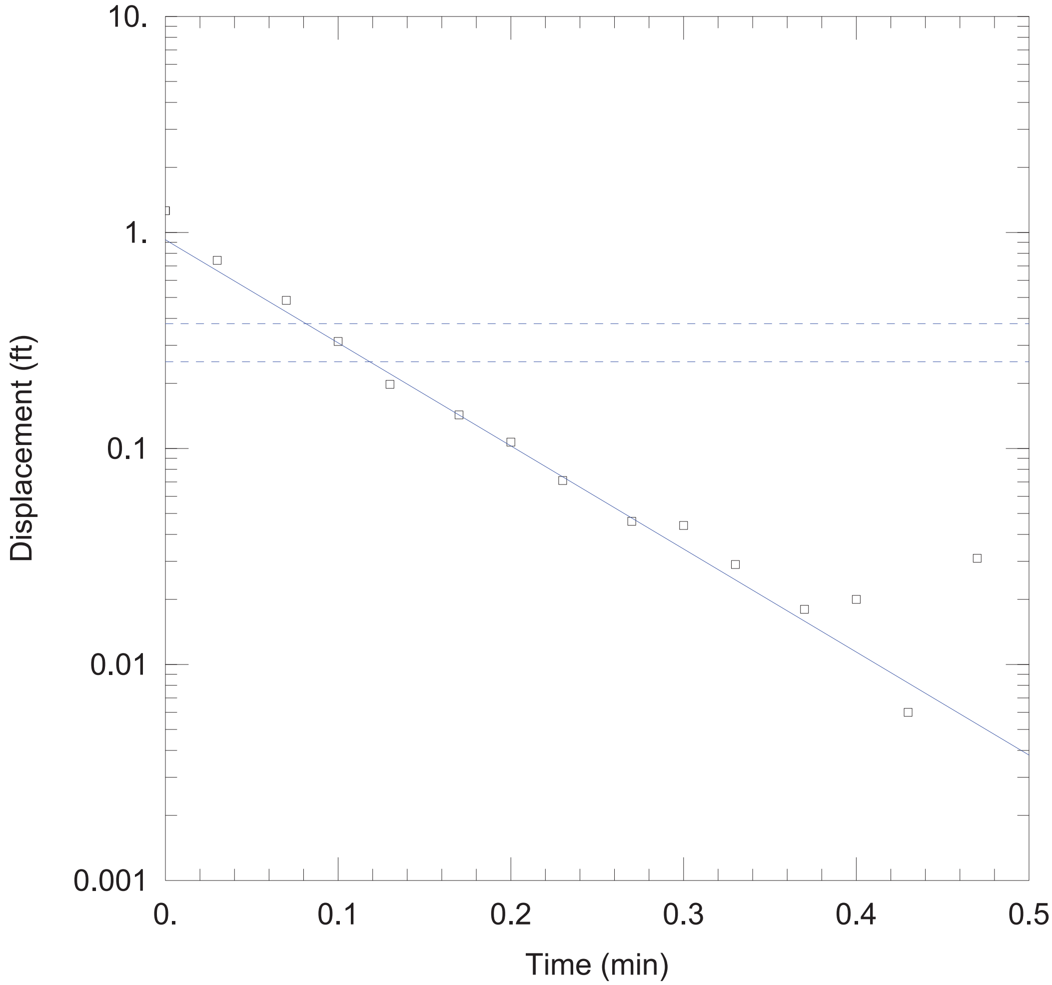
WELL DATA (G-07 (test 1 slug in))

Initial Displacement: 0.54 ft
Total Well Penetration Depth: 23.39 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.39 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.006959 cm/sec y0 = 0.6416 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-07 test 2 (slug-out) BR.aqt
Date: 03/31/21 Time: 11:41:51

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa Ash Pond
Test Well: G-07

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 0.1

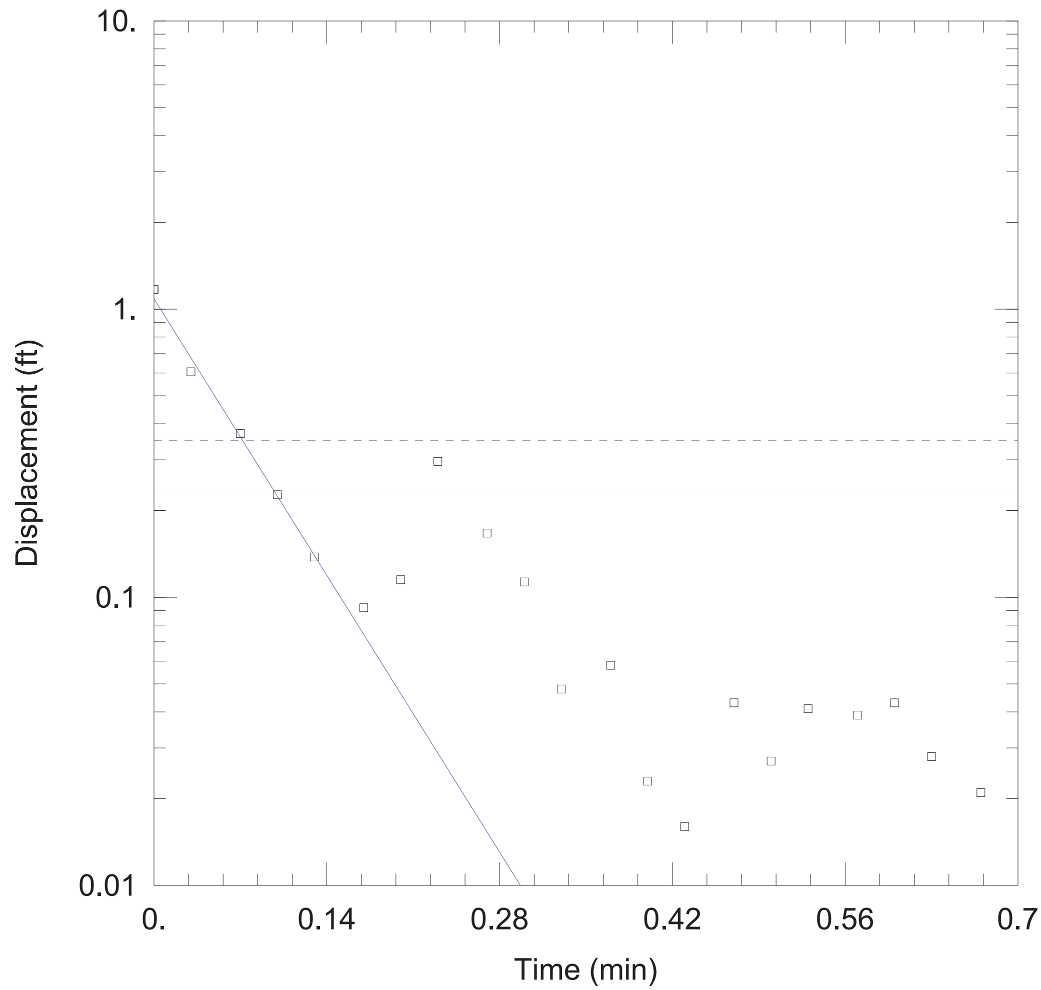
WELL DATA (G-07 (test 2 slug-out))

Initial Displacement: 1.26 ft Static Water Column Height: 23.39 ft
Total Well Penetration Depth: 23.39 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.008223 cm/sec y0 = 0.9246 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-07 test 3 (slug-in) BR.aqt
Date: 03/31/21 Time: 11:42:56

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa Ash Pond
Test Well: G-07

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 0.1

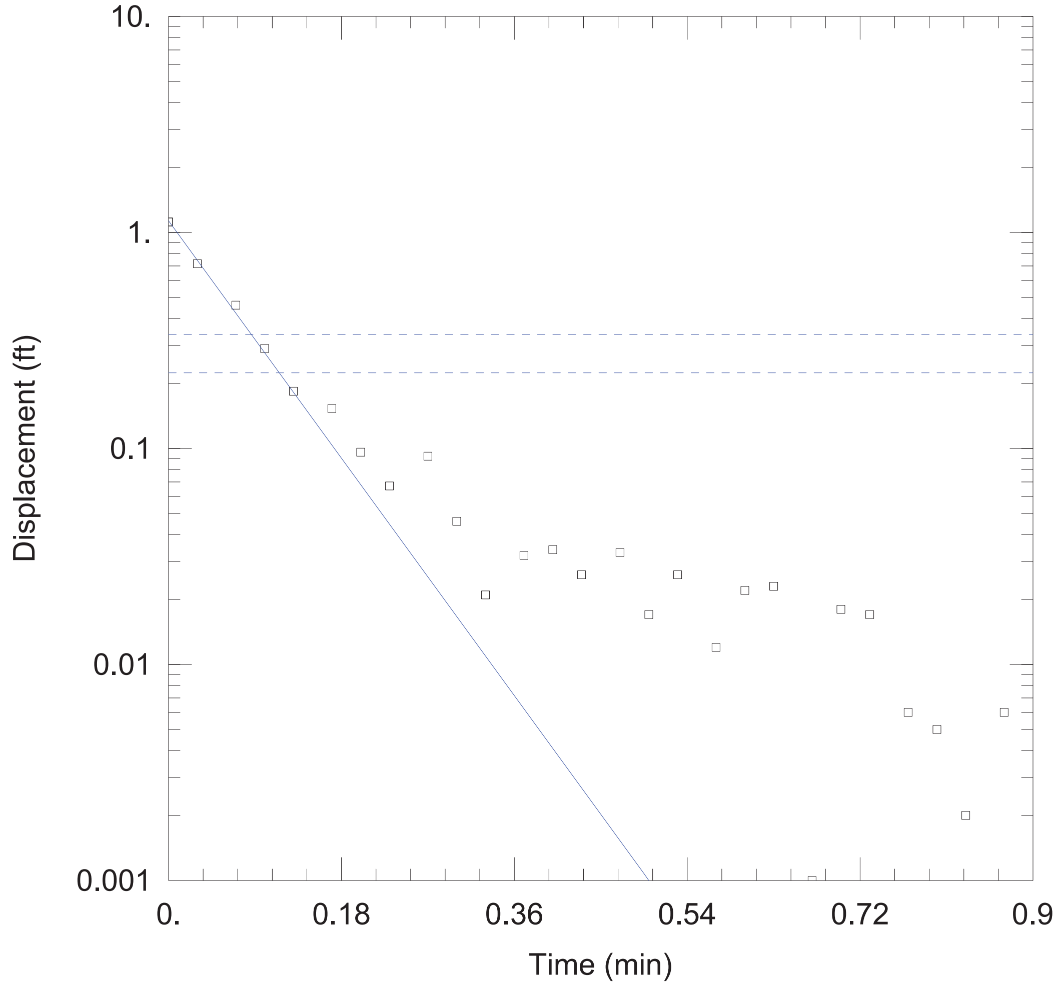
WELL DATA (G-07 (test 3 slug-in))

Initial Displacement: 1.168 ft
Total Well Penetration Depth: 23.39 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.39 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01182 cm/sec y0 = 1.087 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-07 test 4 (slug-out) BR.aqt
Date: 03/31/21 Time: 11:43:39

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-07

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 0.1

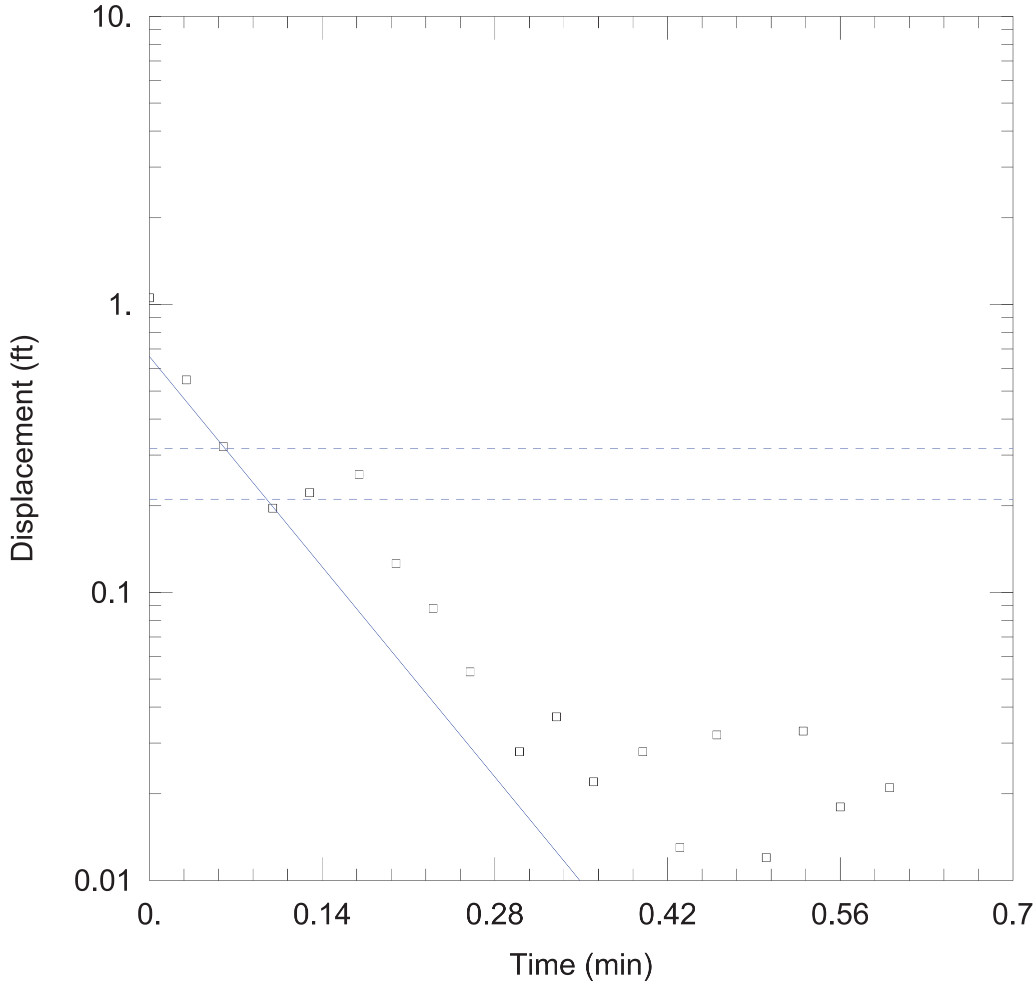
WELL DATA (G-07 (test 4 slug-out))

Initial Displacement: 1.119 ft Static Water Column Height: 23.39 ft
Total Well Penetration Depth: 23.39 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01052 cm/sec y0 = 1.132 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-07 test 5 (slug-in) BR.aqt
Date: 03/31/21 Time: 11:44:38

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-07

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 0.1

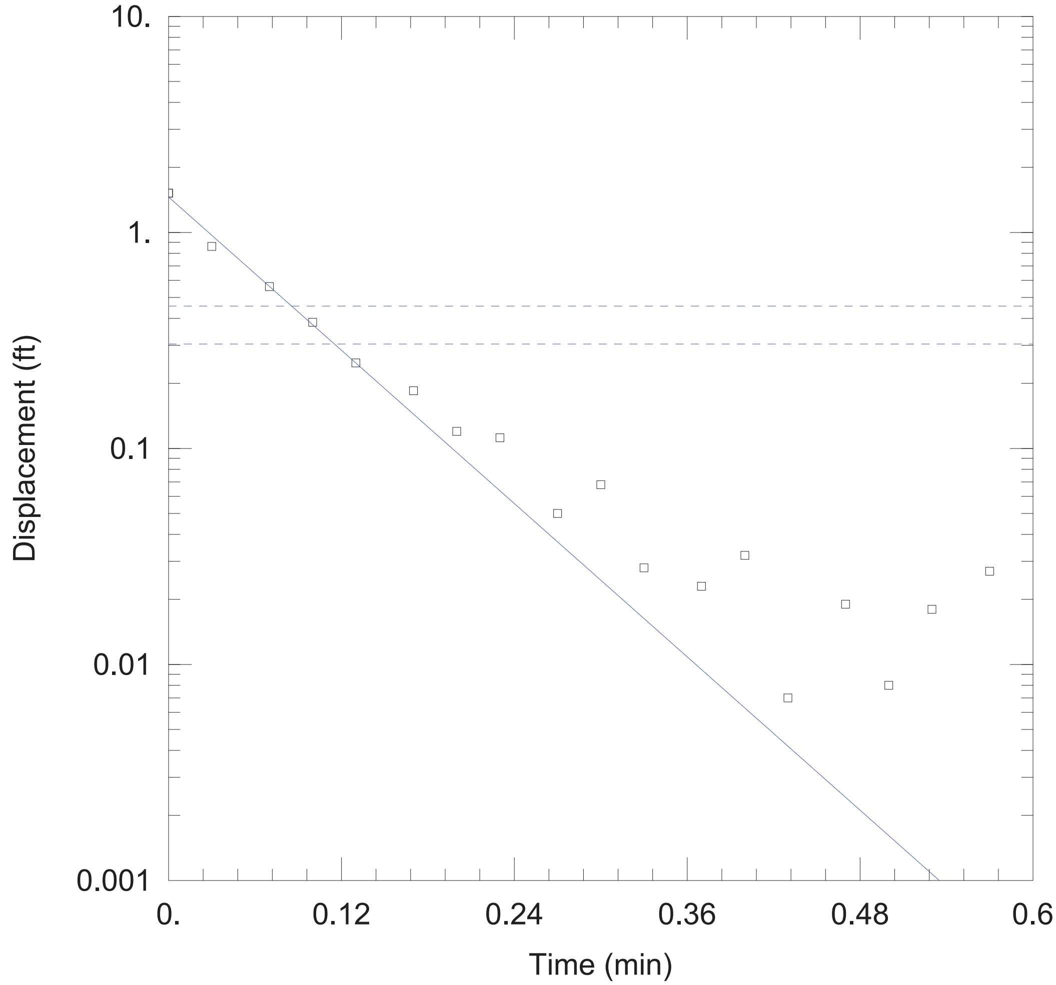
WELL DATA (G-07 (test 5 slug-out))

Initial Displacement: 1.054 ft Static Water Column Height: 23.39 ft
Total Well Penetration Depth: 23.39 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.008984 cm/sec y0 = 0.6591 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G-07 test 6 (slug-out) BR.aqt
Date: 03/31/21 Time: 11:45:44

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa
Test Well: G-07

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 0.1

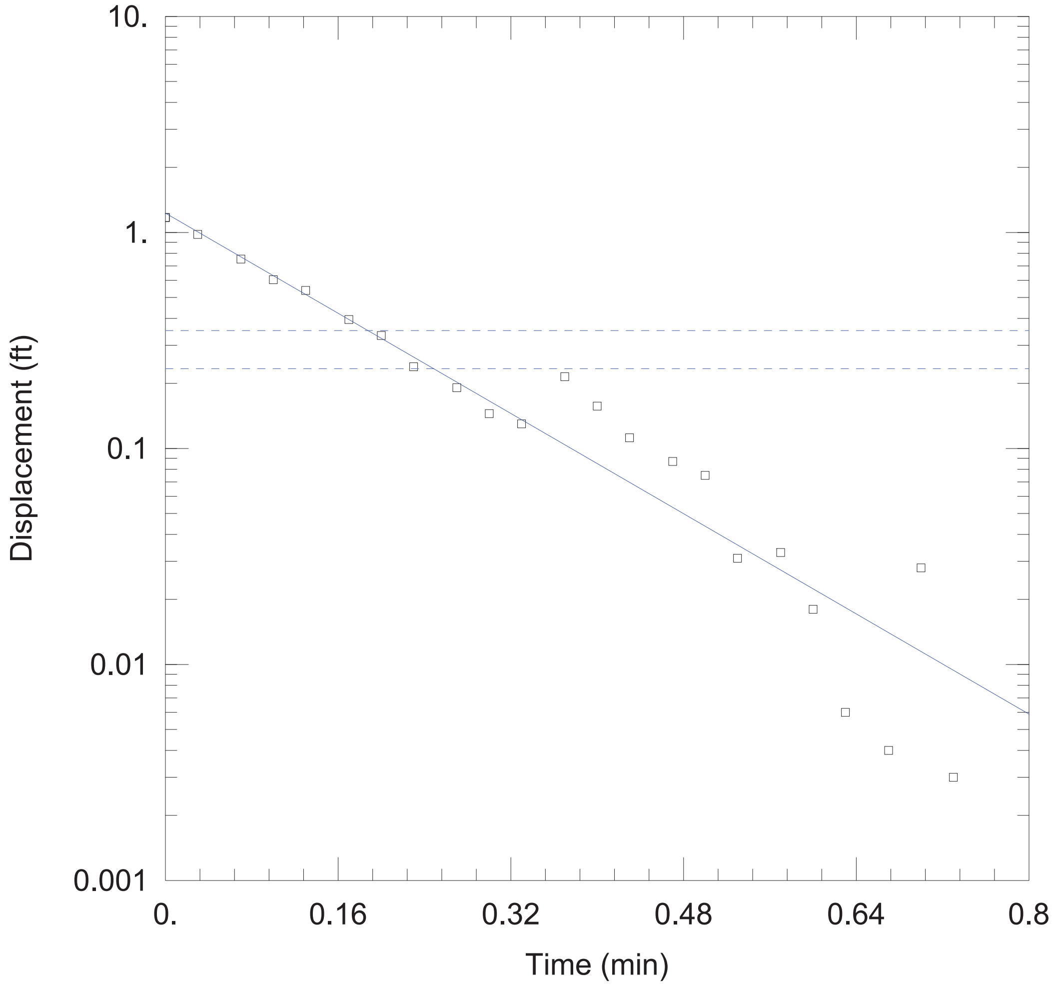
WELL DATA (G-07 (test 6 slug-out))

Initial Displacement: 1.521 ft Static Water Column Height: 23.39 ft
Total Well Penetration Depth: 23.39 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01019 cm/sec y0 = 1.46 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-8 test 1 (slug-in) BR.aqt
Date: 04/09/21 Time: 16:26:39

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-8

AQUIFER DATA

Saturated Thickness: 48. ft Anisotropy Ratio (Kz/Kr): 0.1

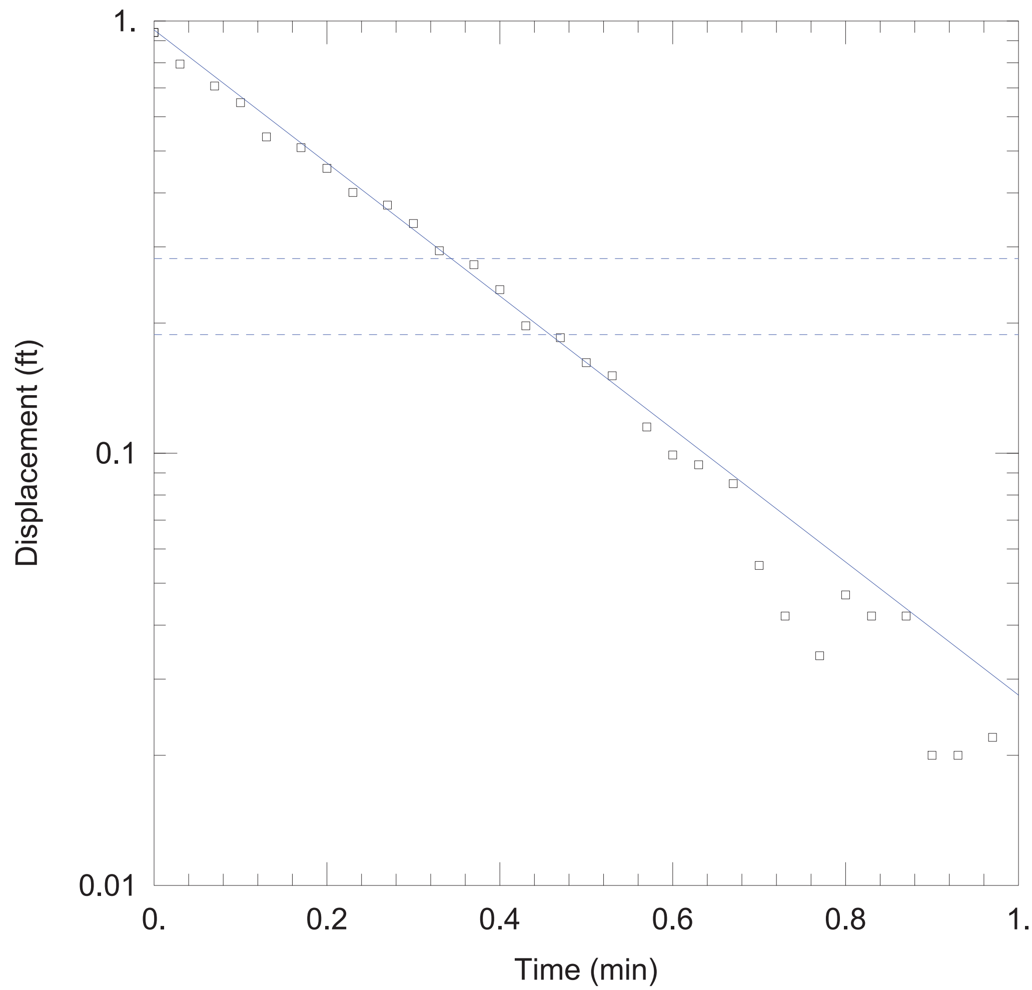
WELL DATA (G-8 (test 1 slug-in))

Initial Displacement: 1.17 ft
Total Well Penetration Depth: 48. ft
Casing Radius: 0.083 ft
Static Water Column Height: 60.85 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.005507 cm/sec y0 = 1.229 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-8 test 2 (slug-out) BR.aqt
Date: 04/09/21 Time: 16:29:24

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-8

AQUIFER DATA

Saturated Thickness: 48. ft
Anisotropy Ratio (Kz/Kr): 0.1

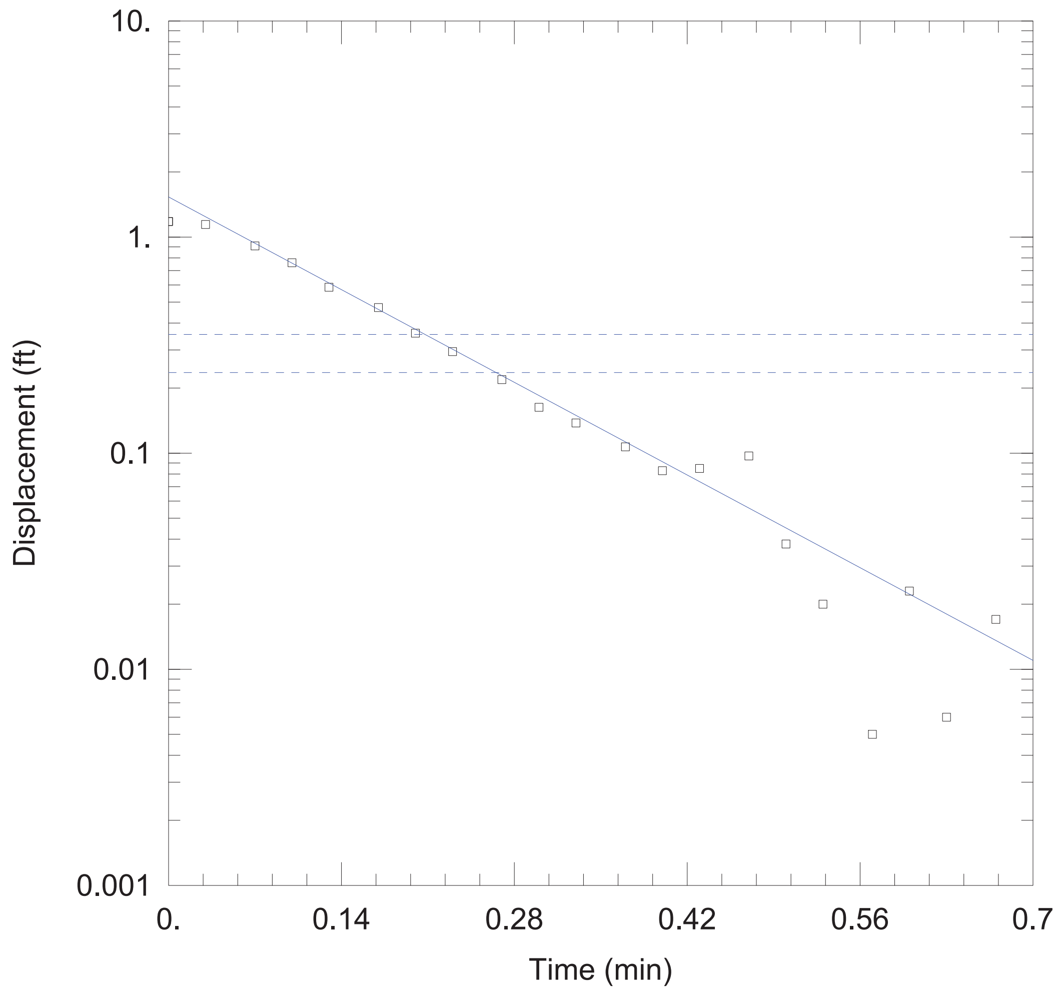
WELL DATA (G-8 (test 2 slug-out))

Initial Displacement: 0.94 ft
Total Well Penetration Depth: 48. ft
Casing Radius: 0.083 ft
Static Water Column Height: 60.85 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.002923 cm/sec
y0 = 0.953 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-8 test 3 (slug-in) BR.aqt
Date: 04/09/21 Time: 16:31:33

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-8

AQUIFER DATA

Saturated Thickness: 48. ft Anisotropy Ratio (Kz/Kr): 0.1

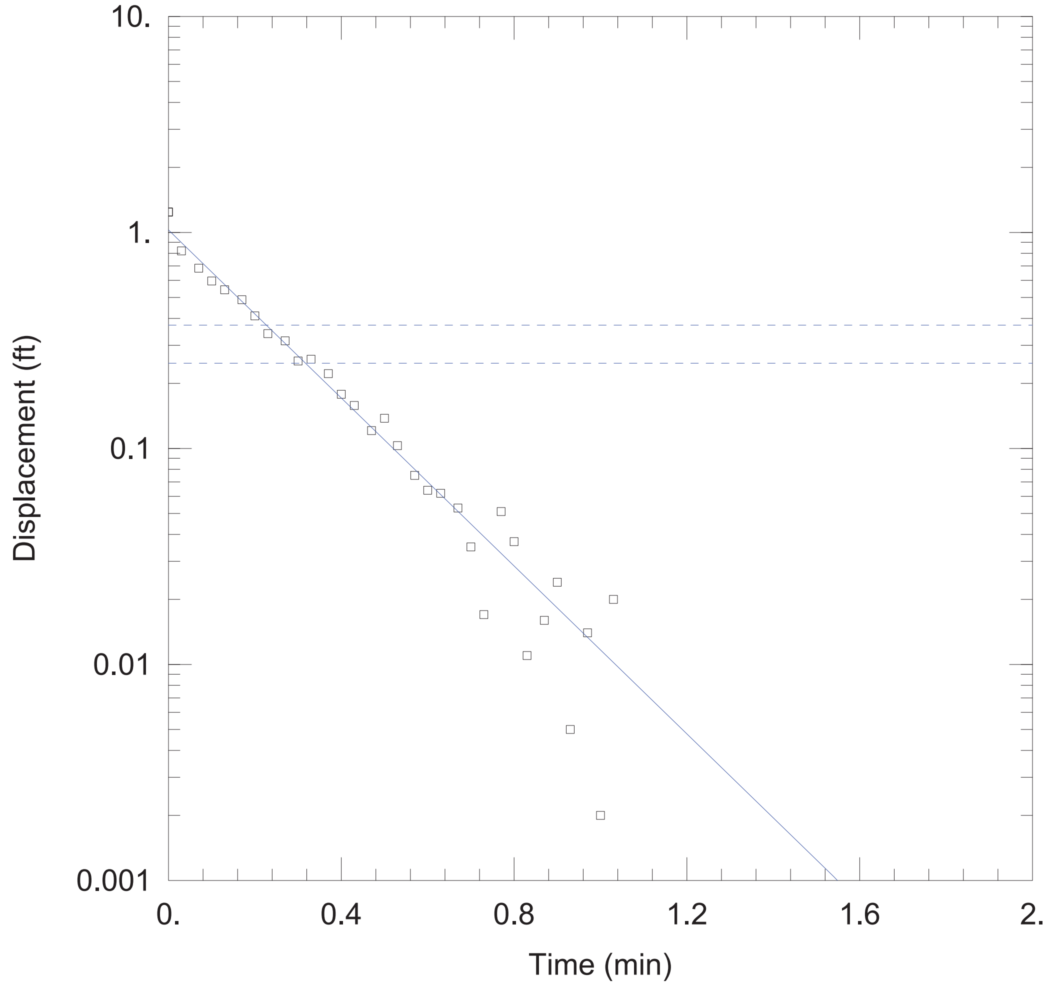
WELL DATA (G-8 (test 2 slug-out))

Initial Displacement: 1.18 ft
Total Well Penetration Depth: 48. ft
Casing Radius: 0.083 ft
Static Water Column Height: 60.85 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.005818 cm/sec
y0 = 1.532 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-8 test 4 (slug-out) BR.aqt
Date: 04/09/21 Time: 16:33:50

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-8

AQUIFER DATA

Saturated Thickness: 48. ft Anisotropy Ratio (Kz/Kr): 0.1

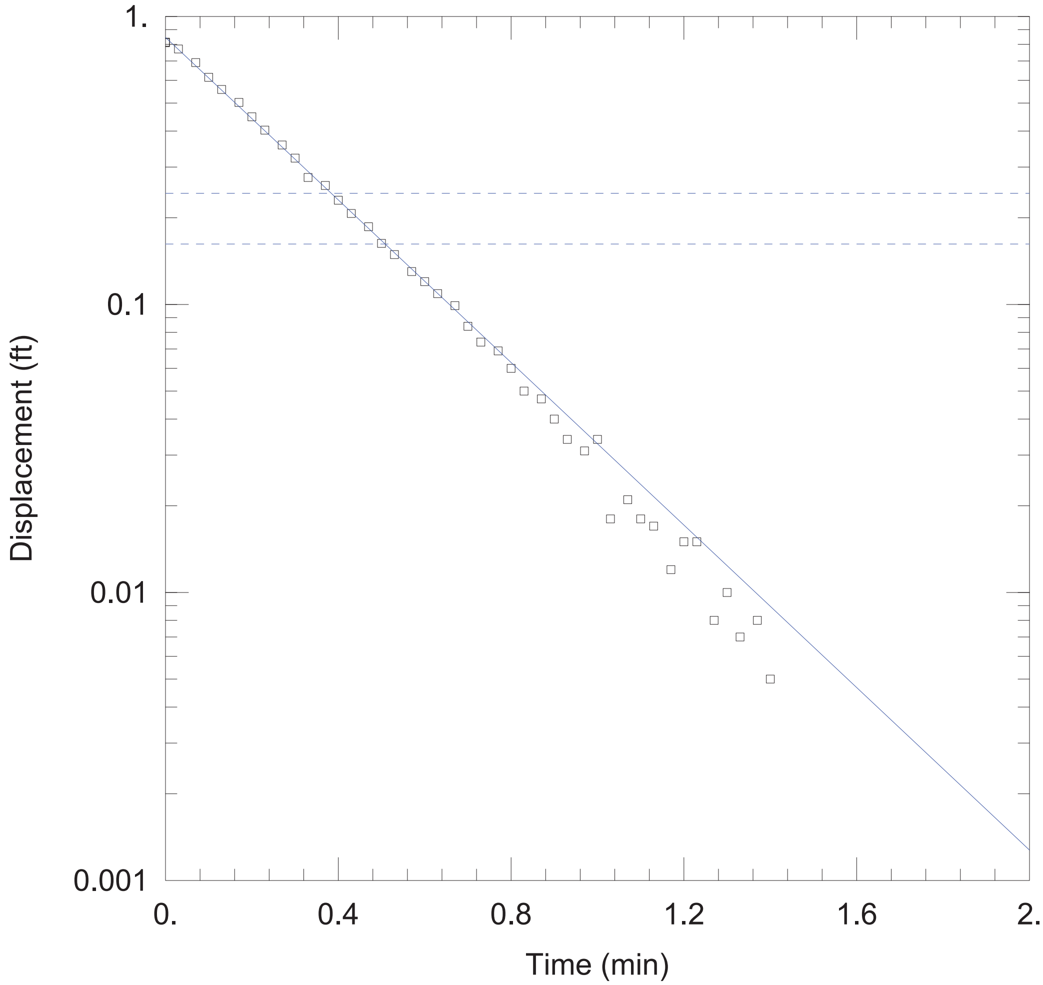
WELL DATA (G-8 (test 4 slug-out))

Initial Displacement: 1.24 ft
Total Well Penetration Depth: 48. ft
Casing Radius: 0.083 ft
Static Water Column Height: 60.85 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.003693 cm/sec y0 = 1.026 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-9 test 1 (slug-in) BR.aqt
Date: 04/09/21
Time: 15:43:53

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-9

AQUIFER DATA

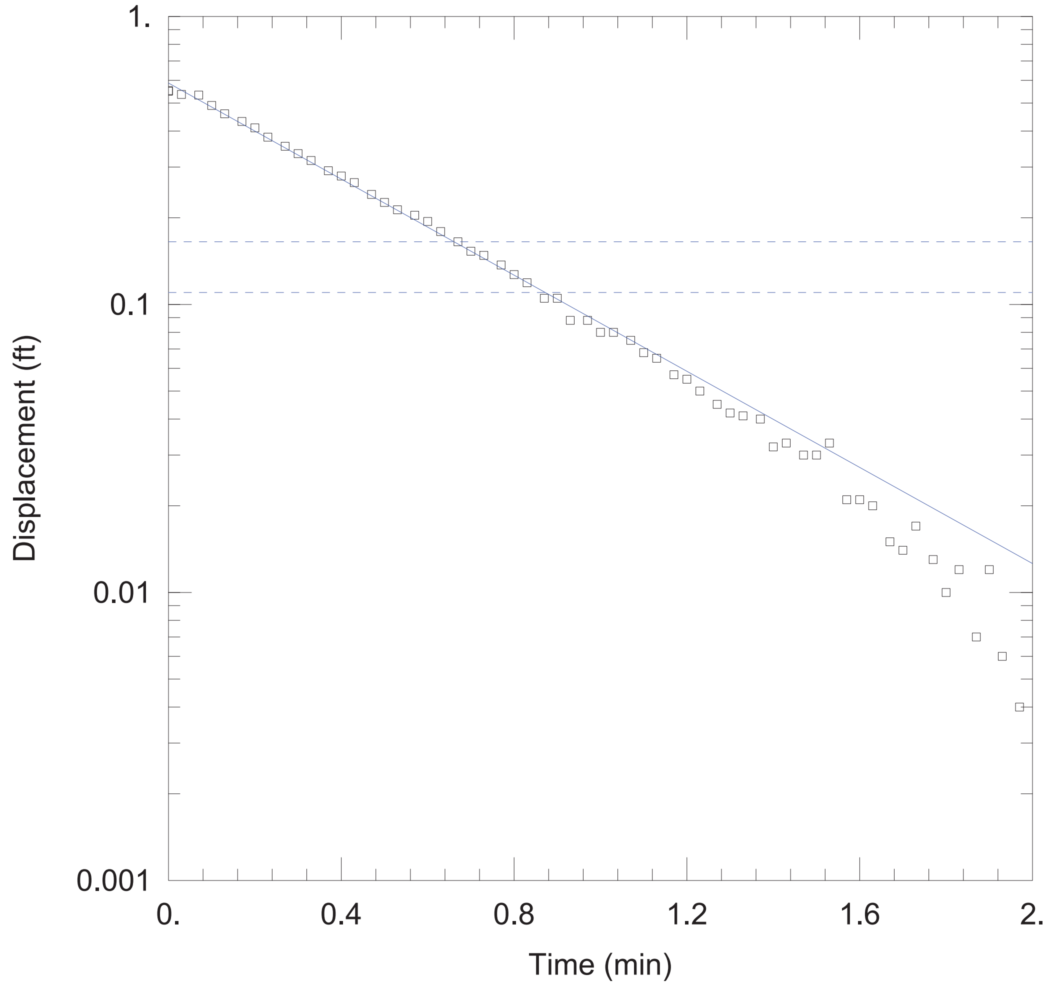
Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (G-9 (test 1 slug-in))

Initial Displacement: 0.81 ft
Static Water Column Height: 40.03 ft
Total Well Penetration Depth: 40.03 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.002618 cm/sec
y0 = 0.8457 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-9 test 2 (slug-out) BR.aqt
Date: 04/09/21 Time: 15:46:36

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-9

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 0.1

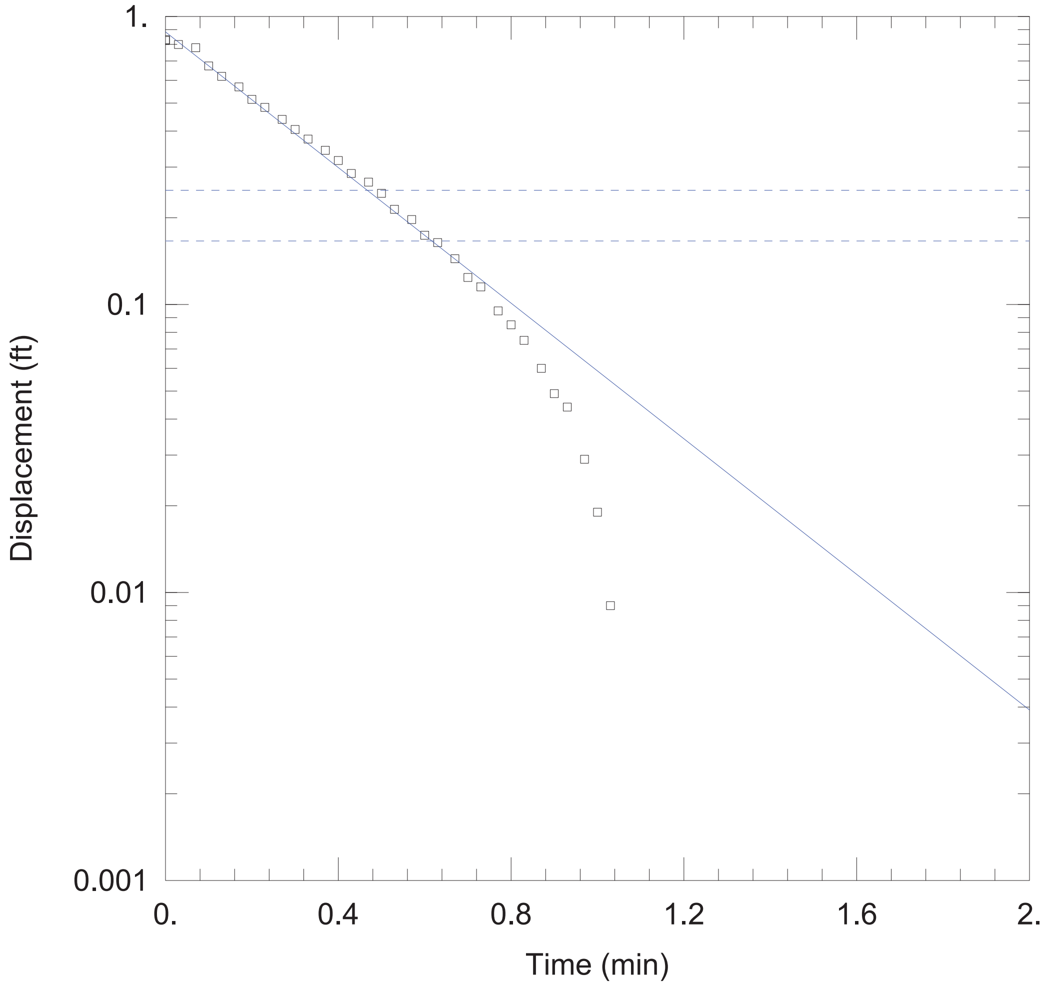
WELL DATA (G-9 (test 2 slug-out))

Initial Displacement: 0.55 ft
Total Well Penetration Depth: 40.03 ft
Casing Radius: 0.083 ft
Static Water Column Height: 40.03 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.001548 cm/sec
y0 = 0.5873 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-10 test 1 (slug-in) BR.aqt
Date: 04/09/21 Time: 14:40:34

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-10

AQUIFER DATA

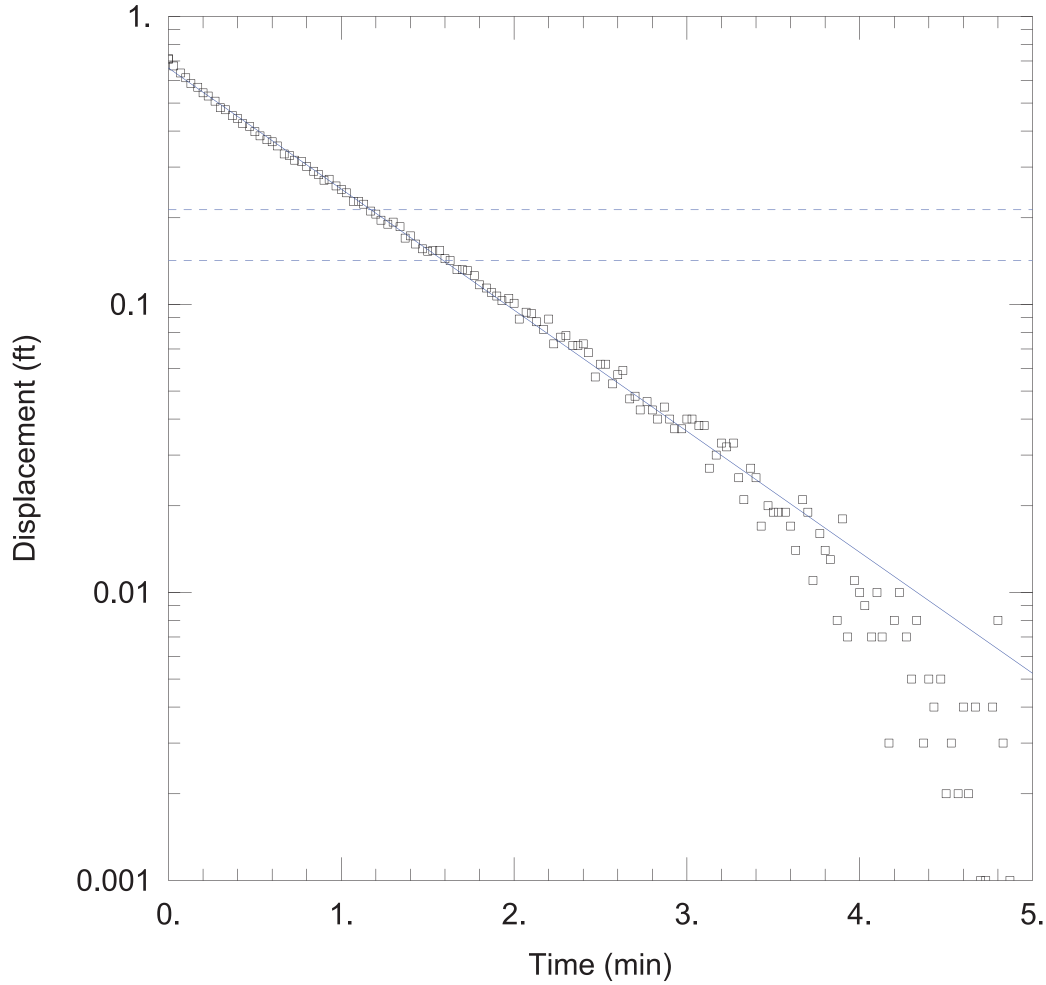
Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (G-10 (test 1 slug-in))

Initial Displacement: 0.83 ft
Static Water Column Height: 10.73 ft
Total Well Penetration Depth: 10.73 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.001355 cm/sec
y0 = 0.8835 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-10 test 2 (slug-out) BR.aqt
Date: 04/09/21 Time: 14:42:40

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-10

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 0.1

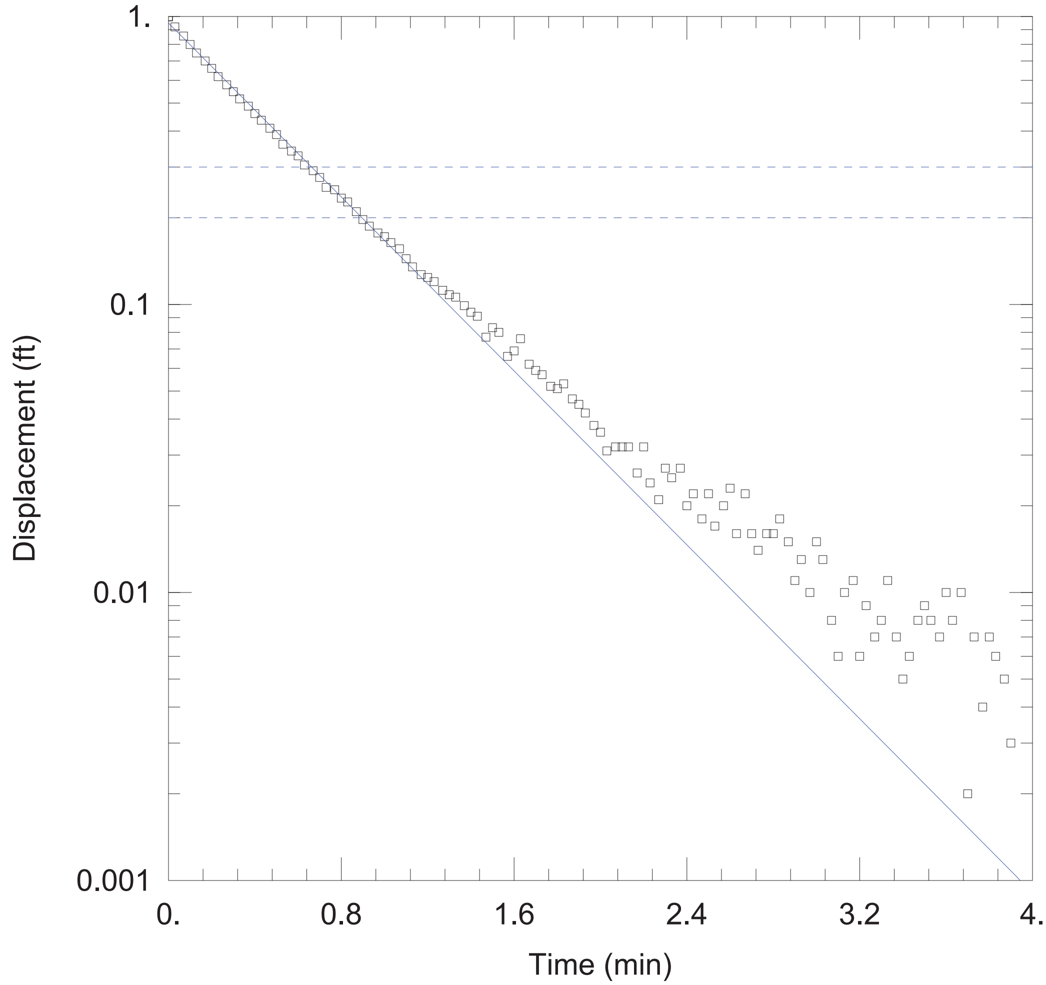
WELL DATA (G-10 (test 2 slug-out))

Initial Displacement: 0.71 ft Static Water Column Height: 10.73 ft
Total Well Penetration Depth: 10.73 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0004838 cm/sec y0 = 0.662 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-10 test 3 (slug-in) BR.aqt
Date: 04/09/21 Time: 14:44:50

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-10

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 0.1

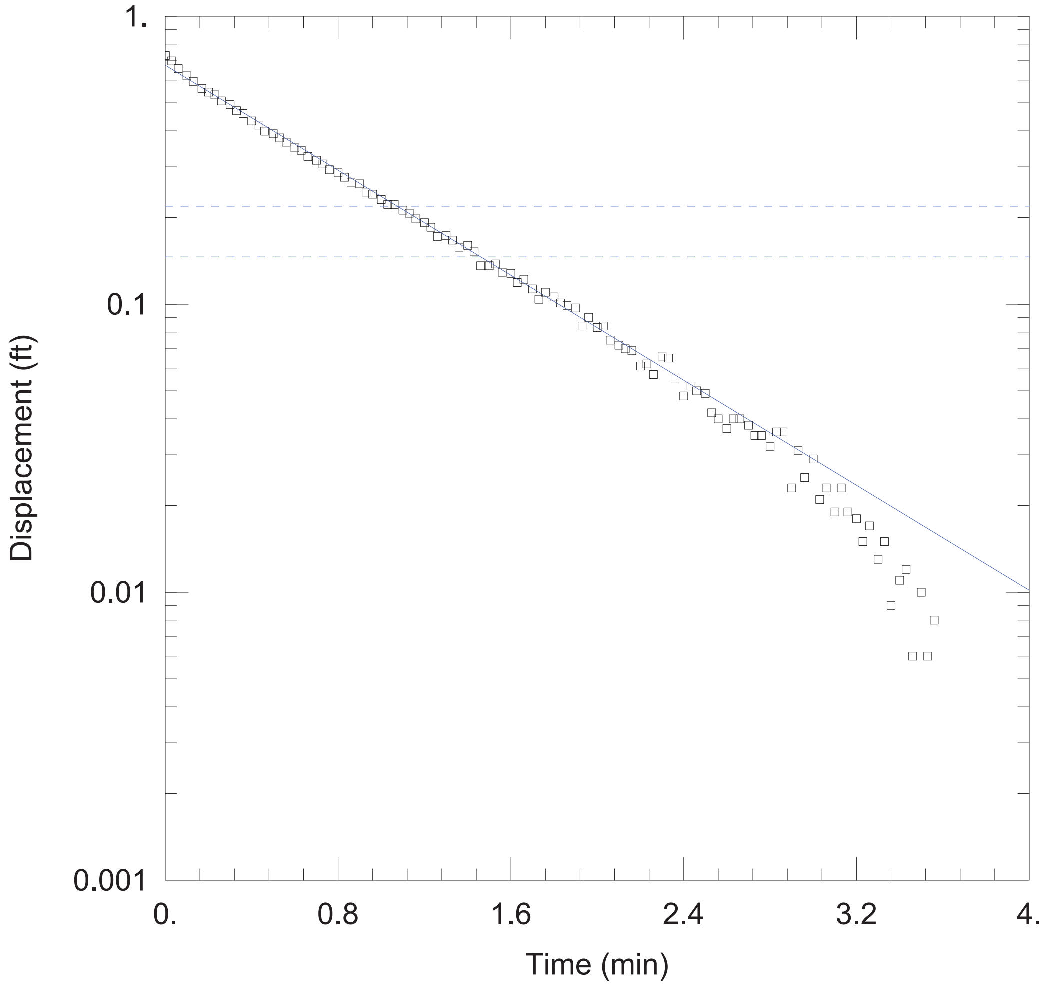
WELL DATA (G-10 (test 3 slug-in))

Initial Displacement: 1. ft Static Water Column Height: 10.73 ft
Total Well Penetration Depth: 10.73 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0008689 cm/sec y0 = 0.9483 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-10 test 4 (slug-out) BR.aqt
Date: 04/09/21 Time: 14:46:31

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-10

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 0.1

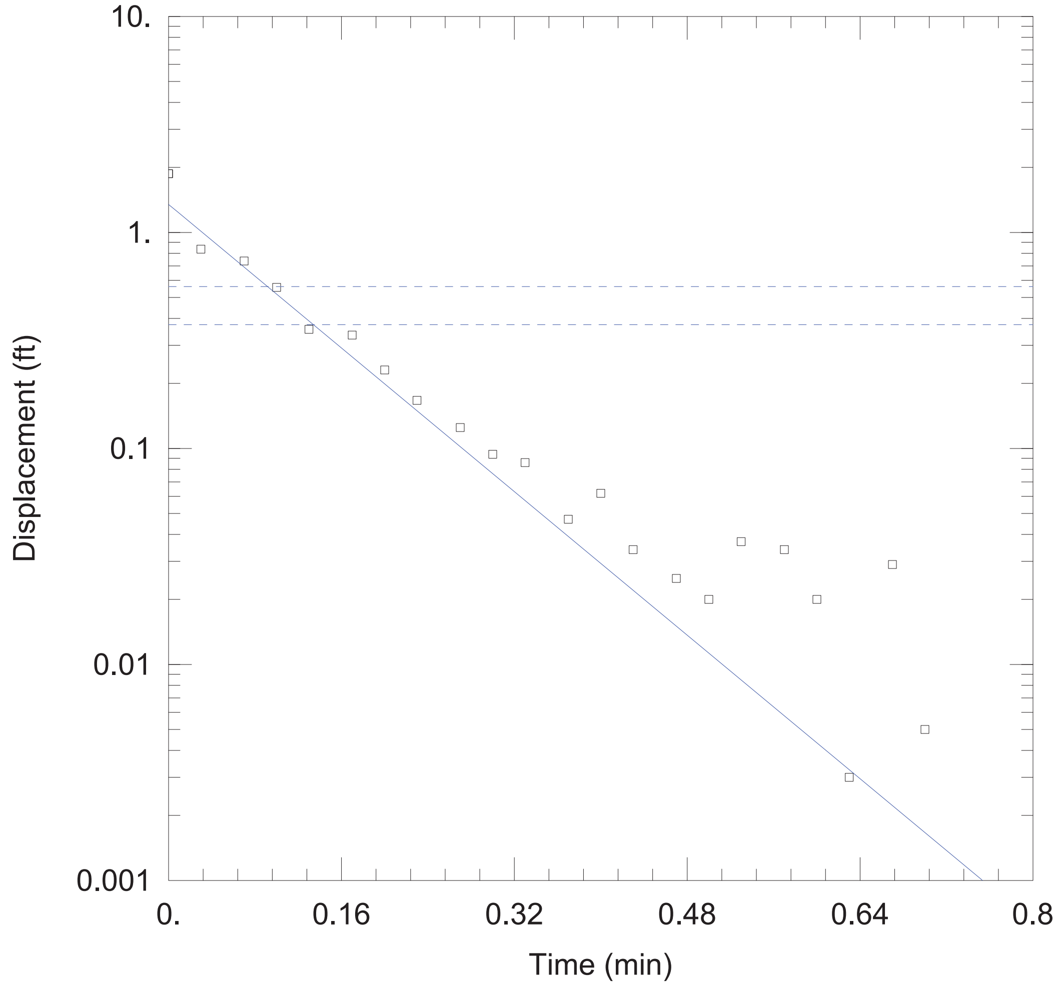
WELL DATA (G-10 (test 4 slug-out))

Initial Displacement: 0.73 ft
Total Well Penetration Depth: 10.73 ft
Casing Radius: 0.083 ft
Static Water Column Height: 10.73 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0005246 cm/sec
y0 = 0.6756 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-11 test 1 (slug-in) BR.aqt
Date: 04/09/21 Time: 15:09:34

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-11

AQUIFER DATA

Saturated Thickness: 13. ft Anisotropy Ratio (Kz/Kr): 0.1

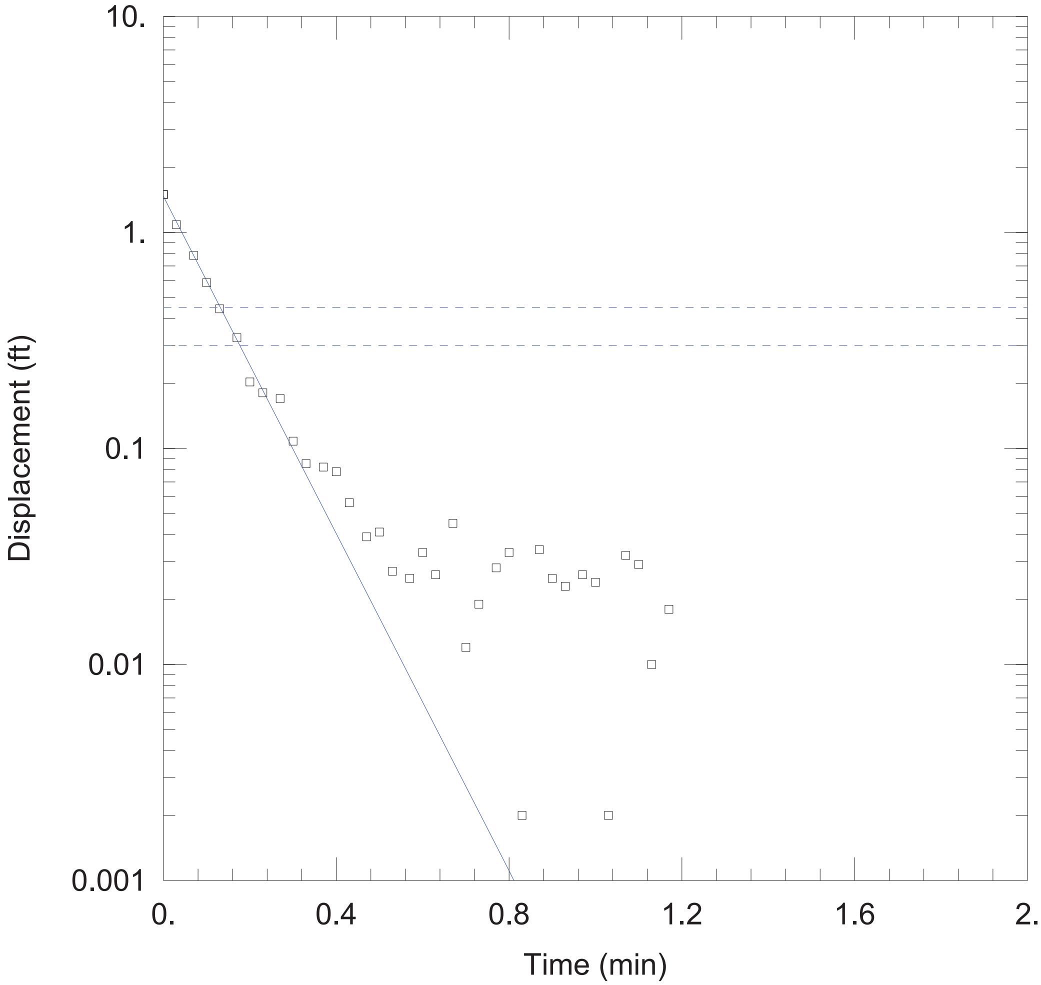
WELL DATA (G-11 (test 1 slug-in))

Initial Displacement: 1.87 ft
Total Well Penetration Depth: 23.2 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.2 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.007151 cm/sec y0 = 1.348 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-11 test 2 (slug-out) BR.aqt
Date: 04/09/21
Time: 15:11:32

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-11

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 0.1

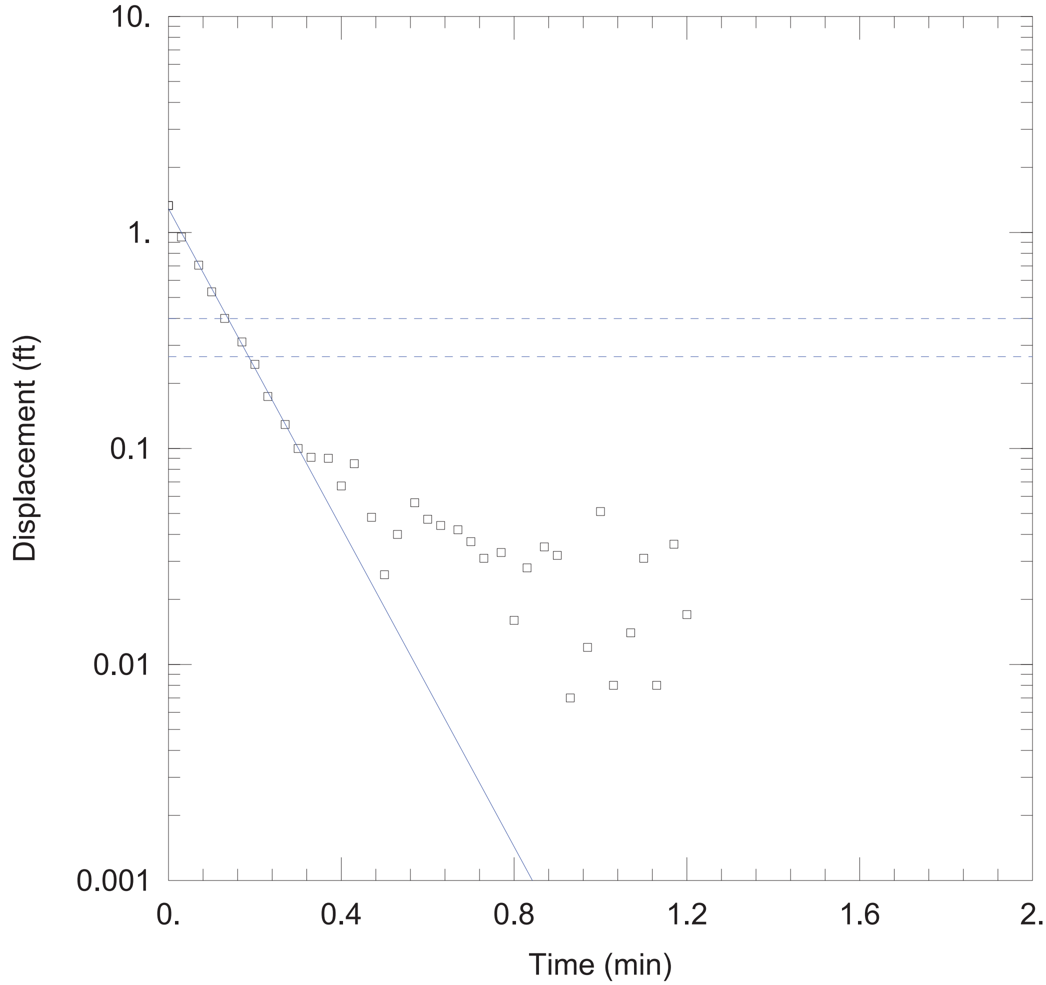
WELL DATA (G-11 (test 2 slug-out))

Initial Displacement: 1.5 ft
Static Water Column Height: 23.2 ft
Total Well Penetration Depth: 23.2 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.006716 cm/sec
y0 = 1.466 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-11 test 3 (slug-in) BR.aqt
Date: 04/09/21 Time: 15:15:17

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-11

AQUIFER DATA

Saturated Thickness: 13. ft Anisotropy Ratio (Kz/Kr): 0.1

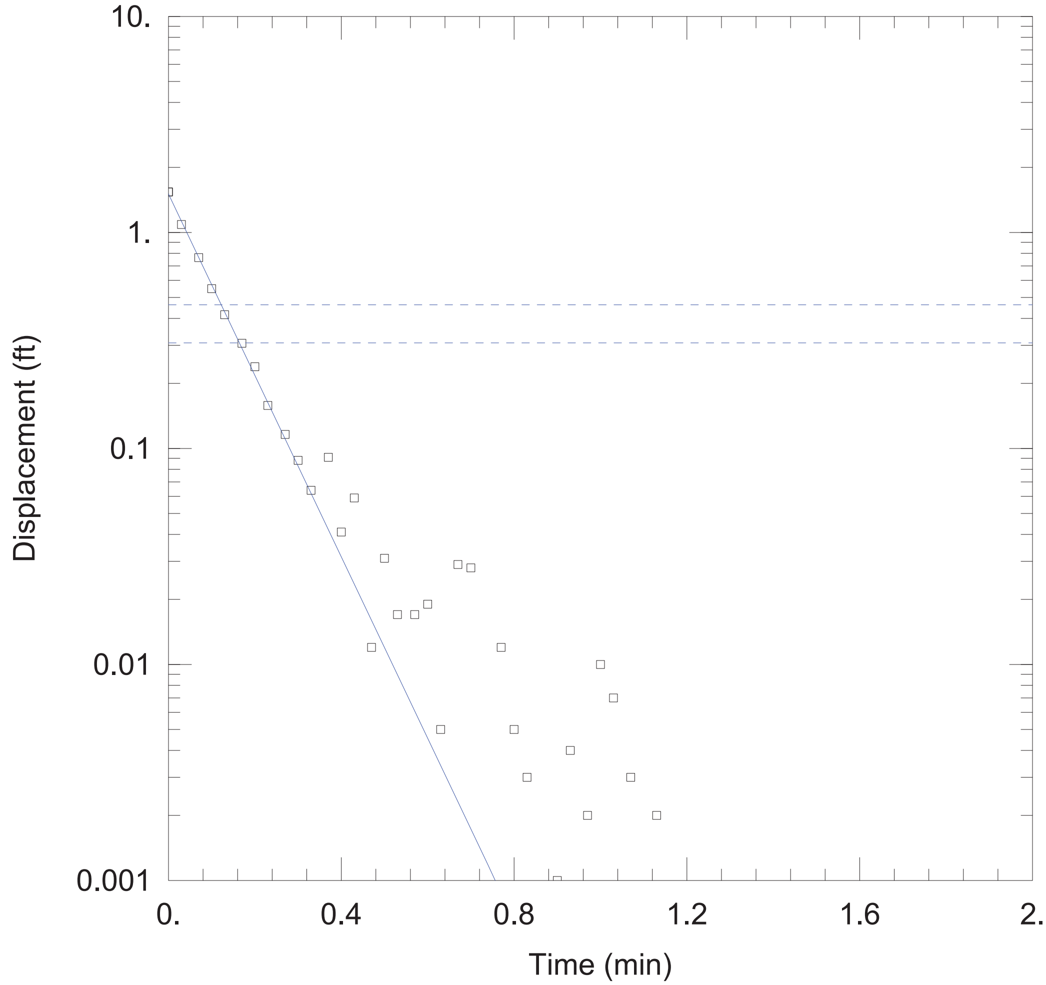
WELL DATA (G-11 (test 3 slug-in))

Initial Displacement: 1.33 ft
Total Well Penetration Depth: 23.2 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.2 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.006355 cm/sec y0 = 1.288 ft



WELL TEST ANALYSIS

Data Set: P:\...\G-11 test 4 (slug-out) BR.aqt
Date: 04/09/21 Time: 15:19:03

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: G-11

AQUIFER DATA

Saturated Thickness: 13. ft Anisotropy Ratio (Kz/Kr): 0.1

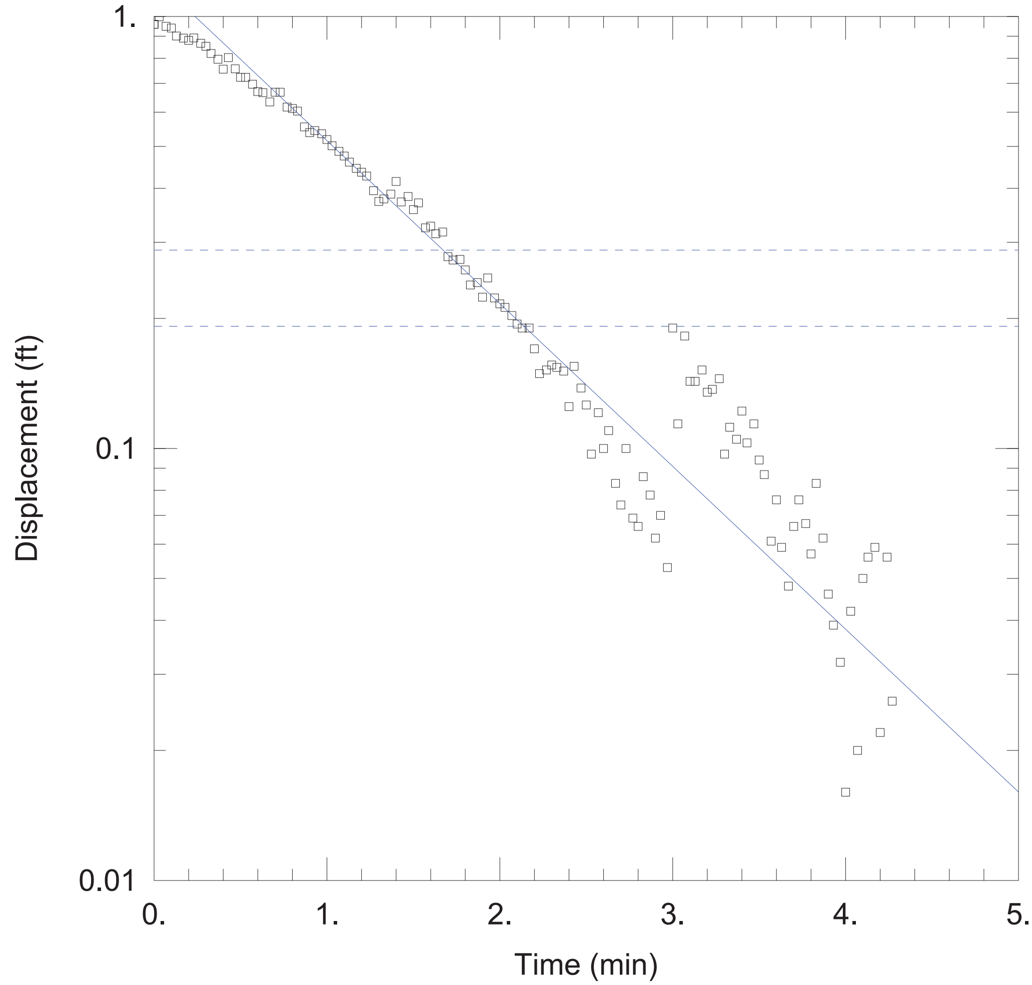
WELL DATA (G-11 (test 4 slug-out))

Initial Displacement: 1.54 ft Static Water Column Height: 23.2 ft
Total Well Penetration Depth: 23.2 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.007229 cm/sec y0 = 1.506 ft



TEST 1 SLUG IN

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G09M test 1 (Slug-in).aqt
Date: 03/31/21 Time: 08:32:59

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa, IL
Test Well: G09M
Test Date: 2/26/2021

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

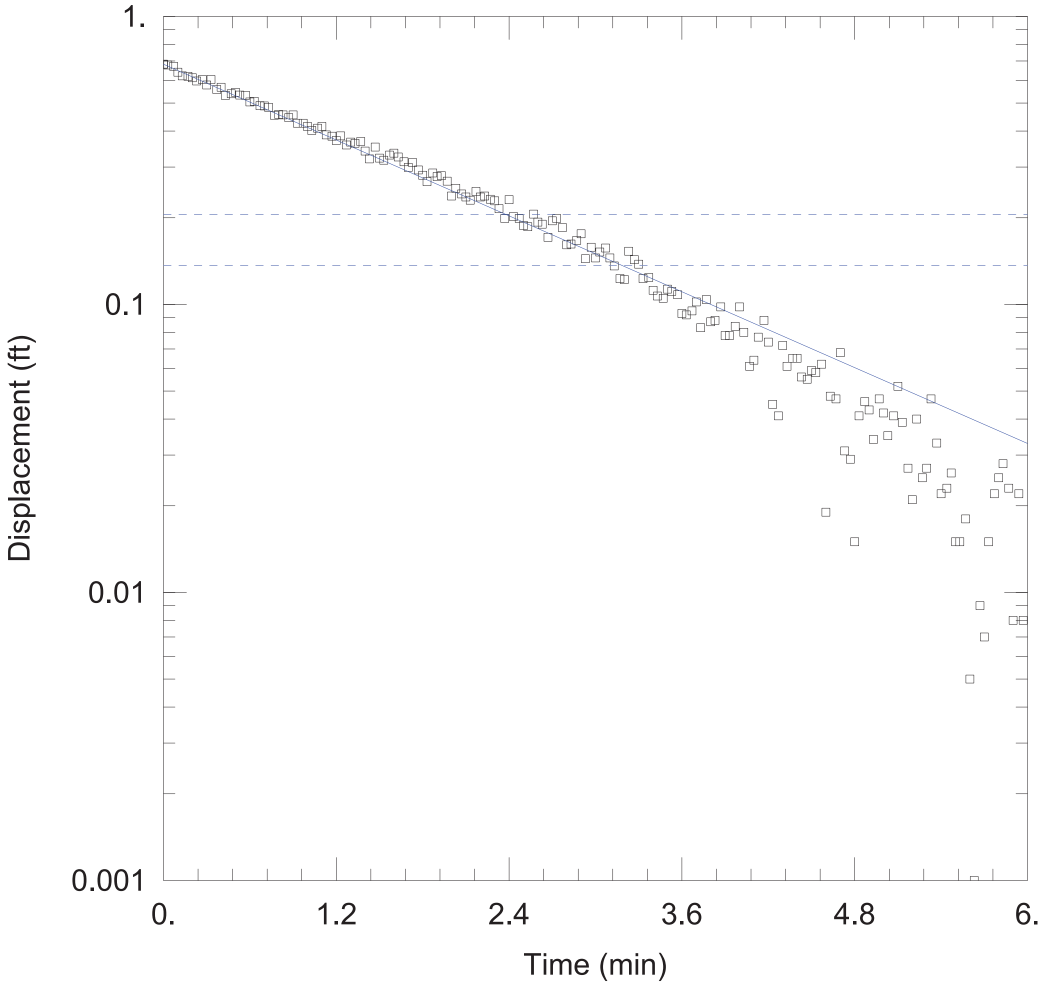
WELL DATA (G09M test 1 (Slug in))

Initial Displacement: 0.959 ft
Static Water Column Height: 127.8 ft
Total Well Penetration Depth: 127.8 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 1. ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0002725 cm/sec
y0 = 1.228 ft



TEST 1 SLUG IN

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G09M test 2 (Slug-out).aqt
Date: 03/31/21 Time: 08:41:16

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa, IL
Test Well: G09M
Test Date: 2/26/2021

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

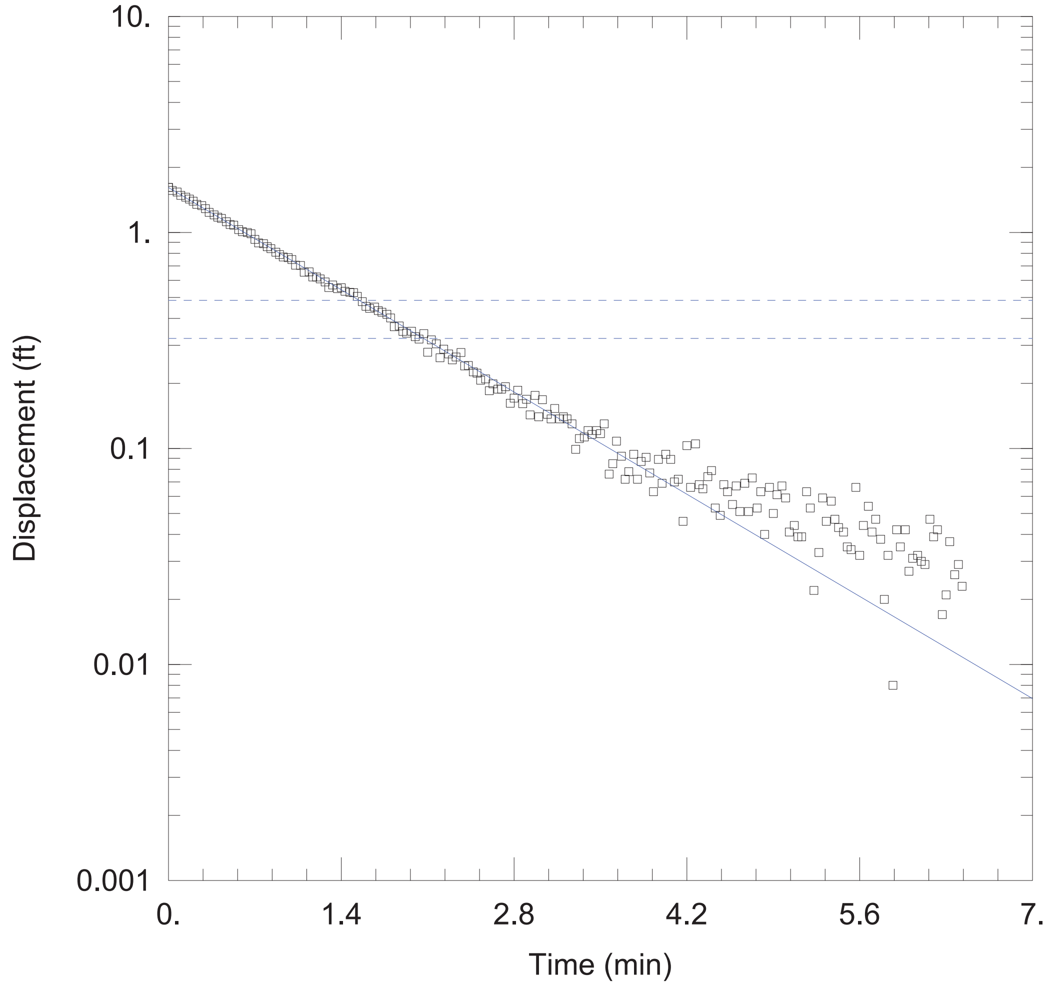
WELL DATA (G09M test 2 (Slug out))

Initial Displacement: 0.683 ft
Static Water Column Height: 127.8 ft
Total Well Penetration Depth: 127.8 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0003783 cm/sec
y0 = 0.6827 ft



TEST 1 SLUG IN

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G09M test 3 (Slug-in).aqt
Date: 03/31/21 Time: 08:44:06

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa, IL
Test Well: G09M
Test Date: 2/26/2021

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

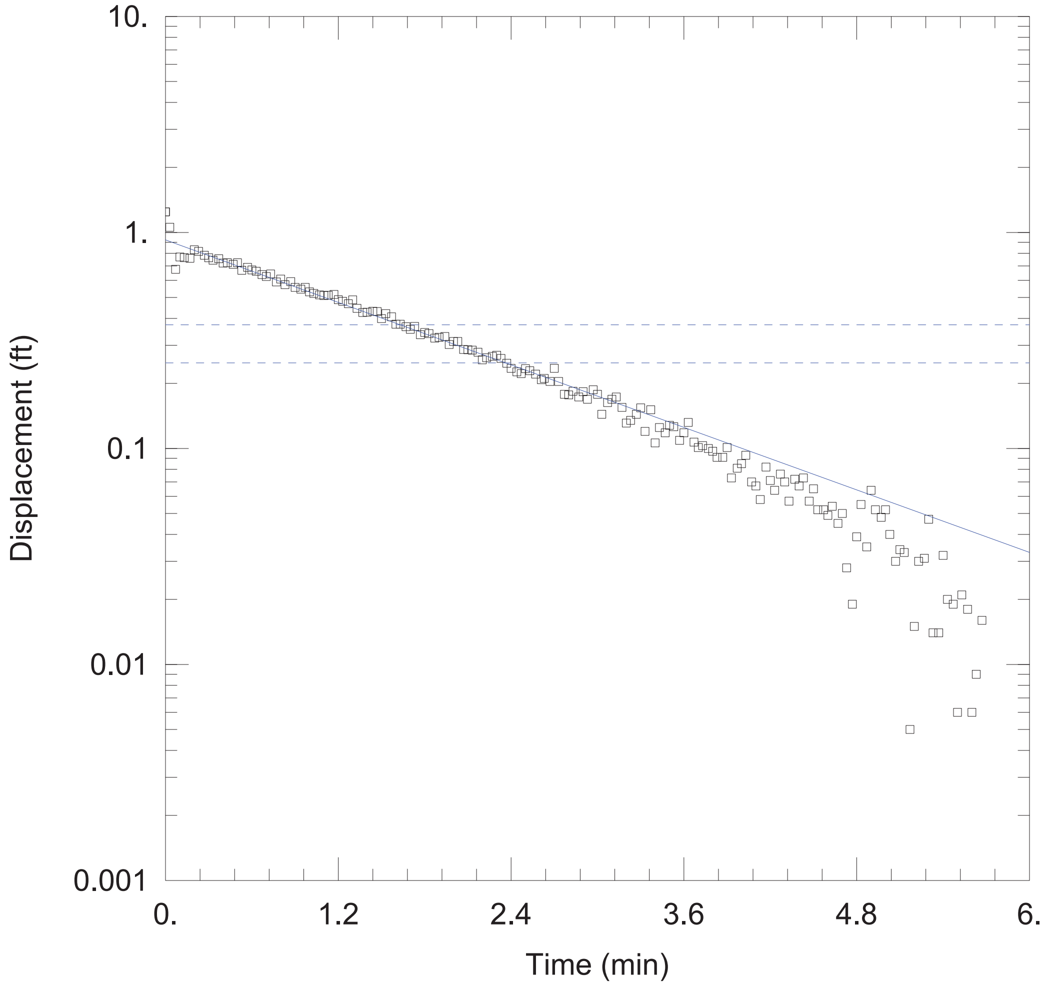
WELL DATA (G09M test 3 (Slug in))

Initial Displacement: 1.615 ft Static Water Column Height: 127.8 ft
Total Well Penetration Depth: 127.8 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0005824 cm/sec y0 = 1.613 ft



TEST 1 SLUG IN

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\G09M test 4 (Slug-out).aqt
Date: 03/31/21 Time: 08:48:06

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa, IL
Test Well: G09M
Test Date: 2/26/2021

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

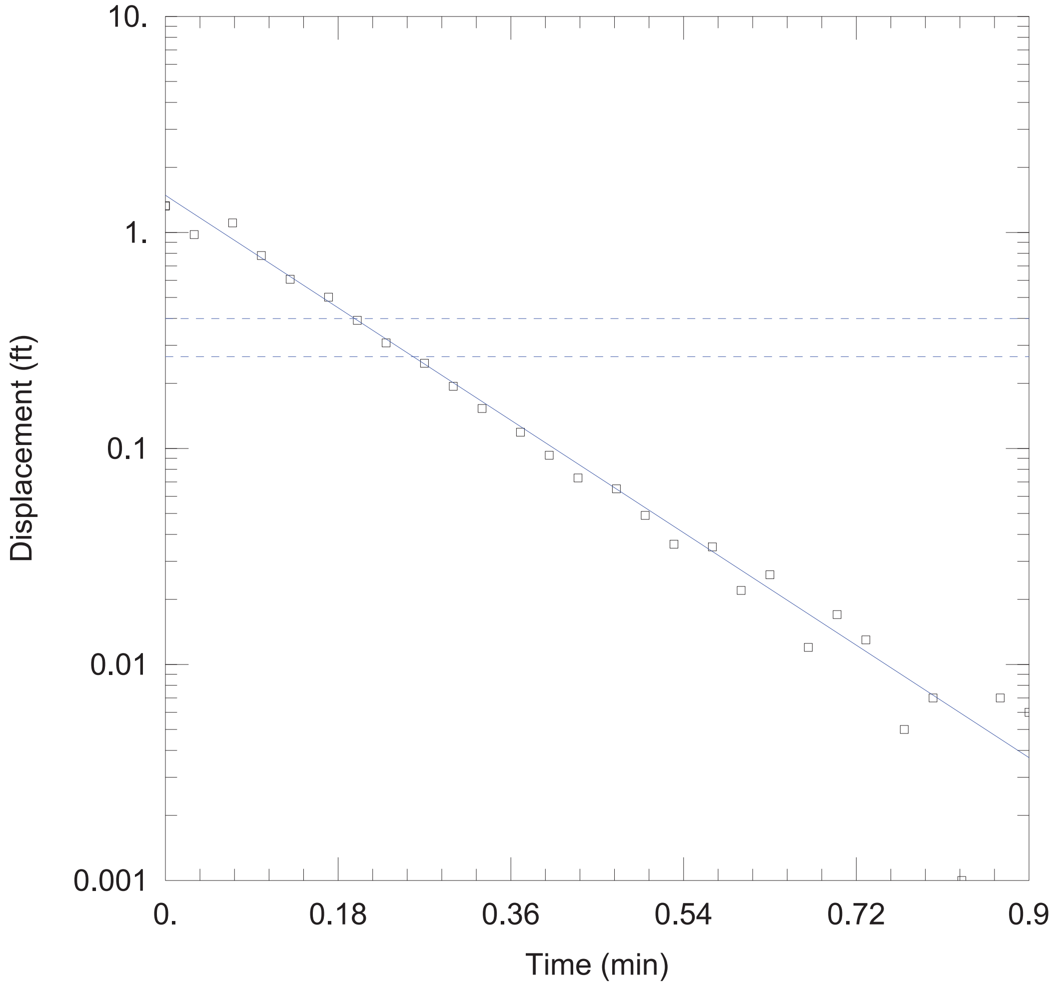
WELL DATA (G09M test 4 (Slug out))

Initial Displacement: 1.244 ft Static Water Column Height: 127.8 ft
Total Well Penetration Depth: 127.8 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0004155 cm/sec y0 = 0.9235 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\XPW-02 test 1 (slug-in) BR.aqt
Date: 03/31/21 Time: 11:03:08

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa Ash Pond
Test Well: XPW-02

AQUIFER DATA

Saturated Thickness: 25. ft Anisotropy Ratio (Kz/Kr): 0.1

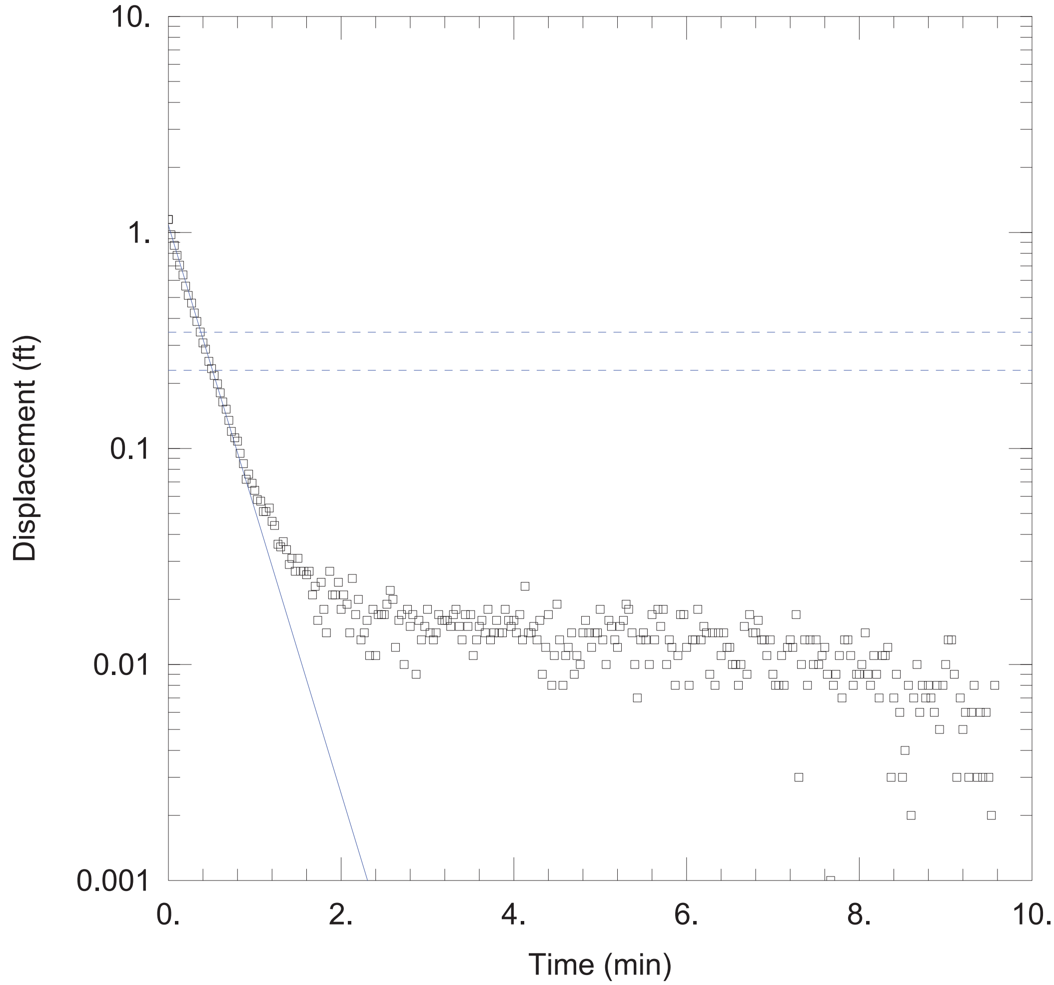
WELL DATA (XPW-02 ((test 1 slug-in))

Initial Displacement: 1.33 ft
Total Well Penetration Depth: 27.13 ft
Casing Radius: 0.083 ft
Static Water Column Height: 27.13 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.009817 cm/sec y0 = 1.486 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\XPW-02 test 2 (slug-out) BR.aqt
Date: 03/31/21 Time: 11:19:01

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa Ash Pond
Test Well: XPW-02

AQUIFER DATA

Saturated Thickness: 25. ft Anisotropy Ratio (Kz/Kr): 0.1

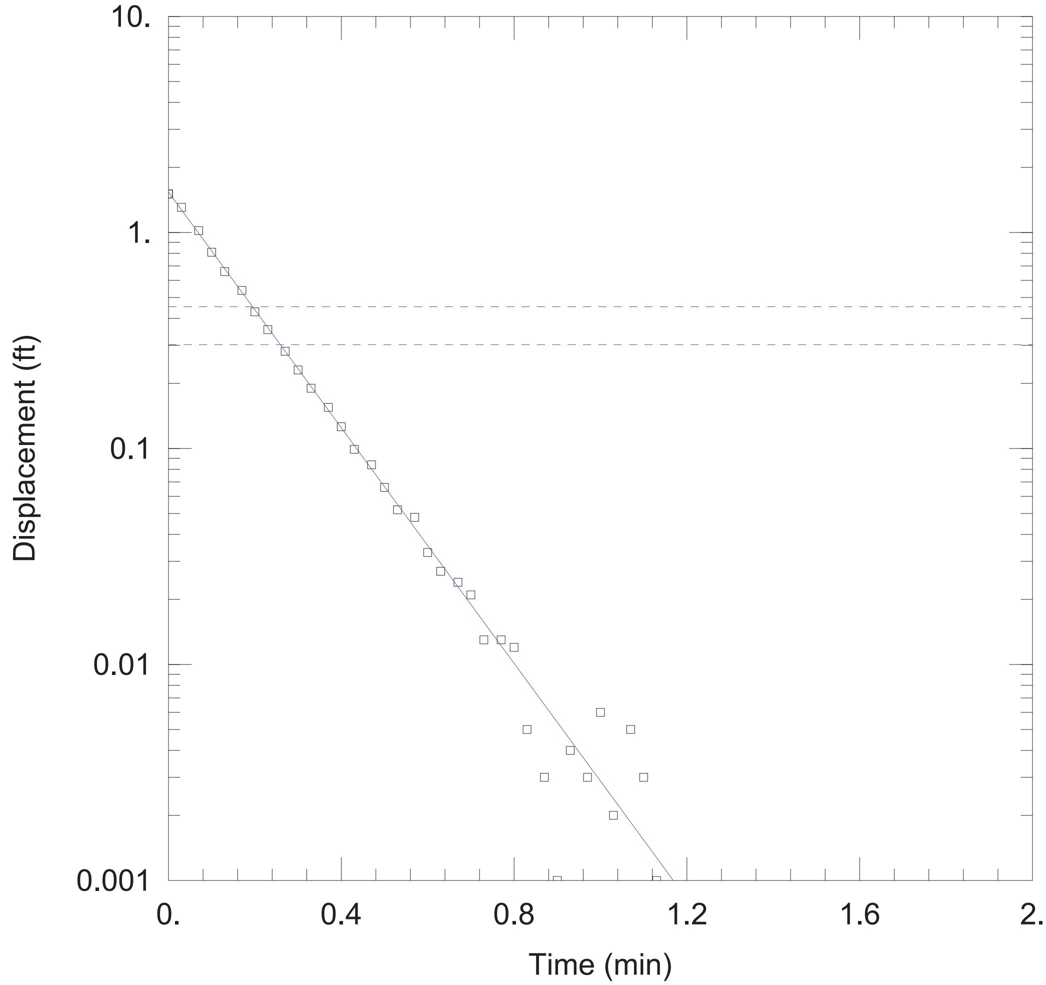
WELL DATA (XPW-02 ((test 2 slug-out))

Initial Displacement: 1.15 ft Static Water Column Height: 27.13 ft
Total Well Penetration Depth: 27.13 ft Screen Length: 5. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.004464 cm/sec y0 = 1.079 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\XPW-02 test 3 (slug-in) BR.aqt
Date: 03/31/21 Time: 11:22:08

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa Ash Pond
Test Well: XPW-02

AQUIFER DATA

Saturated Thickness: 25. ft Anisotropy Ratio (Kz/Kr): 0.1

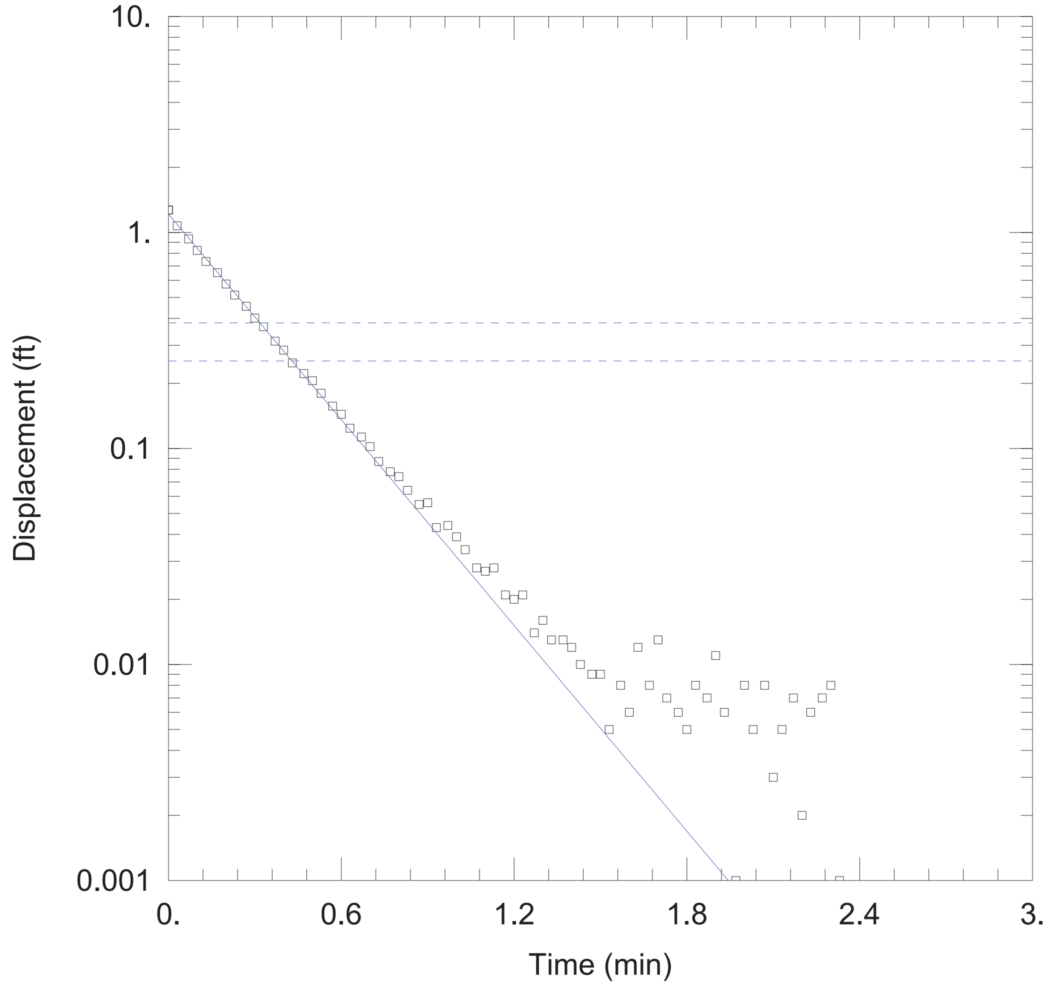
WELL DATA (XPW-02 ((test 3 slug-in))

Initial Displacement: 1.51 ft Static Water Column Height: 27.13 ft
Total Well Penetration Depth: 27.13 ft Screen Length: 5. ft
Casing Radius: 0.083 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.009254 cm/sec y0 = 1.537 ft



WELL TEST ANALYSIS

Data Set: C:\Users\kcarlton\Desktop\Joppa Slug Tests\XPW-02 test 4 (slug-out) BR.aqt
Date: 03/31/21 Time: 11:24:39

PROJECT INFORMATION

Company: Geosyntec
Location: Joppa Ash Pond
Test Well: XPW-02

AQUIFER DATA

Saturated Thickness: 25. ft Anisotropy Ratio (Kz/Kr): 0.1

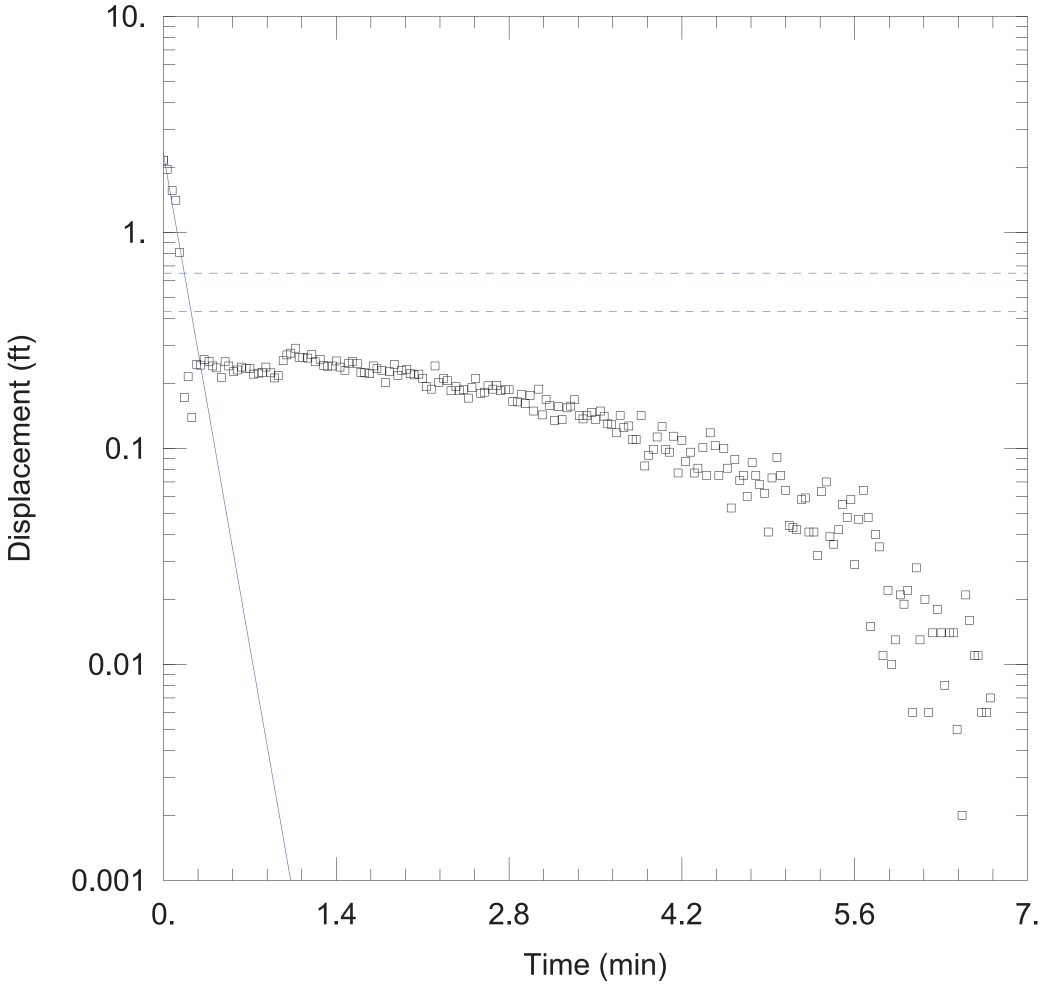
WELL DATA (XPW-02 ((test 4 slug-out))

Initial Displacement: 1.27 ft
Total Well Penetration Depth: 27.13 ft
Casing Radius: 0.083 ft
Static Water Column Height: 27.13 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.005386 cm/sec y0 = 1.217 ft



WELL TEST ANALYSIS

Data Set: P:\...\XPW-03 test 1 (slug-in) BR.aqt
Date: 04/09/21 Time: 13:57:26

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: XPW-03

AQUIFER DATA

Saturated Thickness: 31. ft
Anisotropy Ratio (Kz/Kr): 0.1

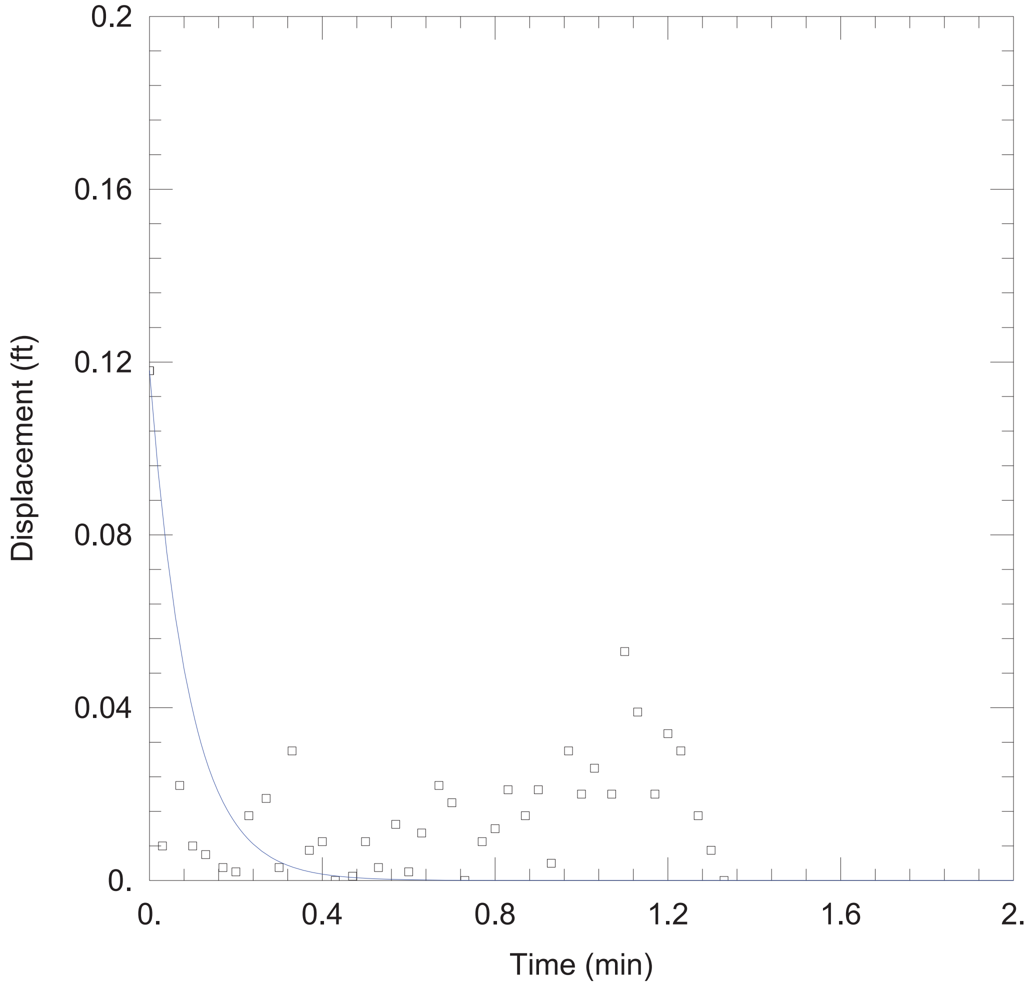
WELL DATA (XPW-03 (test 1 slug-in))

Initial Displacement: 2.159 ft
Static Water Column Height: 31.43 ft
Total Well Penetration Depth: 31.43 ft
Screen Length: 5. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.01129 cm/sec
y0 = 2.303 ft



WELL TEST ANALYSIS

Data Set: P:\...\XPW-03 test 2 (slug-out) BR.aqt
Date: 04/09/21 Time: 14:00:35

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: XPW-03

AQUIFER DATA

Saturated Thickness: 31. ft Anisotropy Ratio (Kz/Kr): 0.1

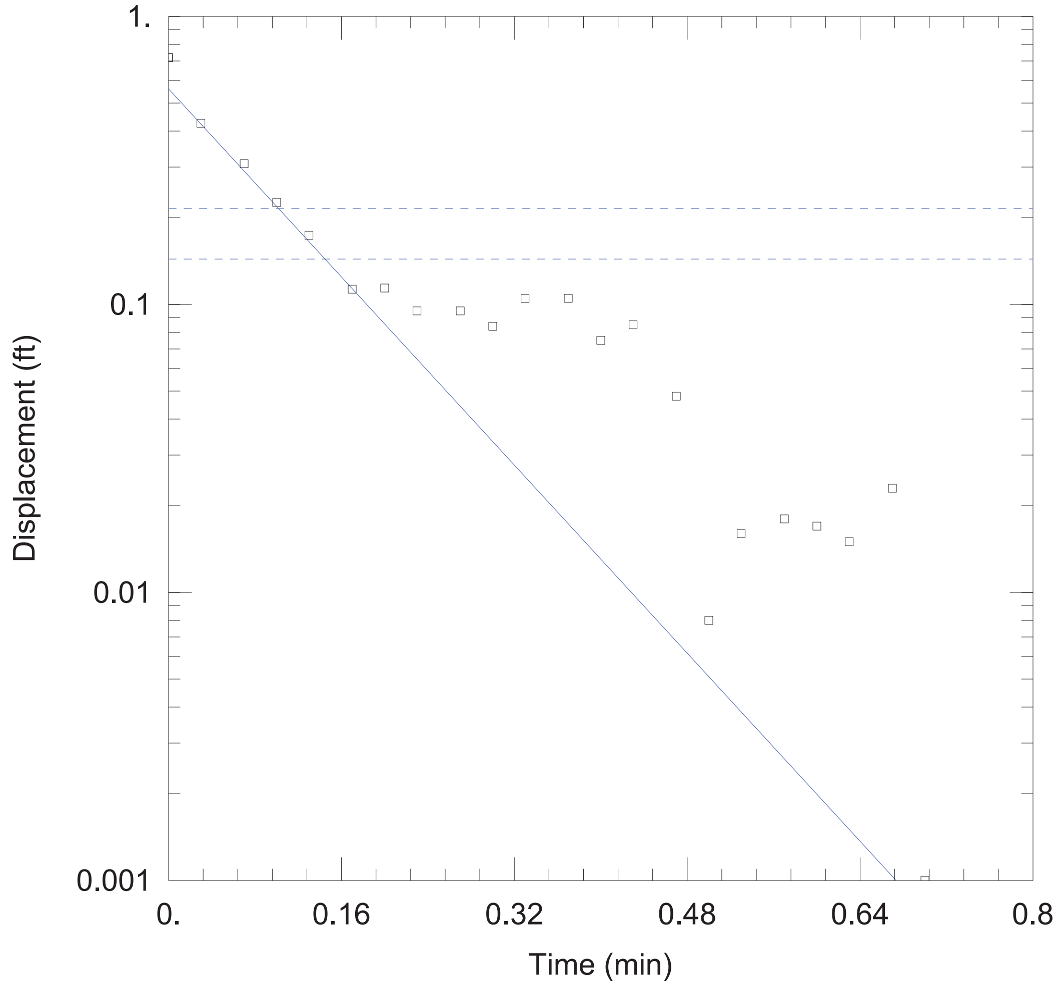
WELL DATA (XPW-03 (test 1 slug-in))

Initial Displacement: 0.118 ft
Total Well Penetration Depth: 31.43 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.43 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 0.01653 cm/sec Le = 0.1 ft



WELL TEST ANALYSIS

Data Set: P:\...\XPW-03 test 3 (slug-in) BR.aqt
Date: 04/09/21 Time: 14:04:42

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: XPW-03

AQUIFER DATA

Saturated Thickness: 31. ft Anisotropy Ratio (Kz/Kr): 0.1

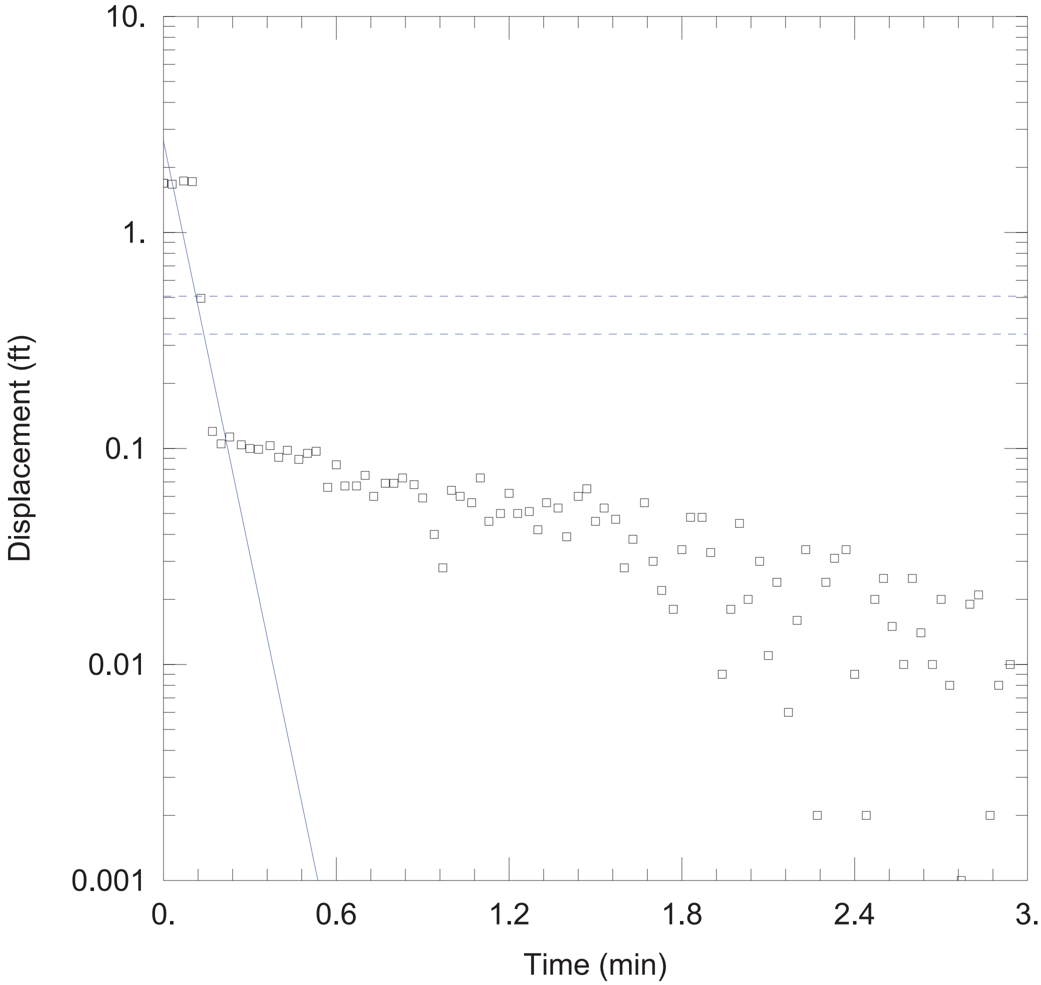
WELL DATA (XPW-03 (test 3 slug-out))

Initial Displacement: 0.719 ft
Total Well Penetration Depth: 31.43 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.43 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.01413 cm/sec y0 = 0.5601 ft



WELL TEST ANALYSIS

Data Set: P:\...\XPW-03 test 4 (slug-out) BR.aqt
Date: 04/09/21
Time: 14:07:51

PROJECT INFORMATION

Company: Geosyntec
Client: Vistra
Project: GLP8021
Location: Joppa Ash Pond
Test Well: XPW-03

AQUIFER DATA

Saturated Thickness: 31. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (XPW-03 (test 4 slug-out))

Initial Displacement: 1.69 ft
Static Water Column Height: 31.43 ft
Total Well Penetration Depth: 31.43 ft
Screen Length: 5. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

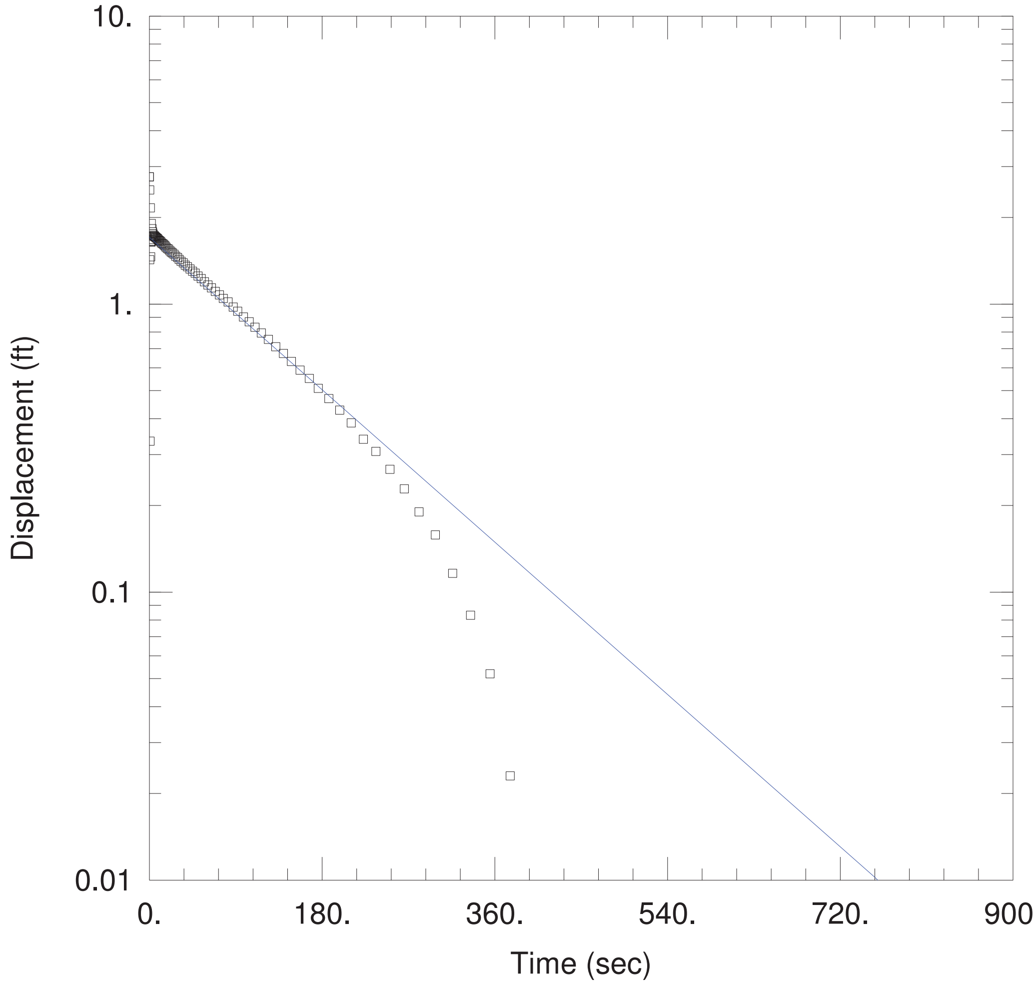
SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.02209 cm/sec
y0 = 2.648 ft

Table 1. Falling/Rising Head Test Results Summary
Joppa East Ash Pond
April 2017
Hydrogeologic Monitoring Plan

Location	Test Type	Slug Type	Number	K (cm/sec)
G01D	Falling Head	Slug In	1	1.33E-04
G01D	Rising Head	Slug Out	1	1.40E-04
G01D	Rising Head	Slug Out	2	1.08E-04
G01D	Rising Head	Slug Out	3	1.04E-04
G02D	Falling Head	Slug In	1	6.50E-04
G02D	Falling Head	Slug In	2	2.37E-05
G02D	Rising Head	Slug Out	2	7.23E-04
G02D	Rising Head	Slug Out	3	6.40E-04
G51D	Falling Head	Slug In	1	2.13E-04
G51D	Falling Head	Slug In	2	3.98E-04
G51D	Rising Head	Slug Out	1	2.35E-04
G51D	Rising Head	Slug Out	2	2.12E-04
G51D	Rising Head	Slug Out	3	2.30E-04
G52D	Rising Head	Slug Out	1	7.13E-08
G53D	Falling Head	Slug In	1	7.52E-04
G53D	Falling Head	Slug In	2	6.41E-04
G53D	Rising Head	Slug Out	1	5.17E-04
G53D	Rising Head	Slug Out	2	4.71E-04
G53D	Rising Head	Slug Out	3	4.57E-04
G54D	Falling Head	Slug In	1	9.93E-04
G54D	Falling Head	Slug In	2	9.04E-04
G54D	Rising Head	Slug Out	1	4.18E-04
G54D	Rising Head	Slug Out	2	8.93E-04
G54D	Rising Head	Slug Out	3	6.57E-04



G01D SI1

Data Set: P:\...\G01D Slug In 1.aqt
Date: 09/22/17
Time: 13:52:56

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G01D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 87.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G01D SI1)

Initial Displacement: 2.767 ft
Static Water Column Height: 10.08 ft
Total Well Penetration Depth: 9.55 ft
Screen Length: 9.55 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0001325 cm/sec
y0 = 1.704 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G01D SI1
Date: 09/22/17
Time: 13:54:26

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G01D

AQUIFER DATA

Saturated Thickness: 87.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G01D SI1

X Location: 831716.1 ft
Y Location: 202039.3 ft

Initial Displacement: 2.767 ft
Static Water Column Height: 10.08 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.55 ft
Total Well Penetration Depth: 9.55 ft

No. of Observations: 102

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.767	47.96	1.279
0.406	2.489	50.96	1.25
0.53	1.426	54.14	1.227
0.75	0.334	57.5	1.195
1.	2.158	61.1	1.164
1.406	1.646	64.7	1.137
1.53	1.457	68.9	1.106
1.75	1.639	73.1	1.075
2.	1.904	77.3	1.045
2.353	1.676	82.1	1.016
2.5	1.653	87.5	0.976
2.75	1.828	92.3	0.943
3.	1.753	98.3	0.902
3.25	1.723	104.3	0.868
3.5	1.782	110.3	0.83
3.86	1.724	116.9	0.794
4.22	1.749	124.1	0.754
4.64	1.728	131.9	0.71
5.06	1.725	139.7	0.674
5.48	1.723	148.1	0.631
5.96	1.713	157.1	0.59
6.5	1.708	166.7	0.551
6.98	1.703	176.3	0.509
7.58	1.694	187.1	0.47
8.18	1.69	198.5	0.428
8.78	1.685	210.5	0.387
9.44	1.669	223.1	0.339
10.16	1.663	236.3	0.308
10.94	1.656	250.7	0.267
11.72	1.649	265.7	0.228

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
12.56	1.631	281.3	0.19
13.46	1.622	298.1	0.158
14.42	1.615	316.1	0.116
15.38	1.602	334.7	0.083
16.46	1.591	355.1	0.052
17.6	1.576	376.1	0.023
18.8	1.559	398.3	0.
20.06	1.549	422.3	-0.026
21.38	1.53	447.5	-0.056
22.82	1.515	473.9	-0.077
24.32	1.505	502.1	-0.092
25.88	1.489	532.1	-0.111
27.56	1.465	563.9	-0.125
29.36	1.451	597.5	-0.138
31.22	1.429	633.5	-0.155
33.26	1.407	669.5	-0.162
35.36	1.389	711.5	-0.178
37.58	1.366	753.5	-0.182
39.98	1.347	795.5	-0.193
42.5	1.324	843.5	-0.195
45.14	1.3	897.5	-0.196

SOLUTION

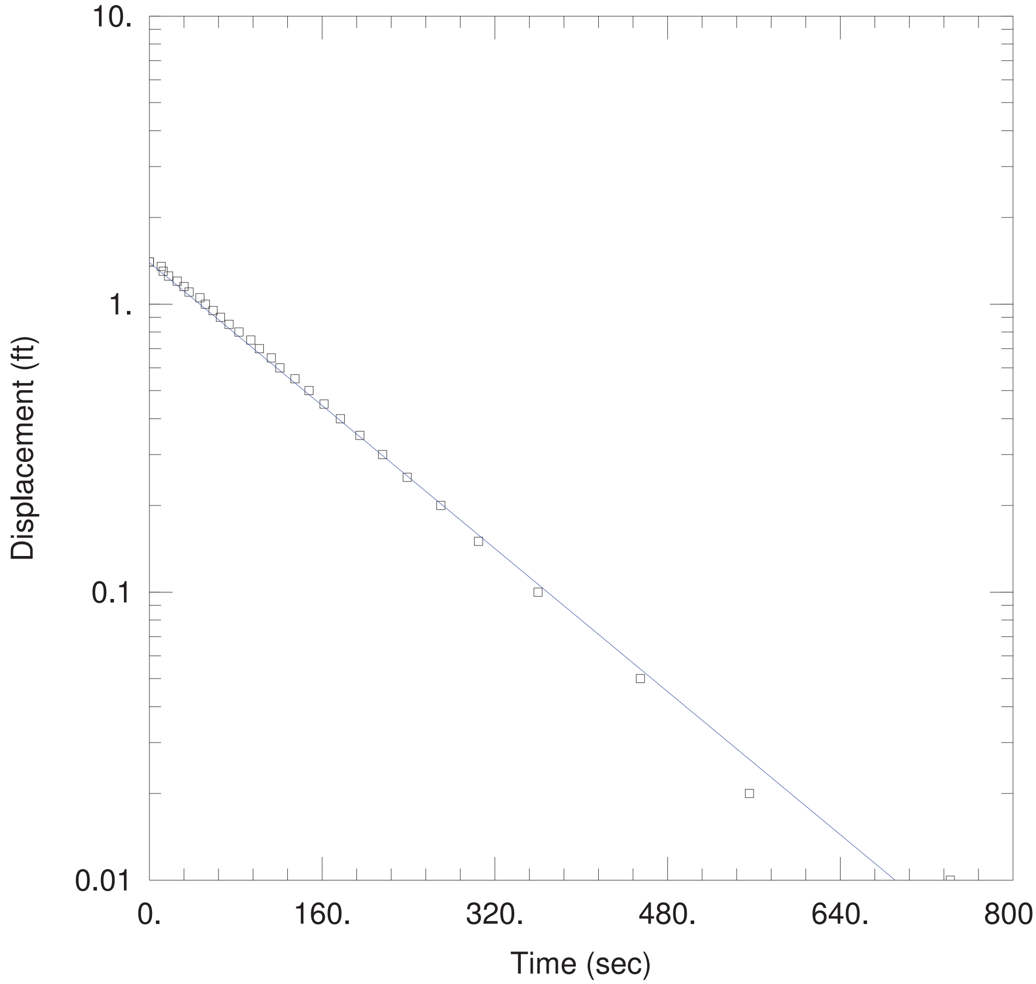
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.03

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0001325	cm/sec
y0	1.704	ft

T = K*b = 0.3522 cm²/sec



G01D SO1

Data Set: P:\...\G01D Slug Out 1.aqt
Date: 09/22/17 Time: 13:57:51

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G01D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 87.2 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G01D SO1)

Initial Displacement: 1.4 ft
Total Well Penetration Depth: 9.55 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.08 ft
Screen Length: 9.55 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0001399 cm/sec y0 = 1.394 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G01D SO1
Date: 09/22/17
Time: 13:58:33

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G01D

AQUIFER DATA

Saturated Thickness: 87.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G01D SO1

X Location: 831716.1 ft
Y Location: 202039.3 ft

Initial Displacement: 1.4 ft
Static Water Column Height: 10.08 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.55 ft
Total Well Penetration Depth: 9.55 ft

No. of Observations: 31

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.4	121.	0.6
11.	1.35	135.	0.55
13.	1.3	148.	0.5
18.	1.25	162.	0.45
26.	1.2	177.	0.4
32.	1.15	195.	0.35
37.	1.1	216.	0.3
47.	1.05	239.	0.25
52.	1.	270.	0.2
59.	0.95	305.	0.15
66.	0.9	360.	0.1
74.	0.85	455.	0.05
83.	0.8	556.	0.02
94.	0.75	742.	0.01
102.	0.7	796.	0.
113.	0.65		

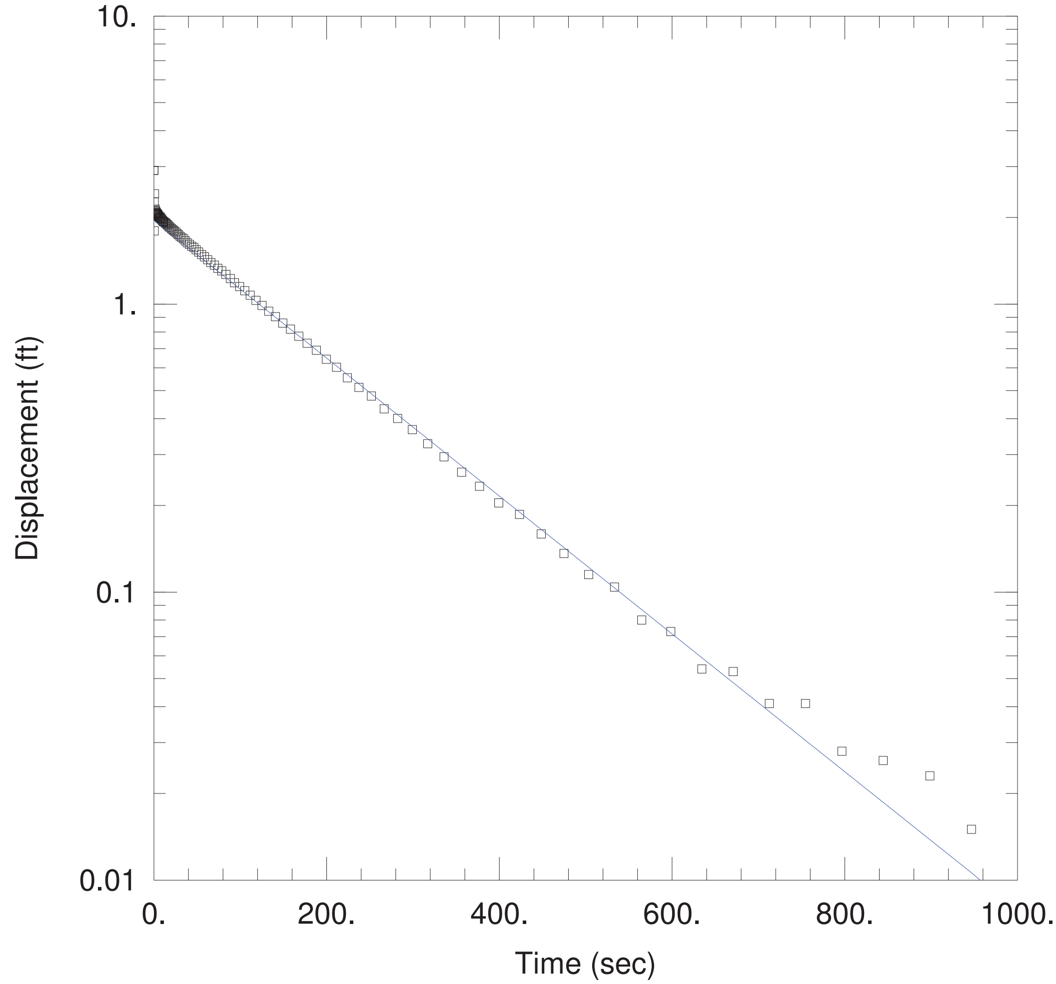
SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.03

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0001399	cm/sec



G01D SO2

Data Set: P:\...\G01D Slug Out 2.aqt
Date: 09/22/17 Time: 14:02:09

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G01D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 87.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G01D SO2)

Initial Displacement: 2.908 ft
Total Well Penetration Depth: 9.55 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.08 ft
Screen Length: 9.55 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0001079 cm/sec
y0 = 1.953 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G01D SO2
Date: 09/22/17
Time: 14:02:37

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G01D

AQUIFER DATA

Saturated Thickness: 87.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G01D SO2

X Location: 831716.1 ft
Y Location: 202039.3 ft

Initial Displacement: 2.908 ft
Static Water Column Height: 10.08 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.55 ft
Total Well Penetration Depth: 9.55 ft

No. of Observations: 108

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.908	43.75	1.588
0.408	1.793	46.39	1.57
0.531	2.266	49.21	1.541
0.75	2.416	52.21	1.515
1.	2.053	55.39	1.486
1.405	2.106	58.75	1.459
1.528	2.079	62.35	1.427
1.75	2.137	65.95	1.394
2.	2.073	70.15	1.366
2.405	2.1	74.35	1.329
2.528	2.071	78.55	1.303
2.75	2.073	83.35	1.267
3.	2.062	88.75	1.225
3.25	2.075	93.55	1.185
3.5	2.037	99.55	1.149
3.75	2.05	105.6	1.111
4.	2.058	111.6	1.072
4.25	2.051	118.2	1.03
4.5	2.012	125.3	0.989
4.75	2.048	133.2	0.943
5.11	2.017	140.9	0.904
5.471	2.027	149.3	0.859
5.89	2.025	158.3	0.818
6.31	2.	167.9	0.773
6.73	1.991	177.6	0.731
7.21	2.008	188.3	0.691
7.75	1.985	199.8	0.643
8.23	1.988	211.8	0.603
8.83	1.973	224.3	0.555
9.43	1.964	237.6	0.514

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
10.03	1.949	251.9	0.479
10.69	1.941	266.9	0.433
11.41	1.933	282.6	0.401
12.19	1.929	299.4	0.366
12.97	1.919	317.4	0.327
13.81	1.908	335.9	0.295
14.71	1.9	356.4	0.261
15.67	1.883	377.4	0.233
16.63	1.879	399.6	0.204
17.71	1.856	423.6	0.186
18.85	1.851	448.8	0.159
20.05	1.832	475.1	0.136
21.31	1.817	503.4	0.115
22.63	1.803	533.4	0.104
24.07	1.79	565.1	0.08
25.57	1.774	598.8	0.073
27.13	1.755	634.8	0.054
28.81	1.742	670.8	0.053
30.61	1.72	712.8	0.041
32.47	1.7	754.8	0.041
34.51	1.682	796.8	0.028
36.61	1.656	844.8	0.026
38.83	1.631	898.8	0.023
41.23	1.61	946.8	0.015

SOLUTION

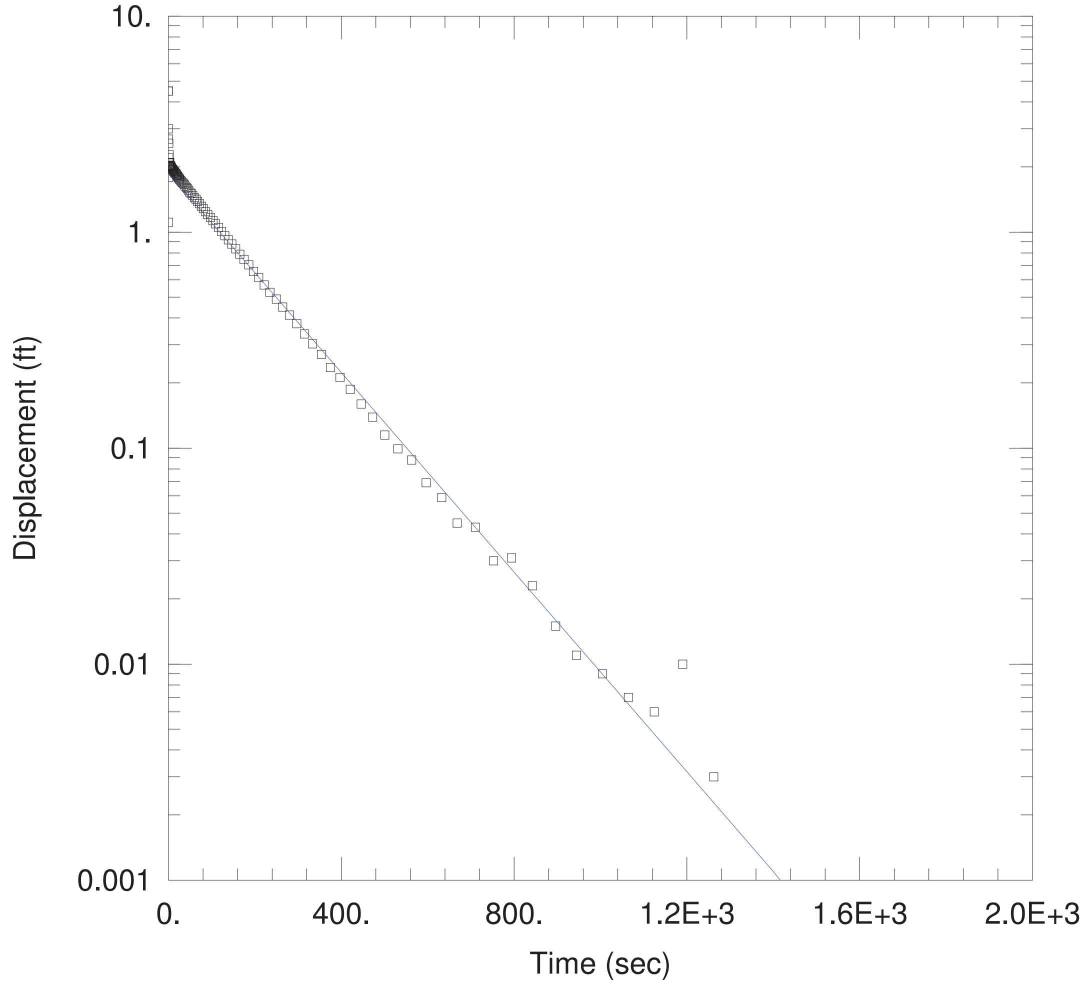
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.03

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0001079	cm/sec
y0	1.953	ft

T = K*b = 0.2868 cm^2/sec



G01D SO3

Data Set: P:\...\G01D Slug Out 3.aqt
Date: 09/22/17 Time: 14:04:38

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G01D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 87.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G01D SO3)

Initial Displacement: 4.498 ft
Static Water Column Height: 10.08 ft
Total Well Penetration Depth: 9.55 ft
Screen Length: 9.55 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0001041 cm/sec
y0 = 1.877 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G01D SO3
Date: 09/22/17
Time: 14:05:00

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G01D

AQUIFER DATA

Saturated Thickness: 87.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G01D SO3

X Location: 831716.1 ft
Y Location: 202039.3 ft

Initial Displacement: 4.498 ft
Static Water Column Height: 10.08 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.55 ft
Total Well Penetration Depth: 9.55 ft

No. of Observations: 105

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	4.498	63.8	1.417
0.124	2.694	68.	1.387
0.345	1.11	72.19	1.351
0.595	3.005	76.39	1.316
0.993	2.208	81.19	1.283
1.117	2.576	86.59	1.242
1.345	1.786	91.39	1.205
1.595	2.278	97.39	1.166
1.845	2.	103.4	1.128
2.095	2.092	109.4	1.091
2.345	2.094	116.	1.049
2.595	2.039	123.2	1.005
2.955	2.019	131.	0.962
3.315	2.1	138.8	0.92
3.735	2.034	147.2	0.879
4.155	2.034	156.2	0.836
4.575	2.017	165.8	0.79
5.055	2.033	175.4	0.748
5.595	2.012	186.2	0.704
6.075	2.005	197.6	0.657
6.675	1.983	209.6	0.616
7.275	1.991	222.2	0.568
7.875	1.969	235.4	0.525
8.535	1.962	249.8	0.49
9.255	1.946	264.8	0.45
10.04	1.944	280.4	0.412
10.82	1.944	297.2	0.376
11.65	1.916	315.2	0.337
12.56	1.924	333.8	0.304
13.52	1.902	354.2	0.271

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
14.48	1.892	375.2	0.236
15.56	1.879	397.4	0.212
16.7	1.872	421.4	0.187
17.9	1.856	446.6	0.16
19.16	1.84	473.	0.139
20.48	1.823	501.2	0.115
21.91	1.805	531.2	0.099
23.41	1.789	563.	0.088
24.98	1.772	596.6	0.069
26.66	1.754	632.6	0.059
28.45	1.735	668.6	0.045
30.32	1.718	710.6	0.043
32.35	1.696	752.6	0.03
34.45	1.681	794.6	0.031
36.67	1.66	842.6	0.023
39.08	1.633	896.6	0.015
41.59	1.611	944.6	0.011
44.23	1.589	1004.6	0.009
47.06	1.559	1064.6	0.007
50.06	1.527	1124.6	0.006
53.23	1.506	1190.6	0.01
56.59	1.476	1262.6	0.003
60.2	1.445		

SOLUTION

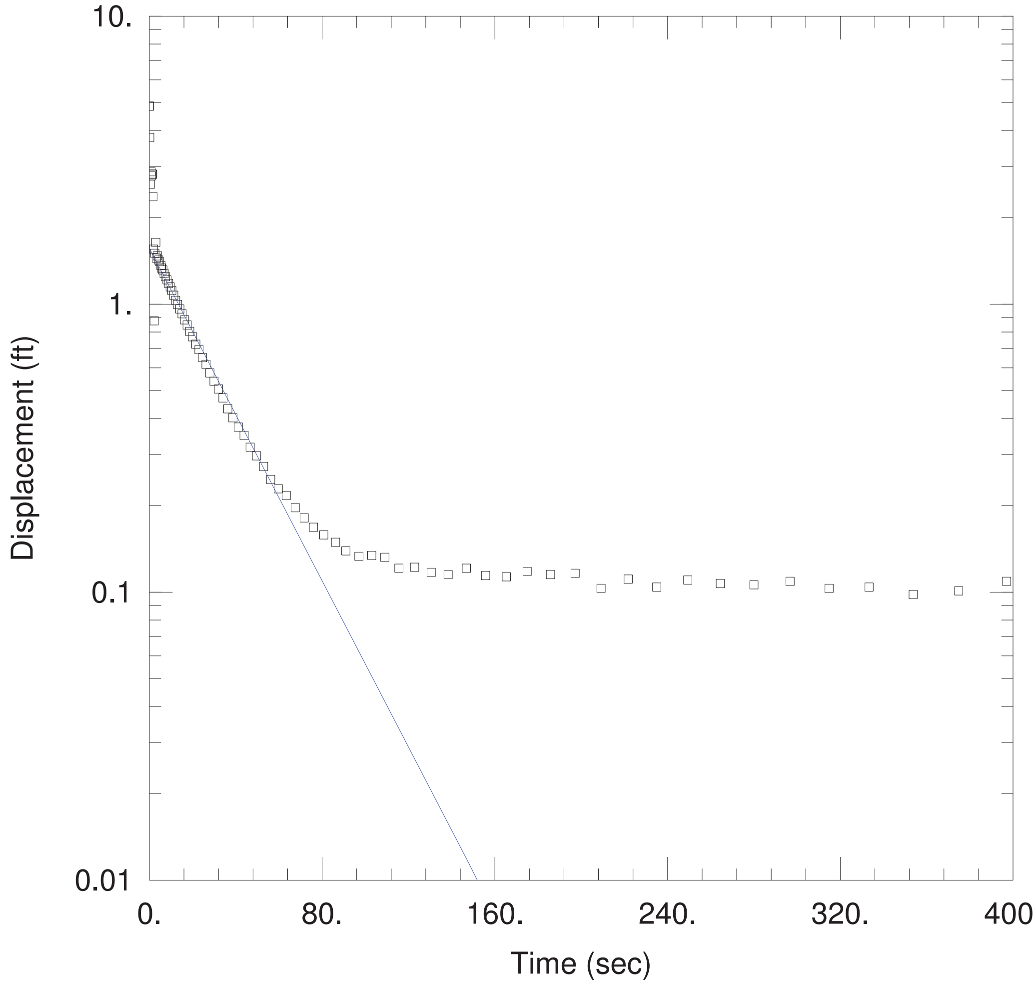
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.03

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0001041	cm/sec
y0	1.877	ft

T = K*b = 0.2768 cm²/sec



SLUG IN 1

Data Set: P:\...\G02D Slug In 1.aqt
Date: 09/22/17 Time: 14:07:01

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G02D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 78.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G02D SI1)

Initial Displacement: 4.872 ft
Static Water Column Height: 10.34 ft
Total Well Penetration Depth: 9.63 ft
Screen Length: 9.63 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0006495 cm/sec
y0 = 1.561 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug In 1
Date: 09/22/17
Time: 14:07:30

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G02D

AQUIFER DATA

Saturated Thickness: 78.8 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G02D SI1

X Location: 832843. ft
Y Location: 202137.1 ft

Initial Displacement: 4.872 ft
Static Water Column Height: 10.34 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.63 ft
Total Well Penetration Depth: 9.63 ft

No. of Observations: 83

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	4.872	36.33	0.433
0.25	3.788	38.73	0.403
0.5	2.61	41.25	0.374
0.75	2.883	43.89	0.35
1.	2.787	46.71	0.318
1.25	2.828	49.71	0.297
1.5	2.819	52.89	0.273
1.75	2.36	56.25	0.246
2.	1.55	59.85	0.228
2.25	0.874	63.45	0.216
2.609	1.501	67.65	0.196
2.97	1.638	71.85	0.181
3.39	1.445	76.05	0.168
3.809	1.468	80.85	0.158
4.408	1.42	86.25	0.149
4.71	1.403	91.05	0.139
5.339	1.362	97.05	0.133
5.729	1.332	103.	0.134
6.329	1.312	109.	0.132
6.93	1.278	115.6	0.121
7.529	1.245	122.8	0.122
8.189	1.213	130.6	0.117
8.91	1.179	138.4	0.115
9.689	1.147	146.8	0.121
10.47	1.114	155.8	0.114
11.31	1.074	165.4	0.113
12.21	1.03	175.	0.118
13.17	0.995	185.8	0.115
14.13	0.961	197.2	0.116
15.21	0.925	209.2	0.103

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
16.35	0.881	221.8	0.111
17.55	0.846	235.	0.104
18.81	0.804	249.4	0.11
20.13	0.769	264.4	0.107
21.57	0.726	280.	0.106
23.07	0.694	296.8	0.109
24.63	0.651	314.8	0.103
26.31	0.618	333.4	0.104
28.11	0.576	353.8	0.098
29.97	0.539	374.8	0.101
32.01	0.507	397.	0.109
34.11	0.472		

SOLUTION

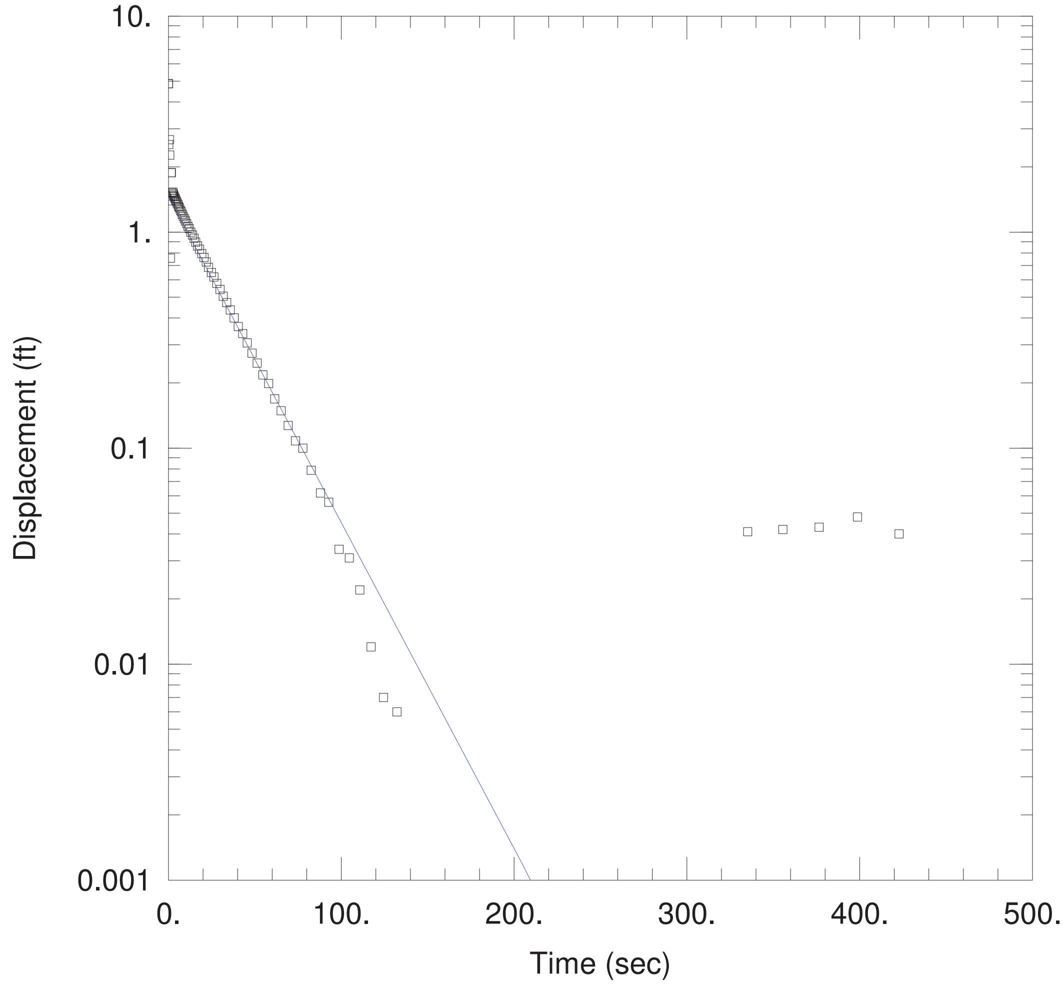
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.043

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0006495	cm/sec
y0	1.561	ft

T = K*b = 1.56 cm²/sec



SLUG IN 2

Data Set: P:\...\G02D Slug In 2.aqt
Date: 09/22/17 Time: 14:09:13

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G02D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 78.8 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G02D SI2)

Initial Displacement: 4.864 ft
Total Well Penetration Depth: 9.63 ft
Casing Radius: 0.03333 ft
Static Water Column Height: 10.34 ft
Screen Length: 9.63 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 2.373E-5 cm/sec y0 = 1.461 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug In 2
Date: 09/22/17
Time: 14:09:43

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G02D

AQUIFER DATA

Saturated Thickness: 78.8 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G02D SI2

X Location: 832843. ft
Y Location: 202137.1 ft

Initial Displacement: 4.864 ft
Static Water Column Height: 10.34 ft
Casing Radius: 0.03333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.63 ft
Total Well Penetration Depth: 9.63 ft

No. of Observations: 91

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	4.864	31.72	0.505
0.25	2.543	33.76	0.472
0.629	2.675	35.86	0.436
0.752	2.268	38.08	0.4
1.	1.396	40.48	0.365
1.25	0.756	43.	0.338
1.643	1.884	45.64	0.307
1.766	1.881	48.46	0.275
2.	1.526	51.46	0.247
2.25	1.469	54.64	0.218
2.639	1.529	58.	0.199
2.762	1.51	61.6	0.169
3.	1.488	65.2	0.149
3.251	1.468	69.41	0.127
3.5	1.46	73.6	0.108
3.75	1.435	77.8	0.1
4.	1.426	82.6	0.079
4.36	1.402	88.	0.062
4.72	1.383	92.8	0.056
5.14	1.361	98.8	0.034
5.56	1.337	104.8	0.031
5.979	1.313	110.8	0.022
6.46	1.292	117.4	0.012
7.	1.264	124.6	0.007
7.48	1.243	132.4	0.006
8.08	1.208	140.2	0.
8.68	1.18	148.6	-0.006
9.28	1.153	157.6	-0.012
9.939	1.124	167.2	-0.011
10.66	1.093	176.8	-0.011

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
11.44	1.062	187.6	-0.013
12.22	1.036	199.	-0.016
13.06	0.999	211.	-0.019
13.96	0.968	223.6	-0.023
14.92	0.937	236.8	-0.025
15.88	0.897	251.2	-0.027
16.96	0.863	266.2	-0.029
18.1	0.832	281.8	-0.029
19.3	0.795	298.6	-0.031
20.56	0.763	316.6	-0.025
21.88	0.728	335.2	0.041
23.32	0.687	355.6	0.042
24.82	0.65	376.6	0.043
26.38	0.619	398.8	0.048
28.06	0.578	422.8	0.04
29.86	0.542		

SOLUTION

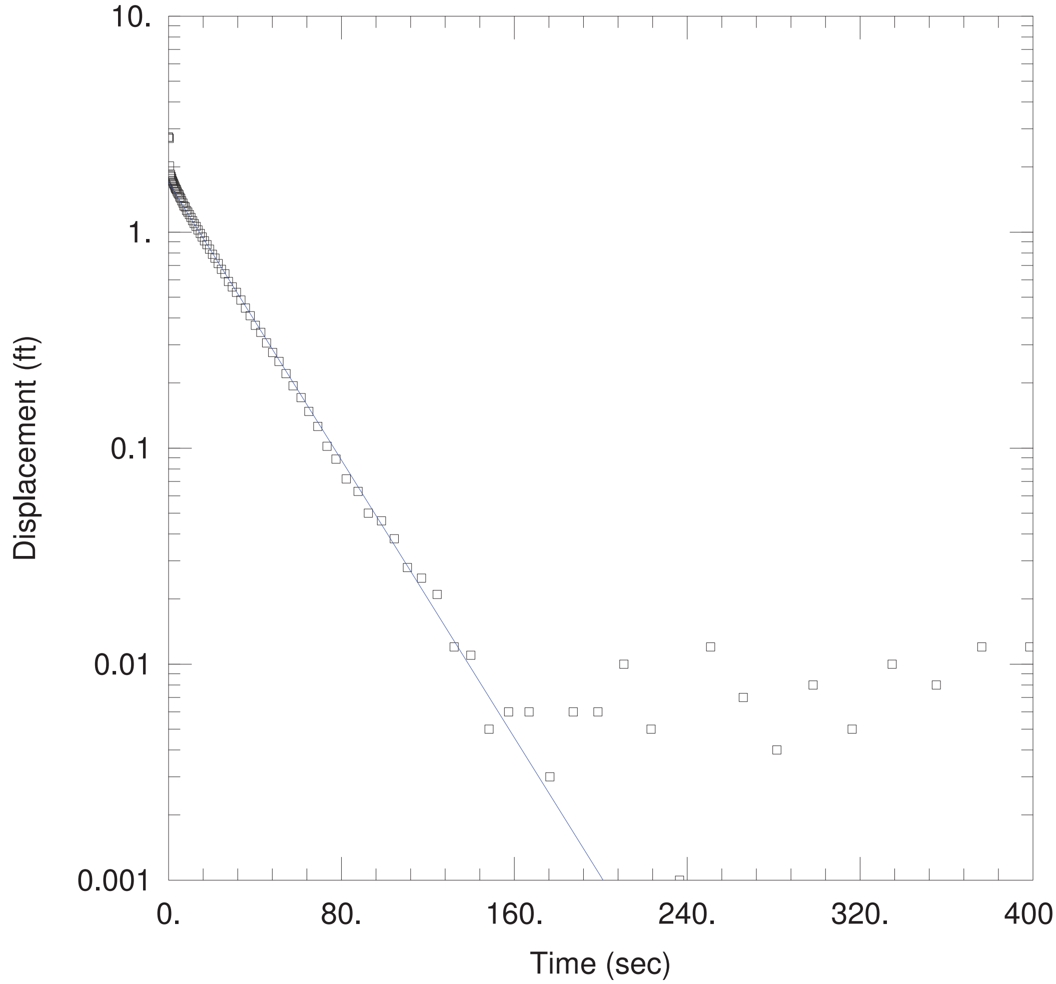
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.043

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	2.373E-5	cm/sec
y0	1.461	ft

T = K*b = 0.05699 cm^2/sec



SLUG OUT 2

Data Set: P:\...\G02D Slug Out 2.aqt
Date: 09/22/17 Time: 14:12:11

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G02D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 78.8 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G02D SO1)

Initial Displacement: 2.749 ft Static Water Column Height: 10.34 ft
Total Well Penetration Depth: 9.63 ft Screen Length: 9.63 ft
Casing Radius: 0.08333 ft Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0007228 cm/sec y0 = 1.693 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 2
Date: 09/22/17
Time: 14:12:31

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G02D

AQUIFER DATA

Saturated Thickness: 78.8 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G02D SO1

X Location: 832843. ft
Y Location: 202137.1 ft

Initial Displacement: 2.749 ft
Static Water Column Height: 10.34 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.63 ft
Total Well Penetration Depth: 9.63 ft

No. of Observations: 89

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.749	31.47	0.525
0.336	2.709	33.51	0.485
0.5	2.02	35.61	0.445
0.75	1.827	37.83	0.41
1.	1.851	40.23	0.37
1.25	1.805	42.75	0.343
1.5	1.773	45.39	0.307
1.75	1.732	48.21	0.277
2.	1.717	51.21	0.252
2.25	1.691	54.39	0.221
2.5	1.669	57.75	0.194
2.75	1.648	61.35	0.171
3.	1.618	64.95	0.148
3.25	1.598	69.15	0.126
3.5	1.581	73.35	0.102
3.75	1.567	77.55	0.089
4.109	1.532	82.35	0.072
4.469	1.508	87.75	0.063
4.889	1.49	92.55	0.05
5.309	1.455	98.55	0.046
5.729	1.432	104.5	0.038
6.209	1.395	110.5	0.028
6.749	1.361	117.1	0.025
7.229	1.322	124.3	0.021
7.829	1.306	132.1	0.012
8.429	1.261	139.9	0.011
9.029	1.238	148.3	0.005
9.689	1.203	157.3	0.006
10.41	1.167	166.9	0.006
11.19	1.129	176.5	0.003

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
11.97	1.094	187.3	0.006
12.81	1.062	198.7	0.006
13.71	1.022	210.7	0.01
14.67	0.986	223.3	0.005
15.63	0.95	236.5	0.001
16.71	0.911	250.9	0.012
17.85	0.875	265.9	0.007
19.05	0.833	281.5	0.004
20.31	0.79	298.3	0.008
21.63	0.756	316.3	0.005
23.07	0.715	334.9	0.01
24.57	0.672	355.3	0.008
26.13	0.64	376.3	0.012
27.81	0.591	398.5	0.012
29.61	0.558		

SOLUTION

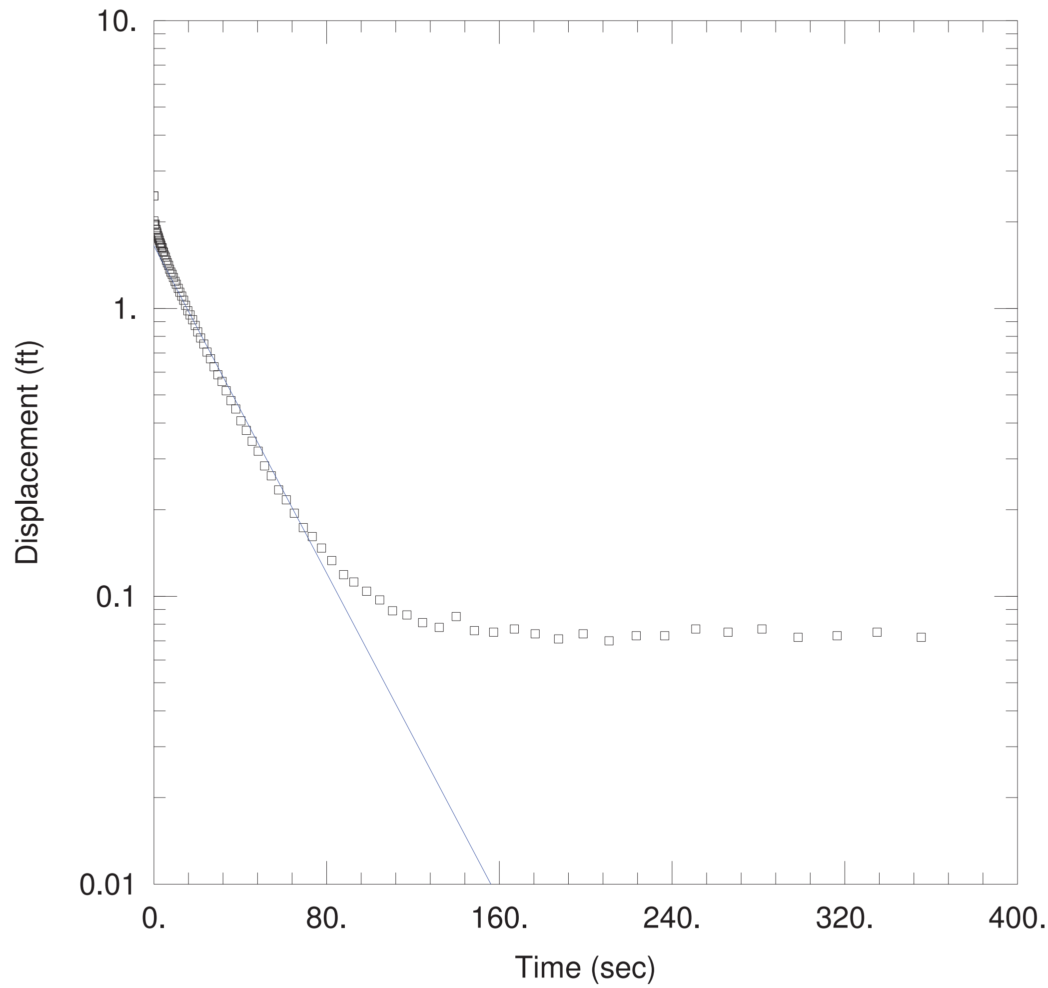
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.043

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0007228	cm/sec
y0	1.693	ft

T = K*b = 1.736 cm²/sec



SLUG OUT 3

Data Set: P:\...\G02D Slug Out 3.aqt
Date: 09/22/17 Time: 14:13:36

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G02D
Test Date: 4/4/2017

AQUIFER DATA

Saturated Thickness: 78.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G02D SO3)

Initial Displacement: 2.457 ft
Total Well Penetration Depth: 9.63 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.34 ft
Screen Length: 9.63 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0006395 cm/sec
y0 = 1.649 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 3
Date: 09/22/17
Time: 14:13:57

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/4/2017
Test Well: G02D

AQUIFER DATA

Saturated Thickness: 78.8 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G02D SO3

X Location: 832843. ft
Y Location: 202137.1 ft

Initial Displacement: 2.457 ft
Static Water Column Height: 10.34 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.63 ft
Total Well Penetration Depth: 9.63 ft

No. of Observations: 88

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.457	27.92	0.627
0.123	2.015	29.72	0.588
0.358	1.954	31.58	0.558
0.608	1.964	33.62	0.518
1.015	1.878	35.72	0.478
1.138	1.878	37.94	0.447
1.358	1.841	40.34	0.407
1.608	1.816	42.86	0.377
1.858	1.791	45.5	0.345
2.108	1.766	48.32	0.319
2.358	1.744	51.32	0.284
2.608	1.721	54.5	0.262
2.858	1.691	57.86	0.234
3.108	1.678	61.46	0.216
3.358	1.657	65.06	0.194
3.608	1.627	69.26	0.173
3.858	1.624	73.46	0.161
4.218	1.578	77.66	0.147
4.578	1.565	82.46	0.133
4.998	1.53	87.86	0.119
5.418	1.509	92.66	0.112
5.838	1.469	98.66	0.104
6.318	1.439	104.7	0.097
6.858	1.41	110.7	0.089
7.338	1.367	117.3	0.086
7.938	1.338	124.5	0.081
8.538	1.313	132.3	0.078
9.138	1.281	140.1	0.085
9.798	1.24	148.5	0.076
10.52	1.214	157.5	0.075

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
11.3	1.172	167.1	0.077
12.08	1.137	176.7	0.074
12.92	1.103	187.5	0.071
13.82	1.067	198.9	0.074
14.78	1.024	210.9	0.07
15.74	0.982	223.5	0.073
16.82	0.95	236.7	0.073
17.96	0.913	251.1	0.077
19.16	0.871	266.1	0.075
20.42	0.829	281.7	0.077
21.74	0.789	298.5	0.072
23.18	0.751	316.5	0.073
24.68	0.706	335.1	0.075
26.24	0.668	355.5	0.072

SOLUTION

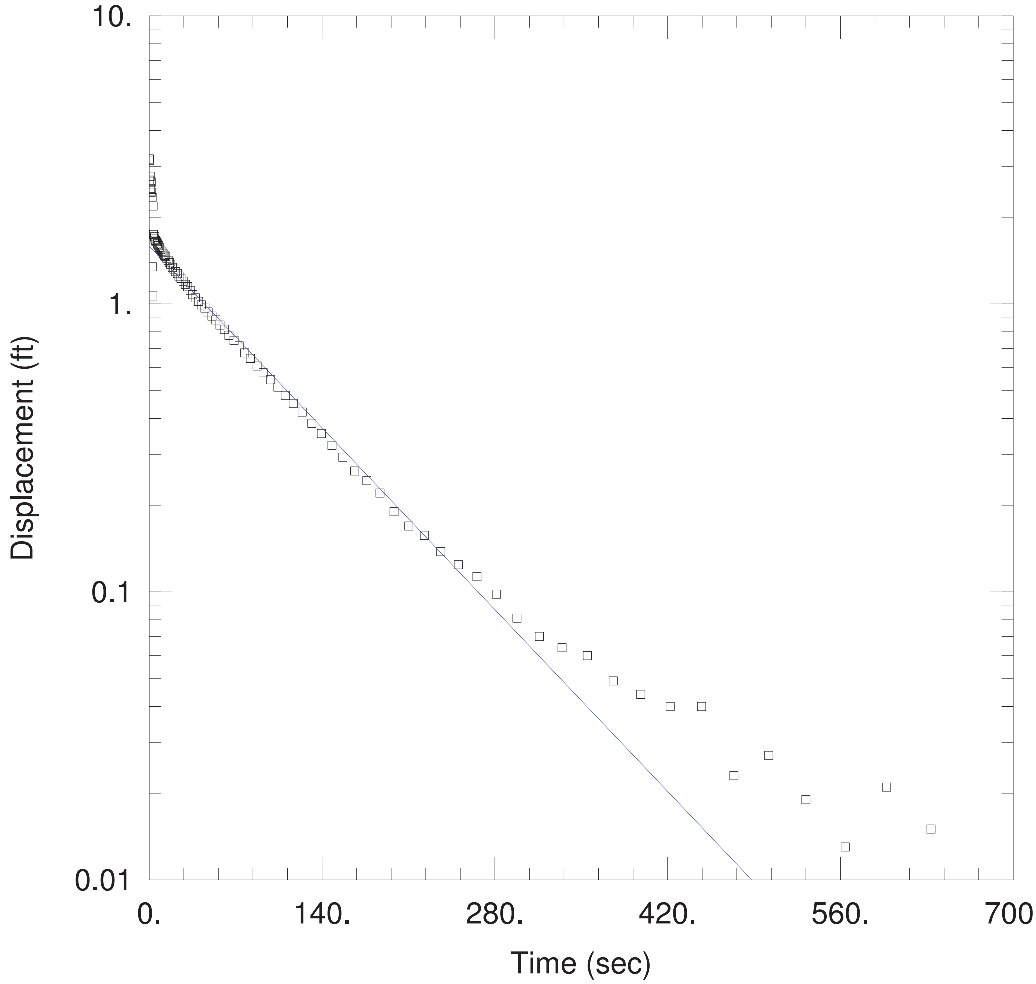
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.043

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0006395	cm/sec
y0	1.649	ft

T = K*b = 1.536 cm²/sec



SLUG IN 1

Data Set: P:\...\G51D Slug In 1.aqt
Date: 09/22/17
Time: 14:16:56

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G51D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G51D SI1)

Initial Displacement: 3.183 ft
Static Water Column Height: 15.7 ft
Total Well Penetration Depth: 12.97 ft
Screen Length: 9.66 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0002131 cm/sec
y0 = 1.587 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug In 1
Date: 09/22/17
Time: 14:17:27

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G51D

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G51D SI1

X Location: 832151.5 ft
Y Location: 200430.1 ft

Initial Displacement: 3.183 ft
Static Water Column Height: 15.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.66 ft
Total Well Penetration Depth: 12.97 ft

No. of Observations: 96

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.183	39.98	1.019
0.352	2.689	42.5	0.99
0.5	3.148	45.14	0.967
0.75	2.67	47.96	0.936
1.	2.77	50.96	0.907
1.25	2.512	54.14	0.878
1.5	2.462	57.5	0.843
1.75	2.437	61.1	0.817
2.	2.645	64.7	0.778
2.25	2.499	68.9	0.746
2.5	2.349	73.1	0.715
2.75	1.343	77.3	0.676
3.	1.065	82.1	0.646
3.25	2.187	87.5	0.608
3.5	1.743	92.3	0.576
3.86	1.741	98.3	0.544
4.22	1.678	104.3	0.514
4.64	1.708	110.3	0.48
5.059	1.66	116.9	0.451
5.479	1.643	124.1	0.421
5.96	1.64	131.9	0.385
6.499	1.616	139.7	0.354
6.979	1.613	148.1	0.322
7.579	1.59	157.1	0.293
8.18	1.572	166.7	0.263
8.779	1.562	176.3	0.243
9.439	1.545	187.1	0.22
10.16	1.525	198.5	0.19
10.94	1.51	210.5	0.169
11.72	1.488	223.1	0.157

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
12.56	1.475	236.3	0.138
13.46	1.461	250.7	0.124
14.42	1.439	265.7	0.113
15.38	1.413	281.3	0.098
16.46	1.388	298.1	0.081
17.6	1.372	316.1	0.07
18.8	1.338	334.7	0.064
20.06	1.32	355.1	0.06
21.38	1.294	376.1	0.049
22.82	1.273	398.3	0.044
24.32	1.247	422.3	0.04
25.88	1.225	447.5	0.04
27.56	1.197	473.9	0.023
29.36	1.168	502.1	0.027
31.22	1.147	532.1	0.019
33.26	1.112	563.9	0.013
35.36	1.076	597.5	0.021
37.58	1.048	633.5	0.015

SOLUTION

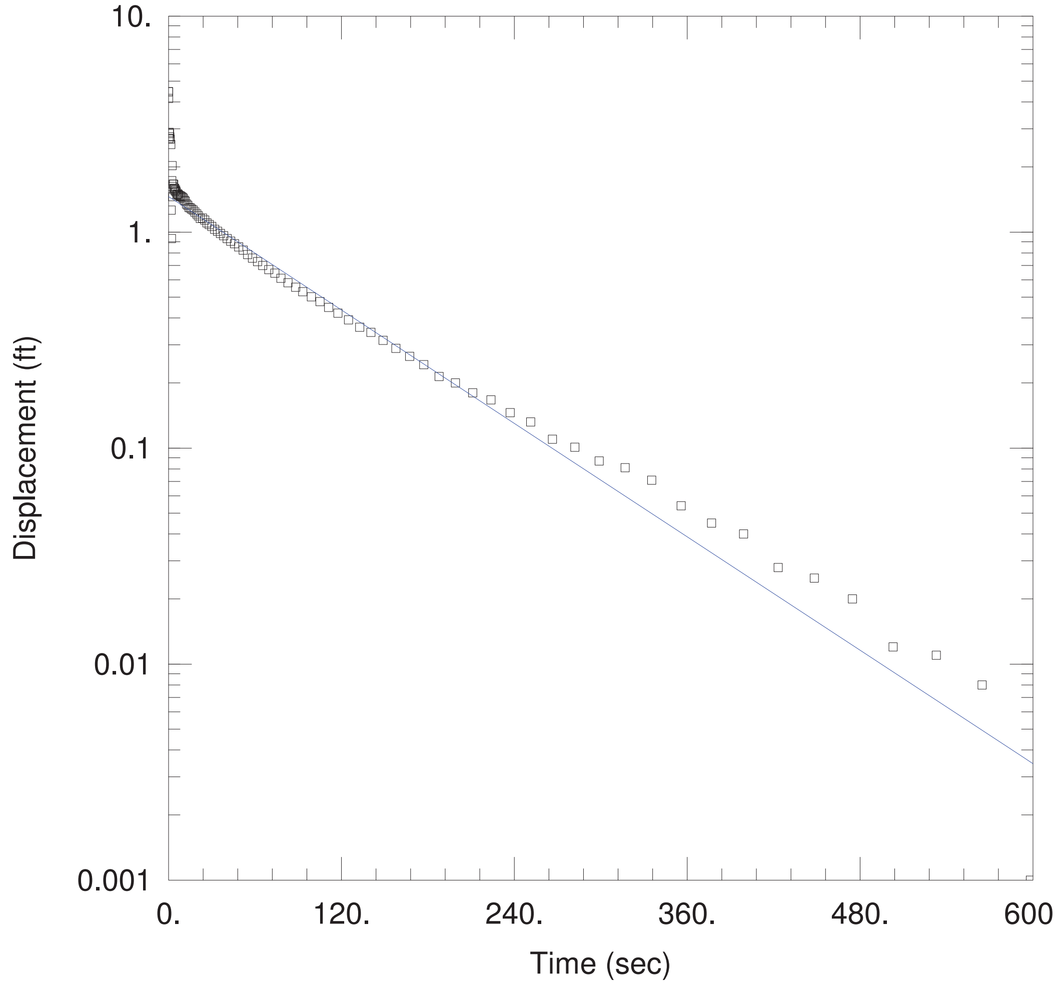
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.152

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0002131	cm/sec
y0	1.587	ft

T = K*b = 0.6293 cm²/sec



SLUG IN 2

Data Set: P:\...\G51D Slug In 2.aqt
Date: 09/22/17 | Time: 14:18:51

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G51D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G51D SI2)

Initial Displacement: 4.465 ft
Static Water Column Height: 15.7 ft
Total Well Penetration Depth: 12.97 ft
Screen Length: 9.66 ft
Casing Radius: 0.08333 ft
Well Radius: 0.03458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0003975 cm/sec
y0 = 1.459 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug In 2
Date: 09/22/17
Time: 14:19:09

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G51D

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G51D SI2

X Location: 832151.5 ft
Y Location: 200430.1 ft

Initial Displacement: 4.465 ft
Static Water Column Height: 15.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.03458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.66 ft
Total Well Penetration Depth: 12.97 ft

No. of Observations: 99

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	4.465	36.18	0.985
0.123	4.153	38.4	0.962
0.322	2.709	40.8	0.931
0.572	2.891	43.32	0.908
0.822	2.85	45.96	0.884
1.072	2.76	48.78	0.852
1.322	2.695	51.78	0.824
1.572	2.54	54.96	0.786
1.822	1.262	58.32	0.758
2.072	0.931	61.92	0.73
2.322	1.731	65.52	0.701
2.572	2.03	69.72	0.669
2.822	1.625	73.92	0.645
3.072	1.46	78.12	0.611
3.322	1.668	82.92	0.583
3.572	1.663	88.32	0.555
3.822	1.569	93.12	0.529
4.072	1.594	99.12	0.502
4.322	1.594	105.1	0.476
4.682	1.549	111.1	0.448
5.042	1.567	117.7	0.421
5.462	1.535	124.9	0.392
5.881	1.49	132.7	0.363
6.301	1.501	140.5	0.343
6.782	1.491	148.9	0.315
7.321	1.476	157.9	0.289
7.801	1.473	167.5	0.266
8.401	1.467	177.1	0.243
9.002	1.457	187.9	0.214
9.601	1.446	199.3	0.2

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
10.26	1.431	211.3	0.18
10.98	1.403	223.9	0.167
11.76	1.388	237.1	0.146
12.54	1.347	251.5	0.132
13.38	1.329	266.5	0.11
14.28	1.298	282.1	0.101
15.24	1.293	298.9	0.087
16.2	1.278	316.9	0.081
17.28	1.263	335.5	0.071
18.42	1.236	355.9	0.054
19.62	1.214	376.9	0.045
20.88	1.186	399.1	0.04
22.2	1.156	423.1	0.028
23.65	1.159	448.3	0.025
25.14	1.135	474.7	0.02
26.7	1.102	502.9	0.012
28.38	1.082	532.9	0.011
30.18	1.062	564.7	0.008
32.04	1.029	598.3	0.001
34.08	1.009		

SOLUTION

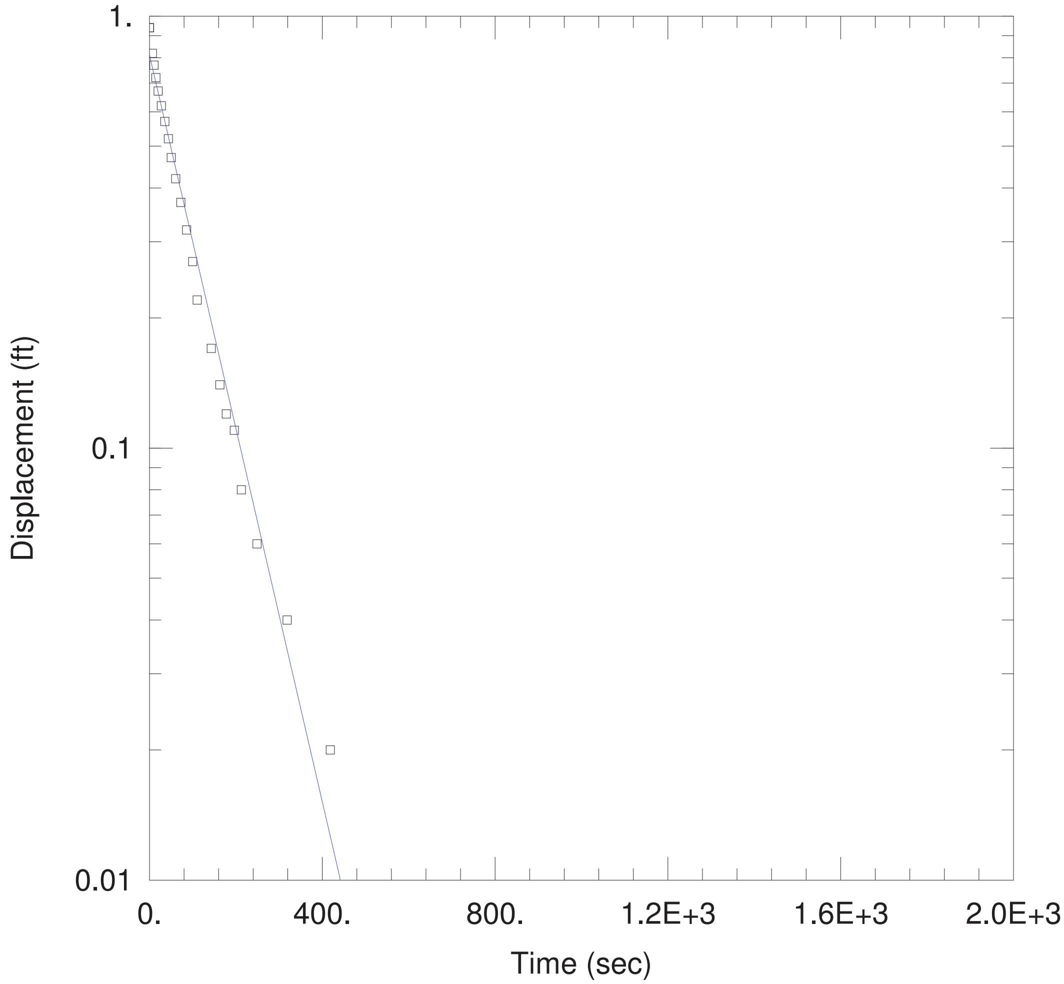
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.137

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0003975	cm/sec
y0	1.459	ft

T = K*b = 1.174 cm²/sec



SLUG OUT 1

Data Set: P:\...\G51D Slug Out 1.aqt
Date: 09/22/17 Time: 14:20:23

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G51D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G51D SO1)

Initial Displacement: 0.94 ft
Total Well Penetration Depth: 12.97 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 15.7 ft
Screen Length: 9.66 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0002346 cm/sec
y0 = 0.8117 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 1
Date: 09/22/17
Time: 14:20:38

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G51D

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G51D SO1

X Location: 832151.5 ft
Y Location: 200430.1 ft

Initial Displacement: 0.94 ft
Static Water Column Height: 15.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.66 ft
Total Well Penetration Depth: 12.97 ft

No. of Observations: 23

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.94	100.	0.27
7.	0.82	111.	0.22
11.	0.77	143.	0.17
15.	0.72	163.	0.14
20.	0.67	178.	0.12
28.	0.62	197.	0.11
36.	0.57	213.	0.08
44.	0.52	249.	0.06
51.	0.47	319.	0.04
61.	0.42	419.	0.02
73.	0.37	1166.	-0.01
86.	0.32		

SOLUTION

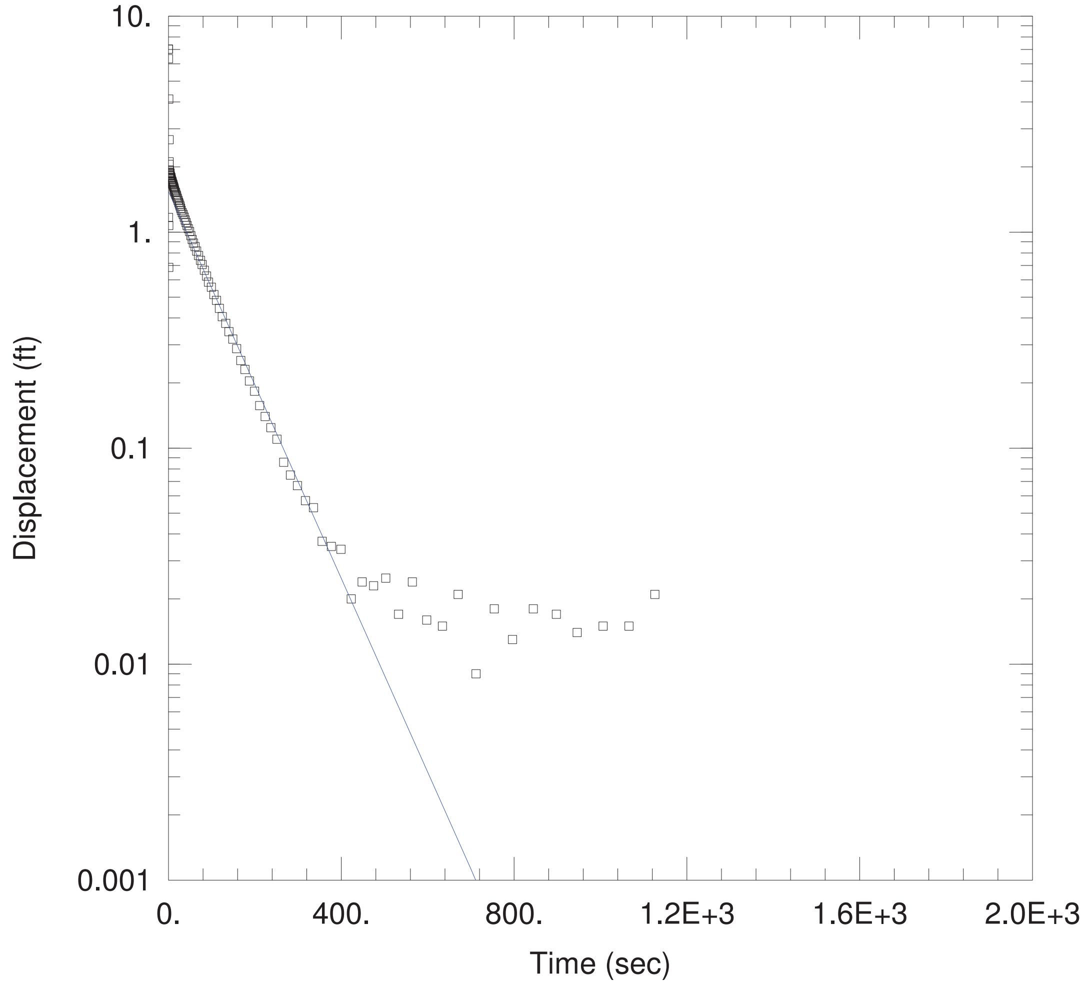
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.152

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0002346	cm/sec
y0	0.8117	ft

T = K*b = 0.6928 cm²/sec



SLUG OUT 2

Data Set: P:\...\G51D Slug Out 2.aqt
Date: 09/22/17 Time: 14:21:57

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G51D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G51D SO2)

Initial Displacement: 7.037 ft
Static Water Column Height: 15.7 ft
Total Well Penetration Depth: 12.97 ft
Screen Length: 9.66 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0002118 cm/sec
y0 = 1.542 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 2
Date: 09/22/17
Time: 14:22:17

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G51D

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G51D SO2

X Location: 832151.5 ft
Y Location: 200430.1 ft

Initial Displacement: 7.037 ft
Static Water Column Height: 15.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.66 ft
Total Well Penetration Depth: 12.97 ft

No. of Observations: 110

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	7.037	48.96	1.004
0.25	1.167	51.96	0.963
0.5	6.352	55.14	0.924
0.879	1.073	58.5	0.888
1.001	4.125	62.1	0.855
1.25	0.687	65.7	0.817
1.5	2.675	69.9	0.777
1.873	2.117	74.1	0.74
1.997	2.059	78.3	0.708
2.25	1.865	83.1	0.665
2.5	1.88	88.5	0.626
2.75	1.937	93.3	0.586
3.	1.835	99.3	0.555
3.25	1.891	105.3	0.513
3.5	1.851	111.3	0.482
3.75	1.868	117.9	0.443
4.	1.831	125.1	0.405
4.25	1.823	132.9	0.377
4.5	1.82	140.7	0.345
4.86	1.797	149.1	0.319
5.22	1.791	158.1	0.288
5.64	1.792	167.7	0.254
6.06	1.784	177.3	0.231
6.48	1.76	188.1	0.204
6.96	1.754	199.5	0.183
7.5	1.73	211.5	0.157
7.98	1.718	224.1	0.14
8.58	1.713	237.3	0.124
9.18	1.692	251.7	0.11
9.78	1.672	266.7	0.086

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
10.44	1.662	282.3	0.075
11.16	1.637	299.1	0.067
11.94	1.623	317.1	0.057
12.72	1.602	335.7	0.053
13.56	1.582	356.1	0.037
14.46	1.563	377.1	0.035
15.42	1.54	399.3	0.034
16.38	1.525	423.3	0.02
17.46	1.497	448.5	0.024
18.6	1.479	474.9	0.023
19.8	1.452	503.1	0.025
21.06	1.428	533.1	0.017
22.38	1.398	564.9	0.024
23.82	1.371	598.5	0.016
25.32	1.35	634.5	0.015
26.88	1.319	670.5	0.021
28.56	1.29	712.5	0.009
30.36	1.258	754.5	0.018
32.22	1.231	796.5	0.013
34.26	1.203	844.5	0.018
36.36	1.17	898.5	0.017
38.58	1.136	946.5	0.014
40.98	1.106	1006.5	0.015
43.5	1.072	1066.5	0.015
46.14	1.036	1126.5	0.021

SOLUTION

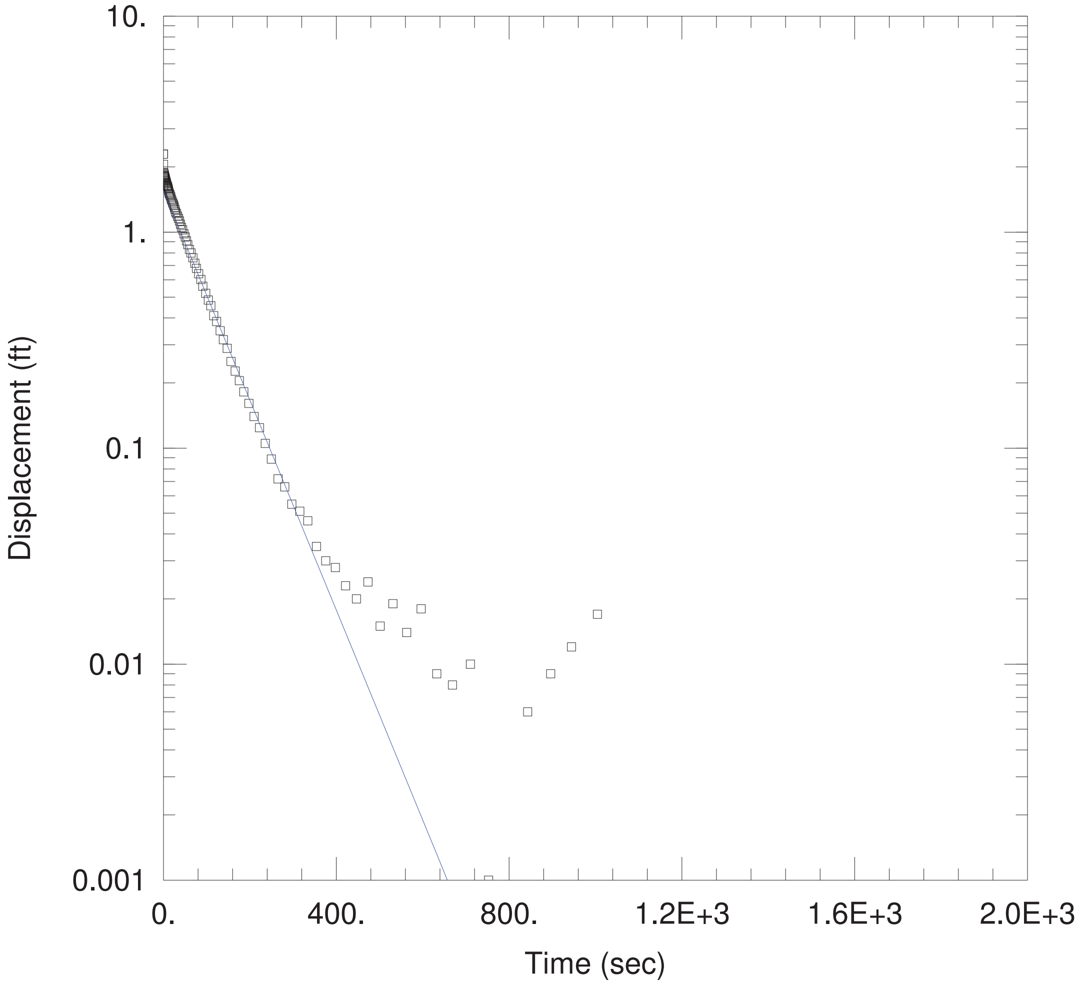
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
In(Re/rw): 2.152

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0002118	cm/sec
y0	1.542	ft

T = K*b = 0.6255 cm²/sec



SLUG OUT 3

Data Set: P:\...\G51D Slug Out 3.aqt
Date: 09/22/17 Time: 14:23:14

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G51D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 96.9 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G51D SO3)

Initial Displacement: 2.298 ft Static Water Column Height: 15.7 ft
Total Well Penetration Depth: 12.97 ft Screen Length: 9.66 ft
Casing Radius: 0.08333 ft Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0002296 cm/sec y0 = 1.56 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 3
Date: 09/22/17
Time: 14:23:30

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G51D

AQUIFER DATA

Saturated Thickness: 96.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G51D SO3

X Location: 832151.5 ft
Y Location: 200430.1 ft

Initial Displacement: 2.298 ft
Static Water Column Height: 15.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.66 ft
Total Well Penetration Depth: 12.97 ft

No. of Observations: 102

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.298	53.64	0.912
0.25	1.633	57.	0.875
0.5	2.056	60.6	0.83
0.75	1.808	64.2	0.8
1.	1.884	68.4	0.759
1.25	1.861	72.6	0.717
1.5	1.825	76.8	0.679
1.75	1.848	81.6	0.64
2.	1.827	87.	0.602
2.25	1.834	91.8	0.561
2.5	1.815	97.8	0.521
2.75	1.8	103.8	0.484
3.	1.799	109.8	0.455
3.36	1.785	116.4	0.41
3.72	1.78	123.6	0.385
4.14	1.767	131.4	0.349
4.56	1.756	139.2	0.317
4.979	1.741	147.6	0.289
5.46	1.731	156.6	0.252
5.999	1.708	166.2	0.227
6.479	1.703	175.8	0.205
7.08	1.686	186.6	0.182
7.68	1.672	198.	0.161
8.279	1.64	210.	0.14
8.939	1.629	222.6	0.124
9.659	1.62	235.8	0.105
10.44	1.597	250.2	0.089
11.22	1.575	265.2	0.072
12.06	1.555	280.8	0.066
12.96	1.531	297.6	0.055

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
13.92	1.507	315.6	0.051
14.88	1.492	334.2	0.046
15.96	1.474	354.6	0.035
17.1	1.452	375.6	0.03
18.3	1.423	397.8	0.028
19.56	1.403	421.8	0.023
20.88	1.375	447.	0.02
22.32	1.352	473.4	0.024
23.82	1.329	501.6	0.015
25.38	1.301	531.6	0.019
27.06	1.274	563.4	0.014
28.86	1.239	597.	0.018
30.72	1.216	633.	0.009
32.76	1.182	669.	0.008
34.86	1.155	711.	0.01
37.08	1.126	753.	0.001
39.48	1.089	795.	0.
42.	1.051	843.	0.006
44.64	1.021	897.	0.009
47.46	0.983	945.	0.012
50.46	0.947	1005.	0.017

SOLUTION

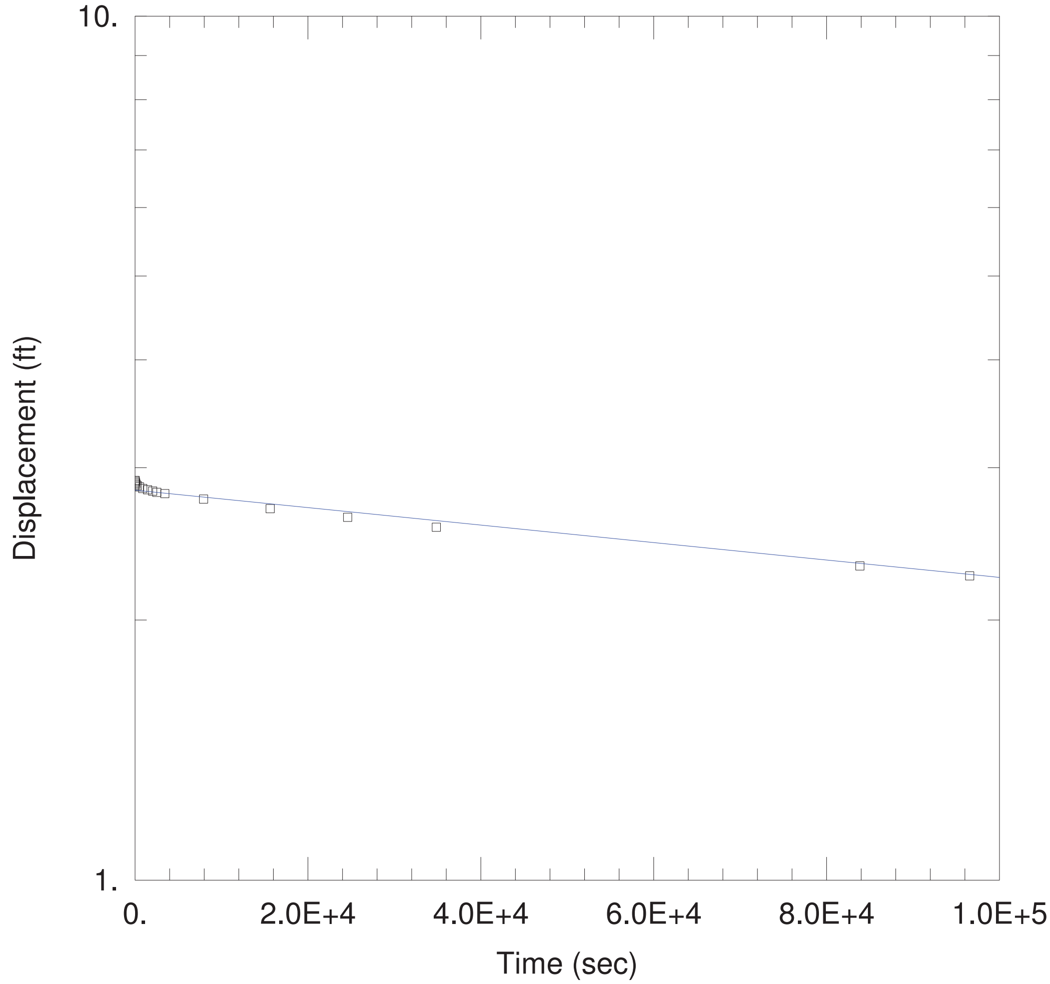
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.152

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0002296	cm/sec
y0	1.56	ft

T = K*b = 0.6781 cm²/sec



SLUG OUT 1

Data Set: P:\...\G52D Slug Out 1.aqt
Date: 09/22/17 Time: 14:28:08

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G52D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 55.9 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G52D SO1)

Initial Displacement: 2.9 ft
Static Water Column Height: 10.03 ft
Total Well Penetration Depth: 4.2 ft
Screen Length: 4.2 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 7.129E-8 cm/sec
y0 = 2.826 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 1
Date: 09/22/17
Time: 14:29:14

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G52D

AQUIFER DATA

Saturated Thickness: 55.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G52D SO1

X Location: 832927.9 ft
Y Location: 198098.9 ft

Initial Displacement: 2.9 ft
Static Water Column Height: 10.03 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 4.2 ft
Total Well Penetration Depth: 4.2 ft

No. of Observations: 17

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.9	2555.	2.81
69.	2.89	3455.	2.8
108.	2.88	7949.	2.76
145.	2.87	1.566E+4	2.69
286.	2.86	2.462E+4	2.63
528.	2.85	3.488E+4	2.56
891.	2.84	8.386E+4	2.31
1461.	2.83	9.658E+4	2.25
2039.	2.82		

SOLUTION

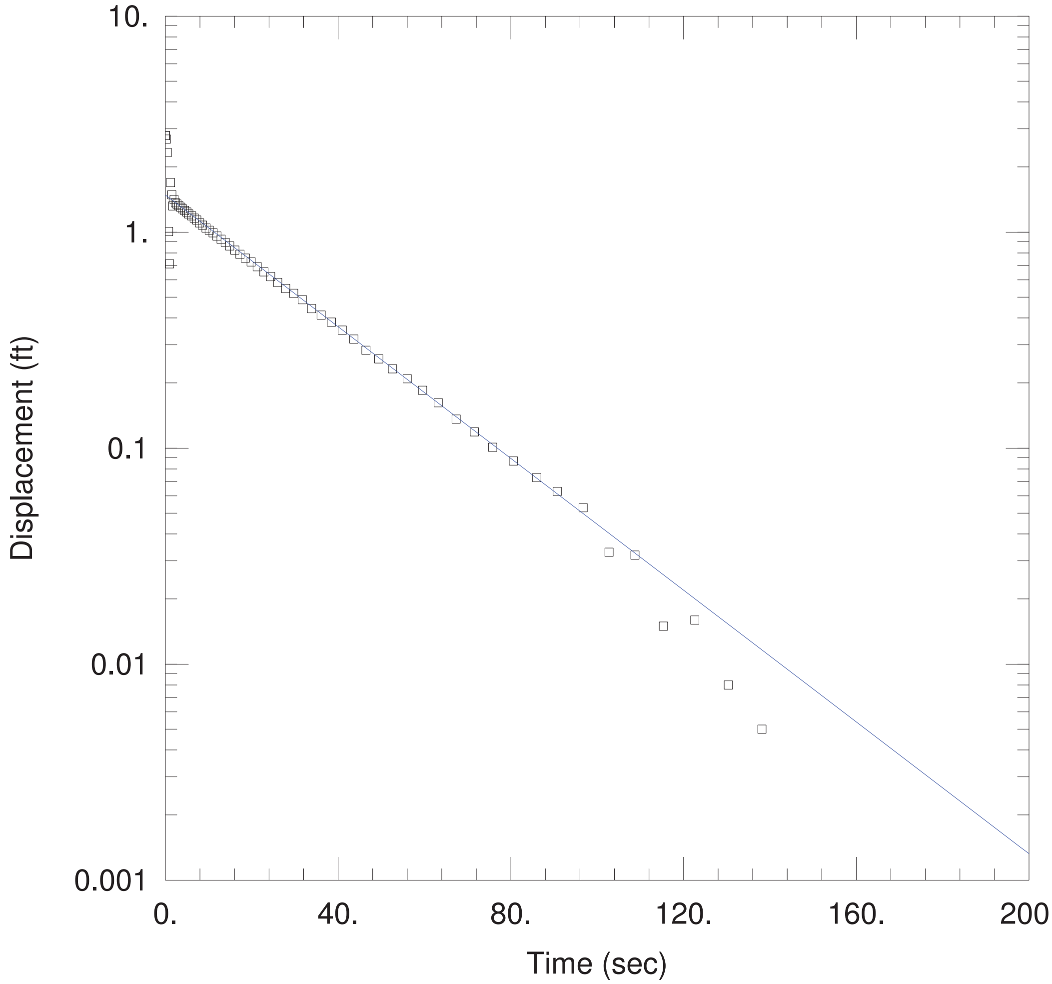
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 1.396

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	7.129E-8	cm/sec
y0	2.826	ft

T = K*b = 0.0001215 cm^2/sec



SLUG IN 1

Data Set: P:\...\G53D Slug In 1.aqt
Date: 09/22/17 Time: 14:32:18

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G53D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G53D SI1)

Initial Displacement: 2.799 ft
Static Water Column Height: 20. ft
Total Well Penetration Depth: 15.91 ft
Screen Length: 9.6 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0007519 cm/sec
y0 = 1.485 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug In 1
Date: 09/22/17
Time: 14:32:46

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G53D

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G53D SI1

X Location: 833980.2 ft
Y Location: 200075.2 ft

Initial Displacement: 2.799 ft
Static Water Column Height: 20. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.6 ft
Total Well Penetration Depth: 15.91 ft

No. of Observations: 64

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.799	19.88	0.726
0.25	2.695	21.32	0.691
0.5	2.335	22.82	0.654
0.75	1.006	24.38	0.621
1.	0.713	26.06	0.584
1.25	1.695	27.86	0.548
1.5	1.489	29.72	0.521
1.75	1.321	31.76	0.486
2.	1.415	33.86	0.442
2.36	1.365	36.08	0.413
2.72	1.35	38.48	0.383
3.14	1.323	41.	0.351
3.56	1.304	43.64	0.319
3.98	1.281	46.46	0.284
4.46	1.26	49.46	0.259
5.	1.237	52.64	0.233
5.48	1.212	56.	0.209
6.08	1.186	59.6	0.185
6.68	1.159	63.2	0.162
7.28	1.136	67.4	0.136
7.94	1.103	71.6	0.119
8.66	1.076	75.8	0.101
9.44	1.045	80.6	0.087
10.22	1.019	86.	0.073
11.06	0.99	90.8	0.063
11.96	0.959	96.8	0.053
12.92	0.926	102.8	0.033
13.88	0.895	108.8	0.032
14.96	0.862	115.4	0.015
16.1	0.825	122.6	0.016

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
17.3	0.79	130.4	0.008
18.56	0.757	138.2	0.005

SOLUTION

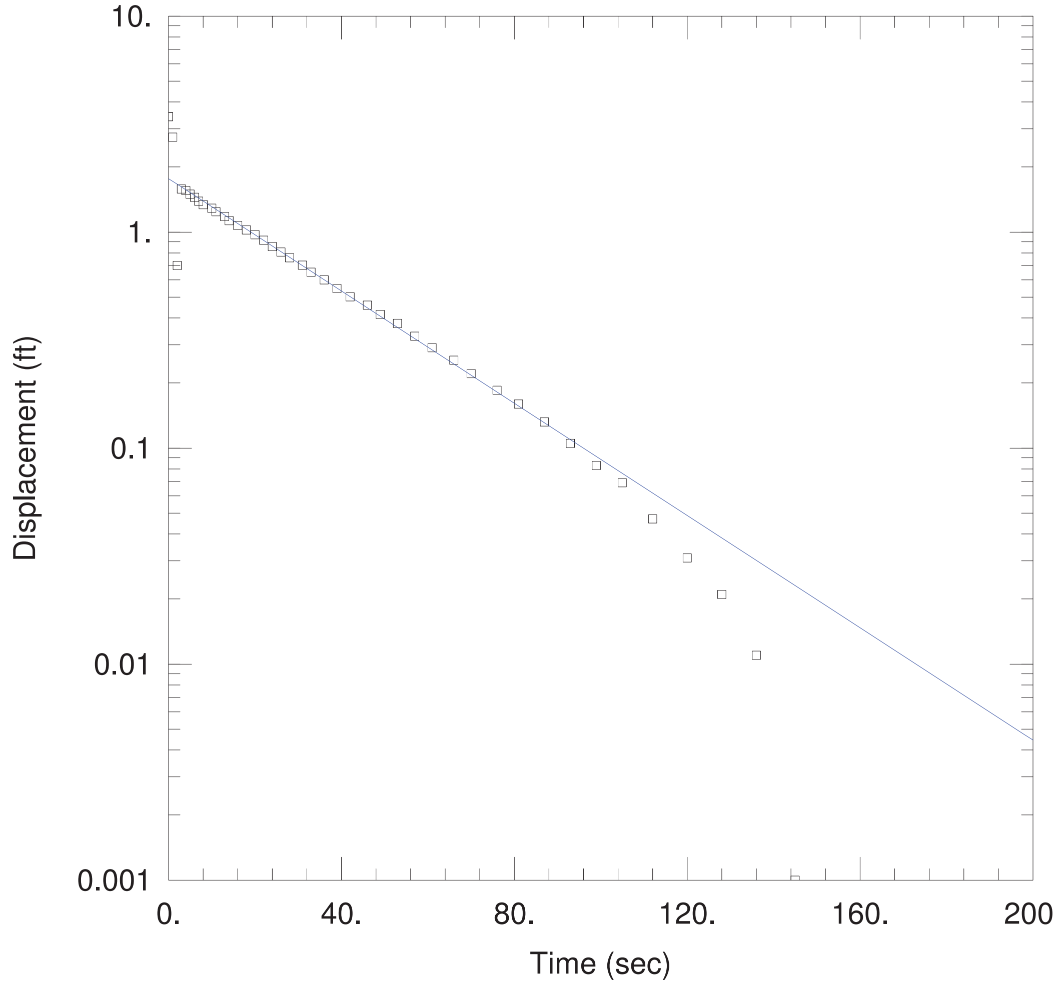
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.232

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0007519	cm/sec
y0	1.485	ft

T = K*b = 2.159 cm^2/sec



SLUG IN 2

Data Set: P:\...\G53D Slug In 2.aqt
Date: 09/22/17
Time: 14:34:32

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G53D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G53D SI2)

Initial Displacement: 3.419 ft
Static Water Column Height: 20. ft
Total Well Penetration Depth: 15.91 ft
Screen Length: 9.6 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0006408 cm/sec
y0 = 1.766 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug In 2
Date: 09/22/17
Time: 14:34:48

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G53D

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G53D SI2

X Location: 833980.2 ft
Y Location: 200075.2 ft

Initial Displacement: 3.419 ft
Static Water Column Height: 20. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.6 ft
Total Well Penetration Depth: 15.91 ft

No. of Observations: 43

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.419	36.	0.601
1.	2.745	39.	0.548
2.	0.7	42.	0.501
3.	1.58	46.	0.459
4.	1.553	49.	0.415
5.	1.497	53.	0.377
6.	1.449	57.	0.329
7.	1.388	61.	0.291
8.	1.339	66.	0.255
10.	1.291	70.	0.221
11.	1.241	76.	0.185
13.	1.178	81.	0.16
14.	1.129	87.	0.132
16.	1.074	93.	0.105
18.	1.023	99.	0.083
20.	0.971	105.	0.069
22.	0.916	112.	0.047
24.	0.856	120.	0.031
26.	0.807	128.	0.021
28.	0.761	136.	0.011
31.	0.702	145.	0.001
33.	0.652		

SOLUTION

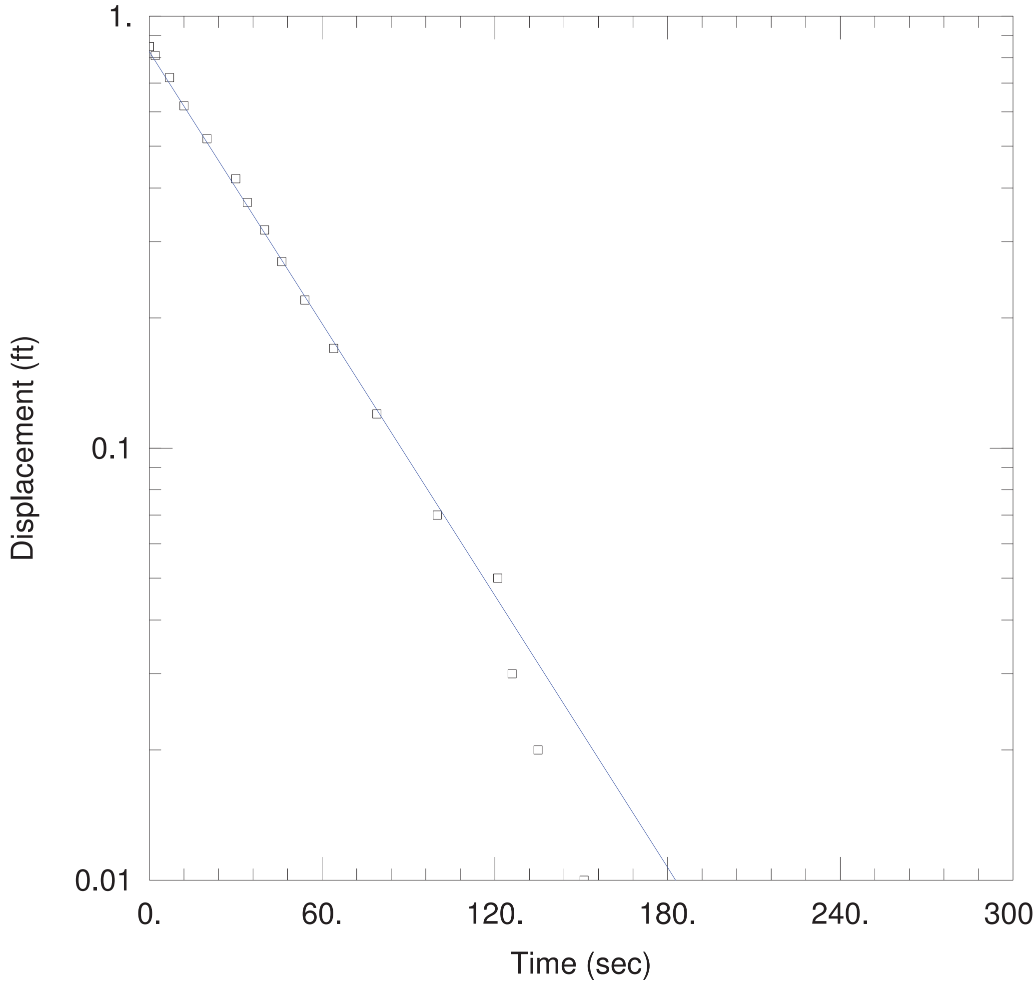
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.232

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0006408	cm/sec
y0	1.766	ft

T = K*b = 1.84 cm^2/sec



SLUG OUT1

Data Set: P:\...\G53D Slug Out 1.aqt
Date: 09/22/17 Time: 14:37:09

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G53D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 94.2 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G53D SO1)

Initial Displacement: 0.85 ft
Total Well Penetration Depth: 15.91 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 20. ft
Screen Length: 9.6 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0005172 cm/sec y0 = 0.8263 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out1
Date: 09/22/17
Time: 14:37:25

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G53D

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G53D SO1

X Location: 833980.2 ft
Y Location: 200075.2 ft

Initial Displacement: 0.85 ft
Static Water Column Height: 20. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.6 ft
Total Well Penetration Depth: 15.91 ft

No. of Observations: 20

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.85	54.	0.22
2.	0.81	64.	0.17
7.	0.72	79.	0.12
12.	0.62	100.	0.07
20.	0.52	121.	0.05
25.	-0.53	126.	0.03
30.	0.42	135.	0.02
34.	0.37	151.	0.01
40.	0.32	167.	0.
46.	0.27	209.	-0.01

SOLUTION

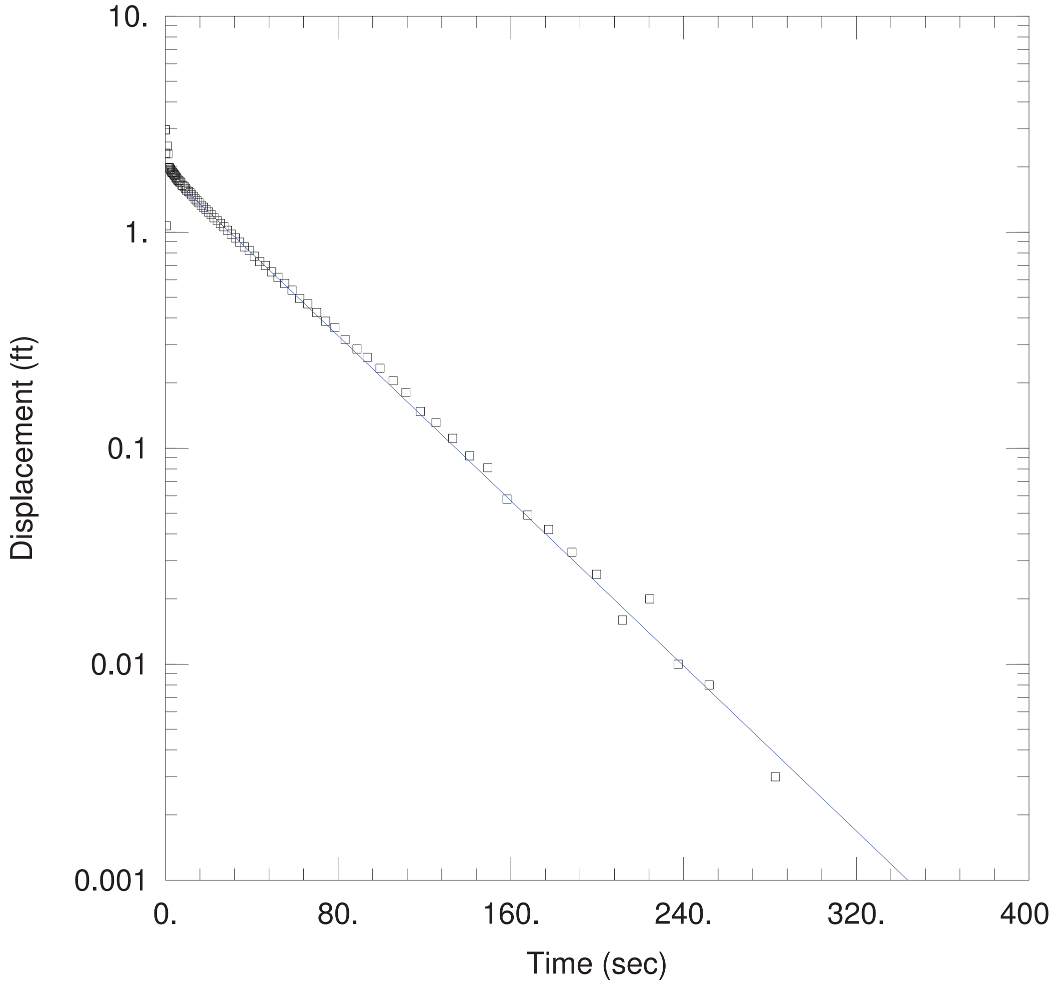
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.232

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0005172	cm/sec
y0	0.8263	ft

T = K*b = 1.485 cm^2/sec



SLUG OUT 2

Data Set: P:\...\G53D Slug Out 2.aqt
Date: 09/22/17
Time: 14:38:38

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G53D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G53D S02)

Initial Displacement: 2.971 ft
Static Water Column Height: 20. ft
Total Well Penetration Depth: 15.91 ft
Screen Length: 9.6 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0004708 cm/sec
y0 = 1.92 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 2
Date: 09/22/17
Time: 14:39:04

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G53D

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G53D S02

X Location: 833980.2 ft
Y Location: 200075.2 ft

Initial Displacement: 2.971 ft
Static Water Column Height: 20. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.6 ft
Total Well Penetration Depth: 15.91 ft

No. of Observations: 90

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.971	25.57	1.095
0.25	2.32	27.13	1.059
0.5	1.067	28.81	1.019
0.75	1.982	30.61	0.979
1.	2.502	32.47	0.938
1.25	2.3	34.51	0.897
1.5	1.991	36.61	0.854
1.75	1.99	38.83	0.823
2.	1.981	41.23	0.773
2.25	1.955	43.75	0.73
2.5	1.95	46.39	0.7
2.75	1.919	49.21	0.654
3.	1.897	52.21	0.617
3.25	1.888	55.39	0.578
3.5	1.88	58.75	0.539
3.75	1.864	62.35	0.493
4.	1.843	65.95	0.465
4.25	1.836	70.15	0.424
4.5	1.824	74.35	0.387
4.75	1.798	78.55	0.361
5.11	1.793	83.36	0.318
5.47	1.764	88.82	0.287
5.89	1.74	93.55	0.263
6.31	1.728	99.55	0.234
6.73	1.706	105.6	0.205
7.21	1.699	111.6	0.181
7.75	1.65	118.2	0.148
8.23	1.636	125.3	0.131
8.83	1.62	133.2	0.111
9.43	1.595	140.9	0.092

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
10.03	1.563	149.3	0.081
10.69	1.541	158.3	0.058
11.41	1.517	167.9	0.049
12.19	1.487	177.6	0.042
12.97	1.461	188.3	0.033
13.81	1.425	199.8	0.026
14.71	1.396	211.8	0.016
15.67	1.366	224.3	0.02
16.63	1.328	237.6	0.01
17.71	1.302	251.9	0.008
18.85	1.27	266.9	-0.002
20.05	1.238	282.6	0.003
21.31	1.204	299.4	-0.006
22.63	1.164	317.4	-0.007
24.07	1.13	335.9	-0.004

SOLUTION

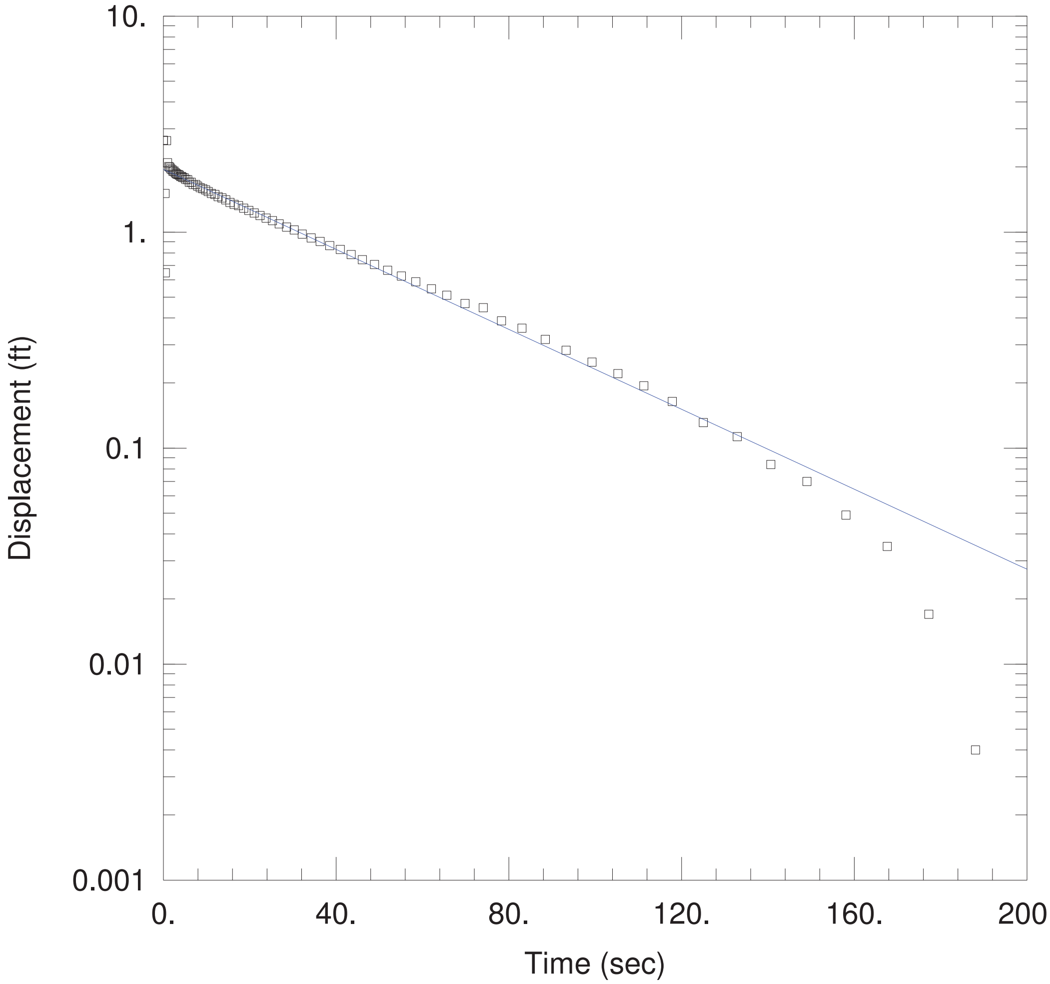
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.232

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0004708	cm/sec
y0	1.92	ft

T = K*b = 1.352 cm²/sec



SLUG OUT 3

Data Set: P:\...\G53D Slug Out 3.aqt
Date: 09/22/17 Time: 14:40:46

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G53D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G53D SO3)

Initial Displacement: 2.656 ft
Static Water Column Height: 20. ft
Total Well Penetration Depth: 15.91 ft
Screen Length: 9.6 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0004565 cm/sec
y0 = 1.95 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: Slug Out 3
Date: 09/22/17
Time: 14:41:01

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G53D

AQUIFER DATA

Saturated Thickness: 94.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G53D SO3

X Location: 833980.2 ft
Y Location: 200075.2 ft

Initial Displacement: 2.656 ft
Static Water Column Height: 20. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 9.6 ft
Total Well Penetration Depth: 15.91 ft

No. of Observations: 79

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.656	19.8	1.26
0.379	1.509	21.06	1.227
0.502	0.648	22.38	1.193
0.75	2.652	23.82	1.16
1.	2.095	25.32	1.129
1.272	2.011	26.88	1.09
1.5	1.994	28.56	1.056
1.75	1.961	30.36	1.023
2.	1.944	32.22	0.979
2.25	1.906	34.26	0.939
2.5	1.913	36.36	0.903
2.75	1.882	38.58	0.864
3.	1.865	40.98	0.829
3.25	1.853	43.5	0.787
3.5	1.844	46.14	0.745
3.75	1.834	48.96	0.707
4.	1.806	51.96	0.666
4.25	1.805	55.14	0.625
4.5	1.79	58.5	0.588
4.86	1.784	62.1	0.546
5.22	1.752	65.7	0.51
5.64	1.745	69.9	0.467
6.06	1.702	74.1	0.447
6.48	1.698	78.3	0.388
6.96	1.66	83.1	0.359
7.5	1.662	88.5	0.318
7.98	1.632	93.3	0.284
8.58	1.603	99.3	0.25
9.18	1.586	105.3	0.221
9.78	1.567	111.3	0.194

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
10.44	1.542	117.9	0.164
11.16	1.51	125.1	0.131
11.94	1.492	132.9	0.113
12.72	1.459	140.7	0.084
13.56	1.436	149.1	0.07
14.46	1.407	158.1	0.049
15.42	1.373	167.7	0.035
16.38	1.343	177.3	0.017
17.46	1.323	188.1	0.004
18.6	1.291		

SOLUTION

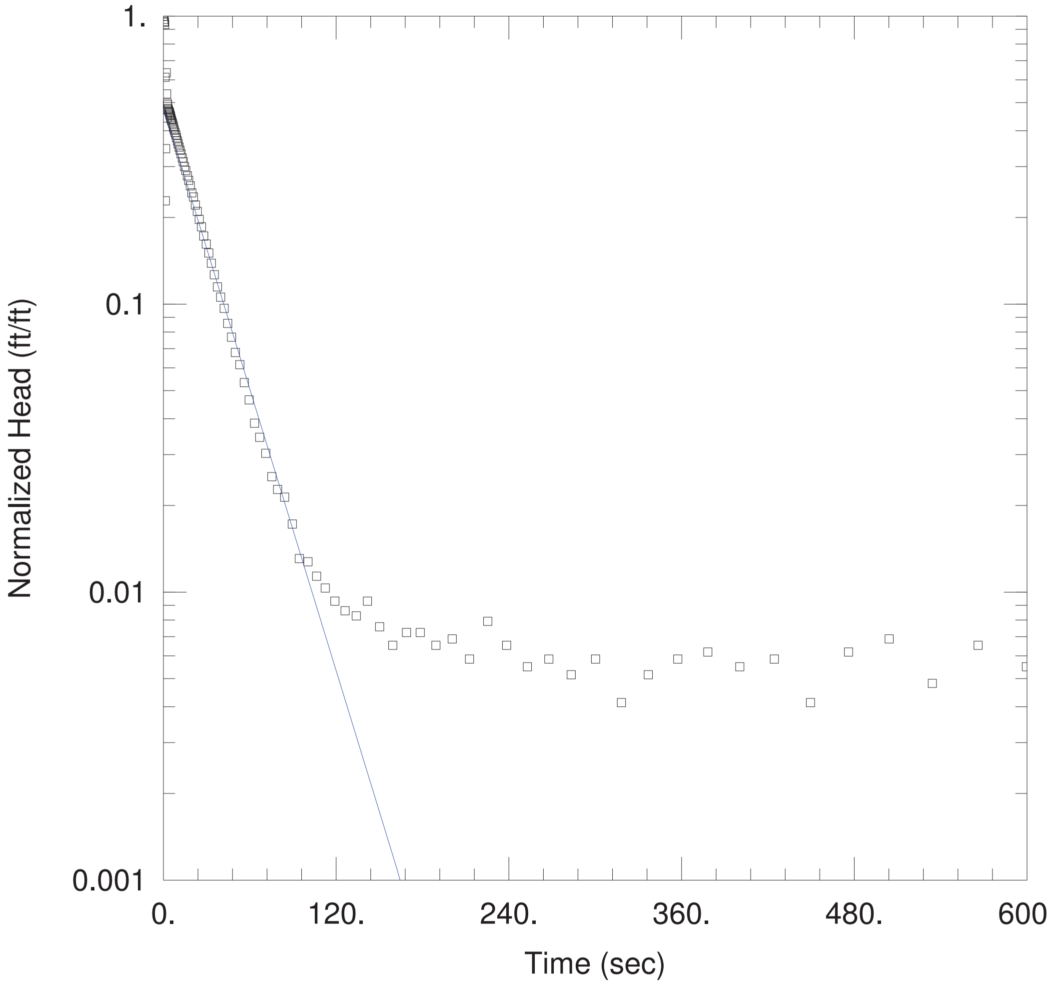
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.232

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0004565	cm/sec
y0	1.95	ft

T = K*b = 1.311 cm^2/sec



G54D SLUG IN 1

Data Set: P:\...\G54D Slug In 1.aqt
Date: 09/22/17 Time: 14:43:41

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G54D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 59.7 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G54D SI1)

Initial Displacement: 2.906 ft Static Water Column Height: 6.14 ft
Total Well Penetration Depth: 5.66 ft Screen Length: 5.66 ft
Casing Radius: 0.08333 ft Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0009929 cm/sec y0 = 1.4 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G54D Slug In 1
Date: 09/22/17
Time: 14:44:07

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G54D

AQUIFER DATA

Saturated Thickness: 59.7 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G54D SI1

X Location: 831610.4 ft
Y Location: 199066.8 ft

Initial Displacement: 2.906 ft
Static Water Column Height: 6.14 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 5.66 ft
Total Well Penetration Depth: 5.66 ft

No. of Observations: 104

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.906	31.61	0.437
0.284	2.832	33.47	0.403
0.5	2.768	35.51	0.367
0.75	2.78	37.61	0.333
1.	2.717	39.83	0.307
1.25	1.779	42.23	0.281
1.5	0.664	44.75	0.249
1.75	1.007	47.39	0.223
2.	1.844	50.21	0.197
2.25	1.559	53.21	0.179
2.5	1.285	56.39	0.155
2.75	1.446	59.75	0.135
3.	1.427	63.35	0.112
3.25	1.387	66.95	0.1
3.5	1.38	71.15	0.088
3.75	1.366	75.35	0.073
4.	1.352	79.55	0.066
4.25	1.342	84.35	0.062
4.5	1.328	89.75	0.05
4.75	1.316	94.55	0.038
5.	1.305	100.6	0.037
5.25	1.289	106.6	0.033
5.5	1.278	112.6	0.03
5.75	1.264	119.2	0.027
6.11	1.249	126.3	0.025
6.47	1.228	134.2	0.024
6.89	1.208	141.9	0.027
7.31	1.187	150.3	0.022
7.73	1.166	159.3	0.019
8.21	1.147	168.9	0.021

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
8.75	1.122	178.6	0.021
9.23	1.099	189.3	0.019
9.83	1.07	200.8	0.02
10.43	1.045	212.8	0.017
11.03	1.02	225.3	0.023
11.69	0.993	238.6	0.019
12.41	0.967	252.9	0.016
13.19	0.934	267.9	0.017
13.97	0.905	283.6	0.015
14.81	0.873	300.4	0.017
15.71	0.845	318.4	0.012
16.67	0.809	336.9	0.015
17.63	0.781	357.4	0.017
18.71	0.747	378.4	0.018
19.85	0.707	400.6	0.016
21.05	0.683	424.6	0.017
22.31	0.642	449.8	0.012
23.63	0.609	476.1	0.018
25.07	0.572	504.4	0.02
26.57	0.539	534.4	0.014
28.13	0.501	566.1	0.019
29.81	0.47	599.8	0.016

SOLUTION

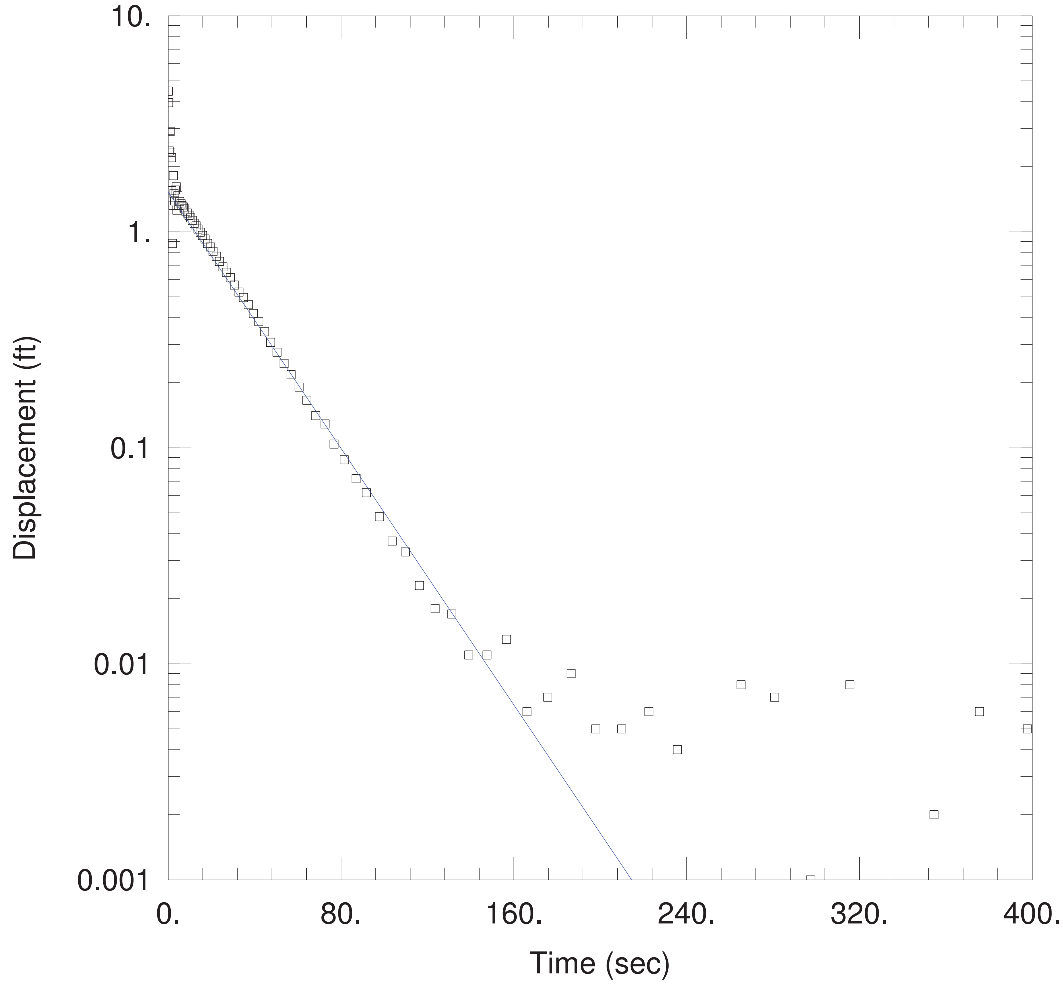
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 1.626

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0009929	cm/sec
y0	1.4	ft

T = K*b = 1.807 cm^2/sec



G54D SLUG IN 2

Data Set: P:\...\G54D Slug In 2.aqt
Date: 09/22/17 Time: 14:45:25

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G54D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 59.7 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G54D SI2)

Initial Displacement: 4.476 ft
Total Well Penetration Depth: 5.66 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.14 ft
Screen Length: 5.66 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0009041 cm/sec y0 = 1.528 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G54D Slug In 2
Date: 09/22/17
Time: 14:45:41

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G54D

AQUIFER DATA

Saturated Thickness: 59.7 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G54D SI2

X Location: 831610.4 ft
Y Location: 199066.8 ft

Initial Displacement: 4.476 ft
Static Water Column Height: 6.14 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 5.66 ft
Total Well Penetration Depth: 5.66 ft

No. of Observations: 86

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	4.476	32.76	0.526
0.25	3.961	34.86	0.496
0.5	2.37	37.08	0.46
0.75	2.692	39.48	0.419
1.	2.914	42.	0.384
1.25	2.337	44.64	0.344
1.5	2.204	47.46	0.308
1.75	1.552	50.46	0.277
2.	0.884	53.64	0.246
2.25	1.323	57.	0.218
2.5	1.822	60.6	0.191
2.75	1.505	64.2	0.166
3.	1.391	68.4	0.141
3.36	1.563	72.6	0.129
3.72	1.615	76.8	0.104
4.14	1.26	81.6	0.088
4.56	1.47	87.	0.072
4.98	1.325	91.8	0.062
5.46	1.382	97.8	0.048
6.	1.347	103.8	0.037
6.48	1.322	109.8	0.033
7.08	1.301	116.4	0.023
7.68	1.275	123.6	0.018
8.28	1.248	131.4	0.017
8.94	1.219	139.2	0.011
9.66	1.193	147.6	0.011
10.44	1.158	156.6	0.013
11.22	1.13	166.2	0.006
12.06	1.093	175.8	0.007
12.96	1.064	186.6	0.009

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
13.92	1.03	198.	0.005
14.88	0.996	210.	0.005
15.96	0.961	222.6	0.006
17.1	0.925	235.8	0.004
18.3	0.882	250.2	0.
19.56	0.85	265.2	0.008
20.88	0.812	280.8	0.007
22.32	0.771	297.6	0.001
23.82	0.73	315.6	0.008
25.38	0.688	334.2	-0.001
27.06	0.65	354.6	0.002
28.86	0.613	375.6	0.006
30.72	0.566	397.8	0.005

SOLUTION

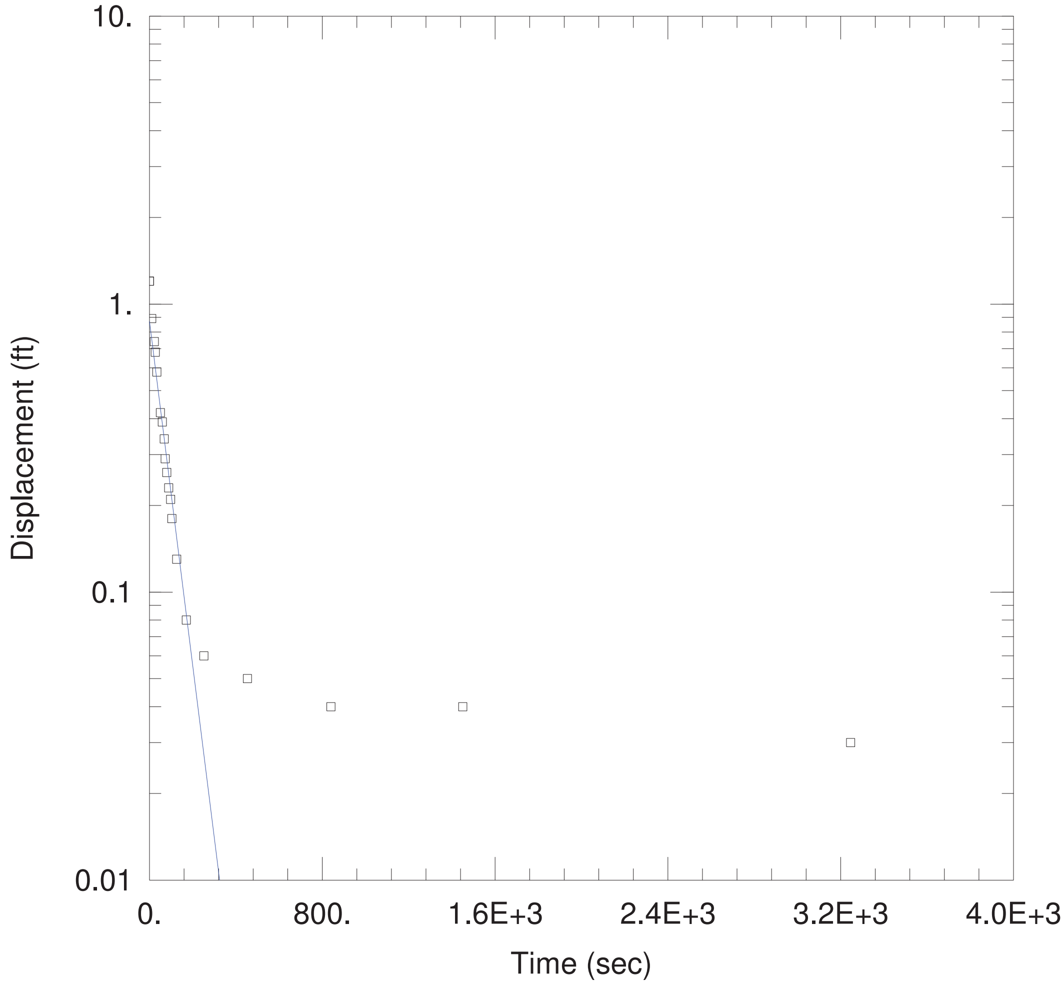
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 1.626

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0009041	cm/sec
y0	1.528	ft

T = K*b = 1.645 cm²/sec



G54D SLUG OUT 1

Data Set: P:\...\G54D Slug Out 1.aqt
Date: 09/22/17 Time: 14:47:11

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G54D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 59.7 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G54D SO1)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 5.66 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.14 ft
Screen Length: 5.66 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0004181 cm/sec y0 = 0.8699 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G54D Slug Out 1
Date: 09/22/17
Time: 14:47:25

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G54D

AQUIFER DATA

Saturated Thickness: 59.7 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G54D SO1

X Location: 831610.4 ft
Y Location: 199066.8 ft

Initial Displacement: 1.2 ft
Static Water Column Height: 6.14 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 5.66 ft
Total Well Penetration Depth: 5.66 ft

No. of Observations: 20

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.2	89.	0.23
11.	0.89	98.	0.21
23.	0.74	104.	0.18
27.	0.68	126.	0.13
35.	0.58	171.	0.08
51.	0.42	252.	0.06
60.	0.39	454.	0.05
69.	0.34	841.	0.04
73.	0.29	1451.	0.04
81.	0.26	3246.	0.03

SOLUTION

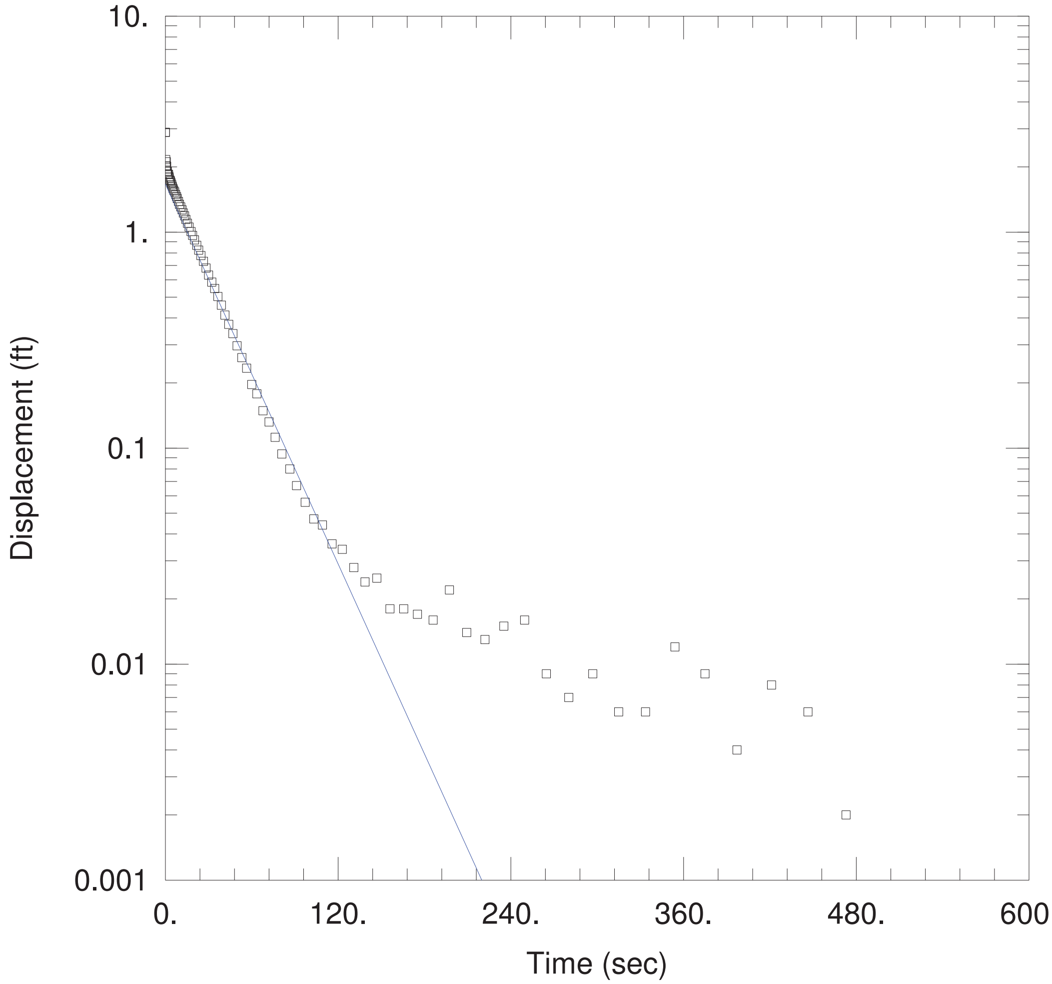
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 1.626

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0004181	cm/sec
y0	0.8699	ft

T = K*b = 0.7609 cm^2/sec



G54D SLUG OUT 2

Data Set: P:\...\G54D Slug Out 2.aqt
Date: 09/22/17 Time: 14:48:47

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G54D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 59.7 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G54D SO2)

Initial Displacement: 2.891 ft
Static Water Column Height: 6.14 ft
Total Well Penetration Depth: 5.66 ft
Screen Length: 5.66 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.000893 cm/sec
y0 = 1.668 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G54D Slug Out 2
Date: 09/22/17
Time: 14:49:02

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G54D

AQUIFER DATA

Saturated Thickness: 59.7 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G54D SO2

X Location: 831610.4 ft
Y Location: 199066.8 ft

Initial Displacement: 2.891 ft
Static Water Column Height: 6.14 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 5.66 ft
Total Well Penetration Depth: 5.66 ft

No. of Observations: 88

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.891	38.98	0.458
0.25	2.168	41.5	0.413
0.5	2.022	44.14	0.374
0.75	2.114	46.96	0.338
1.	2.014	49.96	0.297
1.25	1.911	53.14	0.262
1.5	1.908	56.5	0.234
1.75	1.858	60.1	0.197
2.	1.849	63.7	0.178
2.25	1.843	67.9	0.149
2.5	1.805	72.1	0.132
2.86	1.78	76.3	0.112
3.22	1.742	81.1	0.094
3.64	1.721	86.5	0.08
4.06	1.69	91.3	0.067
4.48	1.655	97.3	0.056
4.96	1.621	103.3	0.047
5.5	1.586	109.3	0.044
5.98	1.559	115.9	0.036
6.58	1.532	123.1	0.034
7.18	1.491	130.9	0.028
7.779	1.458	138.7	0.024
8.44	1.427	147.1	0.025
9.159	1.384	156.1	0.018
9.94	1.341	165.7	0.018
10.72	1.307	175.3	0.017
11.56	1.267	186.1	0.016
12.46	1.225	197.5	0.022
13.42	1.186	209.5	0.014
14.38	1.144	222.1	0.013

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
15.46	1.1	235.3	0.015
16.6	1.056	249.7	0.016
17.8	1.006	264.7	0.009
19.06	0.964	280.3	0.007
20.38	0.919	297.1	0.009
21.82	0.867	315.1	0.006
23.32	0.824	333.7	0.006
24.88	0.778	354.1	0.012
26.56	0.731	375.1	0.009
28.36	0.681	397.3	0.004
30.22	0.631	421.3	0.008
32.26	0.586	446.5	0.006
34.36	0.547	472.9	0.002
36.58	0.503	501.1	0.

SOLUTION

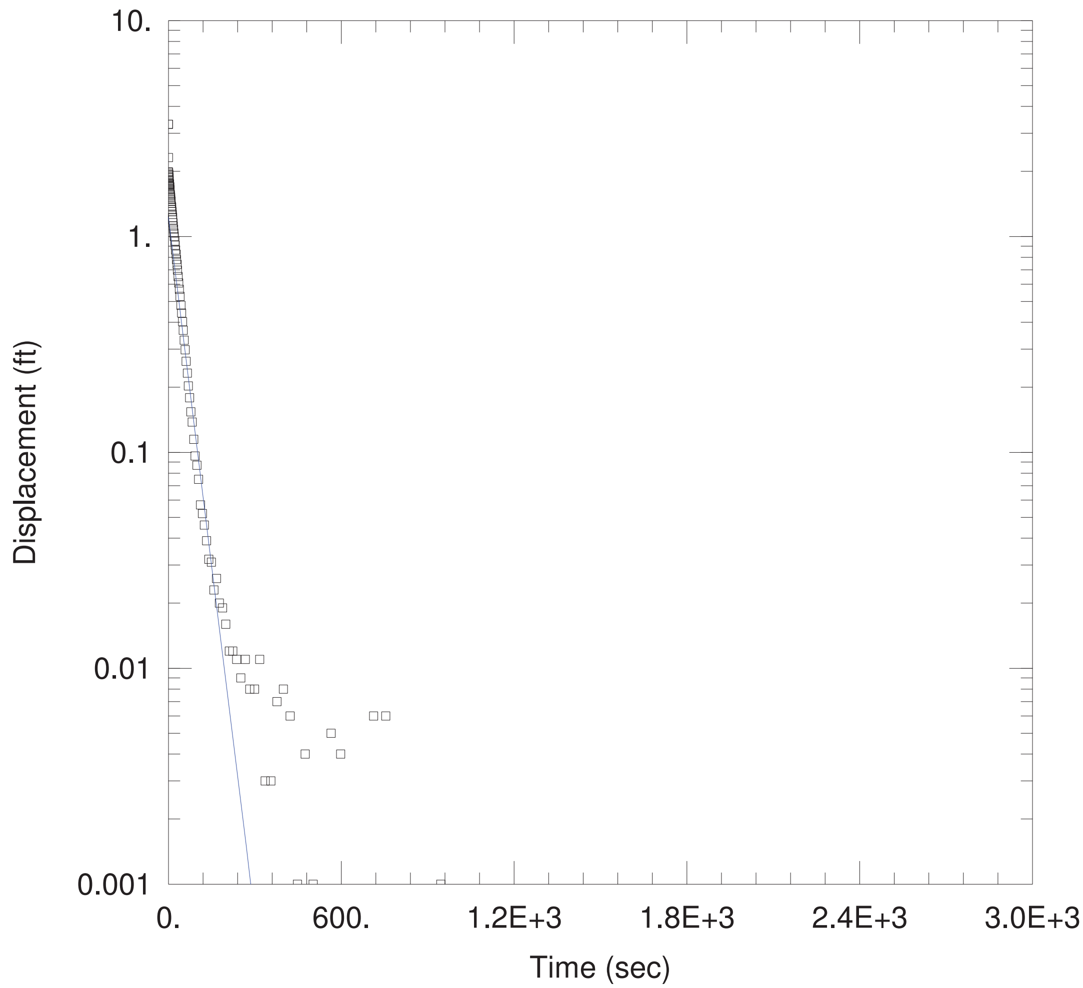
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 1.626

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.000893	cm/sec
y0	1.668	ft

T = K*b = 1.625 cm²/sec



G54D SLUG OUT 3

Data Set: P:\...\G54D Slug Out 3.aqt
Date: 09/22/17 Time: 14:50:24

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Well: G54D
Test Date: 4/3/2017

AQUIFER DATA

Saturated Thickness: 59.7 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (G54D SO3)

Initial Displacement: 3.308 ft Static Water Column Height: 6.14 ft
Total Well Penetration Depth: 5.66 ft Screen Length: 5.66 ft
Casing Radius: 0.08333 ft Well Radius: 0.3458 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0006569 cm/sec y0 = 1.225 ft

Data Set: P:\2200\2285\Data\Slug Testing\DC, HAV, COF, JOP, NEWT 2_2017\Joppa Tests\AQTESOLV and PDF
Title: G54D Slug Out 3
Date: 09/22/17
Time: 14:50:37

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Electric Energy, Inc. - Joppa
Project: 2285
Location: Joppa Power Station
Test Date: 4/3/2017
Test Well: G54D

AQUIFER DATA

Saturated Thickness: 59.7 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: G54D SO3

X Location: 831610.4 ft
Y Location: 199066.8 ft

Initial Displacement: 3.308 ft
Static Water Column Height: 6.14 ft
Casing Radius: 0.08333 ft
Well Radius: 0.3458 ft
Well Skin Radius: 0.3458 ft
Screen Length: 5.66 ft
Total Well Penetration Depth: 5.66 ft

No. of Observations: 125

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.308	78.3	0.154
0.25	2.319	83.1	0.138
0.5	1.98	88.5	0.115
0.75	1.985	93.3	0.096
1.	1.986	99.3	0.087
1.25	1.947	105.3	0.075
1.5	1.93	111.3	0.057
1.75	1.892	117.9	0.052
2.	1.873	125.1	0.046
2.25	1.87	132.9	0.039
2.5	1.839	140.7	0.032
2.75	1.822	149.1	0.031
3.	1.813	158.1	0.023
3.25	1.783	167.7	0.026
3.5	1.754	177.3	0.02
3.75	1.754	188.1	0.019
4.	1.742	199.5	0.016
4.25	1.723	211.5	0.012
4.5	1.697	224.1	0.012
4.86	1.697	237.3	0.011
5.22	1.658	251.7	0.009
5.64	1.641	266.7	0.011
6.06	1.623	282.3	0.008
6.48	1.581	299.1	0.008
6.96	1.562	317.1	0.011
7.5	1.533	335.7	0.003
7.98	1.511	356.1	0.003
8.58	1.481	377.1	0.007
9.18	1.457	399.3	0.008
9.78	1.424	423.3	0.006

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
10.44	1.386	448.5	0.001
11.16	1.365	474.9	0.004
11.94	1.33	503.1	0.001
12.72	1.301	533.1	0.
13.56	1.262	564.9	0.005
14.46	1.226	598.5	0.004
15.42	1.193	634.5	-0.003
16.38	1.155	670.5	0.
17.46	1.119	712.5	0.006
18.6	1.079	754.5	0.006
19.8	1.036	796.5	0.
21.06	0.999	844.5	-0.001
22.38	0.952	898.5	-0.005
23.82	0.912	946.5	0.001
25.32	0.866	1006.5	-0.003
26.88	0.827	1066.5	-0.001
28.56	0.782	1126.5	-0.004
30.36	0.741	1192.5	-0.005
32.22	0.698	1264.5	-0.006
34.26	0.652	1342.5	-0.009
36.36	0.609	1420.5	-0.01
38.58	0.568	1504.5	-0.007
40.98	0.528	1594.5	-0.015
43.5	0.479	1690.5	-0.011
46.14	0.442	1786.5	-0.012
48.96	0.403	1894.5	-0.018
51.96	0.368	2008.5	-0.012
55.14	0.331	2128.5	-0.019
58.5	0.298	2254.5	-0.014
62.1	0.264	2386.5	-0.011
65.7	0.233	2530.5	-0.023
69.9	0.203	2680.5	-0.022
74.1	0.179		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 1.626

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0006569	cm/sec
y0	1.225	ft

T = K*b = 1.195 cm²/sec

BORING LOGS

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G03

Drilling Start Date:	**02/02/2021**	Boring Depth (ft):	**67**	Well Depth (ft):	**67**
Drilling End Date:	**02/02/2021**	Boring Diameter (in):	**4.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**38.23**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**358.56**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**354.84**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**SK**	Location (Lat/Long):	**37.22078, -88.85045**	Filter Pack:	**Sand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
0	SS	14/24	2, 2, 3, 6	5	(0') CLAY (CL); some silt, high organics/roots, brown (10YR 4/3). (0.25') CLAYEY SILT (ML); brownish yellow (10YR 6/6), soft, dry, some light gray mottling.	
2	SS	20/24	2, 3, 4, 5	7	(2') As above: higher plasticity. (MH)	
4	SS	23/24	2, 3, 5, 6	8	(4') As above: few sand, lower plasticity. (ML)	
6	SS	24/24	2, 3, 4, 6	7	(6') SILT (ML); few sand and clay, yellowish brown (10YR 5/6), medium dense, dry, some light gray mottling.	
8	SS	23/24	1, 4, 6, 7	10	(8') As above.	
10	SS	23/24	2, 6, 6, 8	12	(11') As above: trace fine gravel from 11 to 11.5' bgs.	
12	SS	24/24	2, 6, 7, 10	13	(12') As above: brownish yellow (10YR 6/6).	
14	SS	24/24	2, 3, 5, 5	8	(14') As above: more light gray (10YR 7/2) mottling.	
16	SS	24/24	2, 3, 5, 6	8	(16') As above: trace sand.	
18	SS	24/24	3, 4, 5, 9	9	(18') As above: light gray (10YR 7/2) becomes dominant.	
20						

NOTES:

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Client: Dynegy		**WELL LOG**
Project: GLP0821, Joppa Ash Pond		**Well No.** G03
Address: Unnamed Road, Metropolis, IL 62960		**Page:** 2 of 4

Drilling Start Date: **02/02/2021**	Boring Depth (ft): **67**	Well Depth (ft): **67**
Drilling End Date: **02/02/2021**	Boring Diameter (in): **4.25**	Well Diameter (in): **2**
Drilling Company: **Geotechnology**	DTW During Drilling (ft):	Screen Slot (in): **0.010**
Drilling Method: **Hollow Stem Auger**	DTW After Drilling (ft): **38.23**	Riser Material: **Sch 40 PVC**
Drilling Equipment: **CME 55LC**	Top of Casing Elev. (ft): **358.56**	Screen Material: **Sch 40 PVC Slotted**
Driller:	Ground Elev. (ft): **354.84**	Seal Material(s): **Grout & Bentonite**
Logged By: **SK**	Location (Lat/Long): **37.22078, -88.85045**	Filter Pack: **Sand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
20	SS	24/24	1, 4, 8, 10	12	(20') SILT (ML); few clay, brownish yellow (10YR 6/6), very stiff, dry.	
22	SS	24/24	4, 6, 7, 4	13	(22') SANDY SILT (ML); yellowish brown (10YR 5/6), soft, dry.	
24	SS	24/24	2, 5, 5, 8	10	(24') As above: becomes moist, few red (2.5YR 4/6) silt.	
26	SS	24/24	1, 5, 5, 6	10	(26') As above: red silt disappears.	
28	SS	24/24	1, 3, 4, 6	7	(28') As above: becomes grayish brown (10YR 5/2).	
30	SS	24/24	1, 4, 4, 5	8	(30') As above.	30-32 Chem
32	SH	24/24				32-34 Geotech
34	SS	24/24	3, 4, 5, 6	9	(34') POORLY GRADED SAND (SP-SM); fine grained, few silt, brownish yellow (10YR 6/6), loose, moist to wet.	
36	SS	24/24	2, 2, 3, 5	5	(36') SANDY SILT (ML); light yellowish brown (10YR 6/4), soft, moist, medium plasticity.	
38	SS	24/24	2, 2, 3, 5	5	(38') As above: becomes evenly mottled with light gray (10YR 7/2).	
40						

NOTES: SBG03- (32-34)-20210202: 15.5% moisture content, 730 U mg/kg total organic carbon, 112.7 pcf dry unit weight, 2.659 specific gravity, 4.7x 10^{-7}, 27 LL, 16 PL, 11 PI, 0.6% gravel, 53.8% sand, 45.6% fines.
*U = Analyte was not present in concentrations above method detection limit and is reported as the reporting limit

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G03

Drilling Start Date:	02/02/2021	Boring Depth (ft):	67	Well Depth (ft):	67
Drilling End Date:	02/02/2021	Boring Diameter (in):	4.25	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	Hollow Stem Auger	DTW After Drilling (ft):	38.23	Riser Material:	Sch 40 PVC
Drilling Equipment:	CME 55LC	Top of Casing Elev. (ft):	358.56	Screen Material:	Sch 40 PVC Slotted
Driller:		Ground Elev. (ft):	354.84	Seal Material(s):	Grout & Bentonite
Logged By:	SK	Location (Lat/Long):	37.22078, -88.85045	Filter Pack:	Sand

DEPTH (ft)	Sample Type (COLLECT)	Recovery (in)	Blow Counts	N Value / RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample (MEASURE)
40	SS	24/24	1, 4, 4, 4	8	(40') SILT (ML); little sand, brownish yellow (10YR 6/6), soft, moist, medium plasticity.	
42	SS	24/24	1, 3, 4, 5	7	(42') As above.	
44	SS	24/24	2, 4, 6, 6	10	(44') As above: becomes dry, stiff.	
46	SS	24/24	2, 4, 13, 13	17	(46') SILTY SAND (SP-SM); very pale brown (10YR 7/3), loose, moist.	
48	SS	23/24	8, 10, 10, 9	20	(48') As above: becomes brownish yellow (10YR 6/8).	
50	SS	20/24	1, 6, 10, 13	16	(50.5') Wet at 50.5 to 50.8' bgs. (51') SAND (SP); fine grained, light gray (10YR 7/2), loose, moist.	
52	SS	24/24	1, 1, 1, 5	2	(52') As above: brownish yellow (10YR 6/6).	
54	SS	12/24	1, 1, 1, 3	2	(54') GRAVELLY SAND (SW); very pale brown (10YR 7/4), loose, wet.	
56	SS	24/24	1, 1, 1, 3	2	(56') As above: moist, very loose.	
58	SS	11/24	1, 1, 1, 7	2	(58') WELL-GRADED SAND (SW); medium to coarse grained, few gravel, very pale brown (10YR 7/4), very loose, moist.	58-60 Chem and Geotech (not tested)
60						

NOTES:

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Client: **Dynegy**		**WELL LOG**
Project: **GLP0821, Joppa Ash Pond**		**Well No. G03**
Address: **Unnamed Road, Metropolis, IL 62960**		

Drilling Start Date:	**02/02/2021**	Boring Depth (ft):	**67**	Well Depth (ft):	**67**
Drilling End Date:	**02/02/2021**	Boring Diameter (in):	**4.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**38.23**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**358.56**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**354.84**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**SK**	Location (Lat/Long):	**37.22078, -88.85045**	Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
60				SS	20/24	2, 6, 10, 11	16	(60') WELL-GRADED SAND (SW); medium to coarse grained, few gravel, very pale brown (10YR 7/4), wet, loose.	60-62 Geotech	
				SS	24/24	1, 3, 13, 12	16	(62') As above: reddish yellow (7.5YR 6/6).		
				SS	24/24	1, 15, 14, 13	29	(64') GRAVELLY SAND (SW); reddish yellow (7.5YR 6/8), wet, loose.		
65										
				SS	8/12	1, 4		(66') As above: brownish yellow (10YR 6/6).		
								(67') End of Boring.		
70										

NOTES: SBG03- (60-62)-20210202: 20.0% moisture content, 740 U mg/kg total organic carbon, 2.671 specific gravity, 1.5% gravel, 94.4% sand, 4.1% fines.
*U = Analyte was not present in concentrations above method detection limit and is reported as the reporting limit

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Client: Dynegy		**WELL LOG**
Project: GLP0821, Joppa Ash Pond		**Well No.** G05
Address: Unnamed Road, Metropolis, IL 62960		

Drilling Start Date:	**02/01/2021**	Boring Depth (ft):	**66**	Well Depth (ft):	**60**
Drilling End Date:	**02/01/2021**	Boring Diameter (in):	**7.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**361.68**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**358.45**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**BA**	Location (Lat/Long):	**37.21716, -88.84883**	Filter Pack:	**Sand**

COLLECT

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)
0	SS	18/24	6, 8, 3, 4	11
2	SS	12/24	2, 3, 4, 4	7
4	SS	24/24	3, 3, 7, 7	10
6	SS	24/24	3, 6, 7, 9	13
8	SS	24/24	3, 5, 5, 7	10
10	SS	24/24	3, 4, 5, 6	9
12	SS	24/24	2, 3, 5, 6	8
14	SS	24/24	4, 5, 8, 9	13
16	SS	24/24	2, 3, 5, 7	8
18	SS	24/24	2, 3, 4, 4	7

SOIL/ROCK VISUAL DESCRIPTION
(0') TOPSOIL.
(0.25') POORLY GRADED GRAVEL (GP)
(1.5') CLAY (CL); light brown (10YR 7/3), very stiff, low plasticity, dry.
(2') As above.
(4') As above: medium stiff.
(6') As above: mottled light brown (10YR 7/3) and light gray (8/1).
(8') As above: trace coarse gravel.
(10') As above: stiff.
(12') As above.
(13') CLAY (CL); mostly same as above with some very fine to fine grained sand and silt.
(14') As above: slightly moist.
(16') As above: dry.
(18') As above.

MEASURE: Lab Sample

Depth scale: 0, 5, 10, 15, 20 ft

NOTES:

Geosyntec consultants	Client: Dynegy Project: GLP0821, Joppa Ash Pond Address: Unnamed Road, Metropolis, IL 62960	**WELL LOG** Well No. G05 Page: 2 of 4

Drilling Start Date:	**02/01/2021**	Boring Depth (ft): **66**		Well Depth (ft):	**60**
Drilling End Date:	**02/01/2021**	Boring Diameter (in): **7.25**		Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft): **361.68**		Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft): **358.45**		Seal Material(s):	**Grout & Bentonite**
Logged By:	**BA**	Location (Lat/Long): **37.21716, -88.84883**		Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample	DEPTH (ft)
20				SS	24/24	4, 6, 6, 9	12	(20') As above.		
				SS	24/24	3, 5, 6, 7	11	(22') As above: medium stiff.		
25				SS	24/24	4, 7, 7, 4	14	(24') As above.		
				SS	24/24	3, 4, 7, 9	11	(26') As above: stiff.		
				SS	24/24	4, 5, 8, 10	13	(28') As above.		
30				SS	24/24	2, 4, 6, 7	10	(30') As above.		
				SH	24/24	3, 8, 11, 12	19	(32') As above.		
35				SS	24/24	8, 10, 11, 12	21	(34') As above.		
				SS	24/24	3, 5, 7, 9	12	(36') As above.		
				SS	24/24	3, 8, 11, 14	19	(38') SILTY CLAY (CL); same as above with more silt.		
40										

NOTES:

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG
Well No. G05

Drilling Start Date:	**02/01/2021**	Boring Depth (ft):	**66**	Well Depth (ft):	**60**
Drilling End Date:	**02/01/2021**	Boring Diameter (in):	**7.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**361.68**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**358.45**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**BA**	Location (Lat/Long):	**37.21716, -88.84883**	Filter Pack:	**Sand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
40	SS	24/24	5, 8, 8, 11	16	(40') As above: very stiff/hard.	
	SS	24/24	3, 4, 8, 7	12	(42') As above: brown mottling gone, now just gray (8/1).	
	SS	24/24	8, 8, 10, 12	18	(44') As above: hard.	
45	SS	24/24	3, 5, 8, 11	13	(46') As above.	
	SS	24/24	4, 4, 6, 7	10	(48') As above: medium stiff.	
50	SS	24/24	5, 7, 10, 12	17	(50') As above: some very fine to fine grained sand and silt, stiff.	
	SS	12/24	8, 8, 8, 9	16	(52') SILTY SAND (SM); mostly very fine to fine grained sand and silt with some clay, moist, tight, poorly graded, light gray (8/1) with some brown mottling.	
	SS	24/24	3, 4, 7, 11	11	(54') As above.	
55	SS	24/24	4, 8, 10, 14	18	(56') POORLY GRADED SAND (SP-SM); very fine to fine grained sand, some silt, tight, saturated at 57' bgs, light gray (8/1), some rust spots (5YR 6/8).	
	SS	24/24	3, 8, 8, 9	16	(58') POORLY GRADED SAND (SP); light gray (8/1), mostly fine to medium grained sand, medium packing, wet.	
60						

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G05

Drilling Start Date:	**02/01/2021**	Boring Depth (ft):	**66**	Well Depth (ft):	**60**
Drilling End Date:	**02/01/2021**	Boring Diameter (in):	**7.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**361.68**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**358.45**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**BA**	Location (Lat/Long):	**37.21716, -88.84883**	Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	Sample Type (COLLECT)	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample (MEASURE)	DEPTH (ft)
60				SS	24/24	2 4 5 8	9	(60') As above: wet. (61') As above: moist, some red color lamination.		
				SS	24/24	2 2 3 4	5	(62') As above: some silt, saturated, poorly graded, medium packing/toughness. (SP-SM) (63') As above: moist, some red lamination.		
65				SS	24/24	1 2 3 5	5	(64') As above: saturated, medium to loose toughness.		
								(65.5') SAND (SW); some gravel, color change to (5YR 7/6)		
								(66') End of Boring.		
70										

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G0f
Page: 1 o47

Drilling Start Date:	01/29/2021	Boring Depth (ft):	62	Well Depth (ft):	60
Drilling End Date:	01/29/2021	Boring Diameter (in):	f .25	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	wolloS utem AVger	DTW After Drilling (ft):		Riser Material:	uch 70 P&C
Drilling Equipment:	CME 55LC	Top of Casing Elev. (ft):	353.86	Screen Material:	uch 70 P&C ulotted
Driller:		Ground Elev. (ft):	352.47	Seal Material(s):	GroVt H Bentonite
Logged By:	BA H CL	Location (Lat/Long):	37.21116, -88.8492	Filter Pack:	uand

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
0	SS	24/24	4, 8, 6, 6	14	(0') TOPSOIL. (0.25') FAT CLAY (CH); light brown (5YR 6/8), stiff, dry.	
	SS	12/24	4, 5, 5, 6	10	(2') As above.	
	SS	24/24	4, 4, 7, 5	11	(4') As above.	
5	SS	24/24	4, 6, 7, 8	13	(6') As above.	
	SS	24/24	4, 3, 3, 5	6	(8') As above: medium stiffness.	
10	SS	24/24	4, 4, 7, 8	11	(10') LEAN CLAY (CL); light brown (5YR 7/4) to gray (mottled), stiff, dry.	
	SS	24/24	4, 5, 5, 6	10	(12') As above: top 6" soft with plant material.	
	SS	24/24	3, 3, 4, 4	7	(14') As above.	
15	SS	24/24			(16') As above.	
	SS	24/24	3, 4, 5, 7	9	(18') As above: silt and clay, some fine sand, stiff, dry. (ML-CL)	
20						

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Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G0f
Page: 2 o47

Drilling Start Date:	**01/29/2021**	Boring Depth (ft):	**62**	Well Depth (ft):	**60**
Drilling End Date:	**01/29/2021**	Boring Diameter (in):	**f .25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**wolloS utem AVger**	DTW After Drilling (ft):		Riser Material:	**uch 70 P&C**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**353.86**	Screen Material:	**uch 70 P&C ulotted**
Driller:		Ground Elev. (ft):	**352.47**	Seal Material(s):	**GroVt H Bentonite**
Logged By:	**BA H CL**	Location (Lat/Long):	**37.21116, -88.8492**	Filter Pack:	**uand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
20	SS	24/24	3, 4, 6, 7	10	(20') As above: rust spots.	
22	SS	24/24	3, 3, 4, 6	7	(22') As above: moist.	
24	SS	24/24	3, 3, 4, 5	7	(24') As above: mottled (10R 8/1).	
26	SS	24/24	3, 4, 7, 7	11	(26') SILTY SAND (SP-SM); mostly silt, fine grained sand, some mottling as previous, poorly graded, tight, moist.	
28	SS	24/24	3, 6, 7, 7	13	(28') POORLY GRADED SAND (SP); very fine to fine grained sand, light gray (10R 8/1), tight, moist.	
30	SS	24/24	9, 20, 21, 26	41	(30') As above. (31') POORLY GRADED SAND (SP); medium to coarse grained, loose, moist, (10R 8/1).	
32	SH	18/24	10, 6, 9, 9	15	(32') As above: color change to orange (5YR 6/8), clay at bottom.	
34	SS	24/24	4, 5, 6, 7	11	(34') FAT CLAY (CH); stiff, moist, light gray/orange mottled (10R 8/1 to 5YR 6/8).	
36	SS	24/24	3, 3, 5, 5	8	(36') As above: medium stiffness.	
38	SS	24/24	2, 2, 2, 3	4	(38') As above.	
40						

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Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G0f
Page: 3 o47

Drilling Start Date: 01/29/2021	Boring Depth (ft): 62	Well Depth (ft): 60
Drilling End Date: 01/29/2021	Boring Diameter (in): f .25	Well Diameter (in): 2
Drilling Company: Geotechnology	DTW During Drilling (ft):	Screen Slot (in): 0.010
Drilling Method: wolloS utem AVger	DTW After Drilling (ft):	Riser Material: uch 70 P&C
Drilling Equipment: CME 55LC	Top of Casing Elev. (ft): 353.86	Screen Material: uch 70 P&C ulotted
Driller:	Ground Elev. (ft): 352.47	Seal Material(s): GroVt H Bentonite
Logged By: BA H CL	Location (Lat/Long): 37.21116, -88.8492	Filter Pack: uand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
40				SS	24/24	3, 3, 5, 8	8	(40') As above.		
				SS	24/24	6, 12, 23, 24	35	(42') SILTY SAND (SP-SM); very fine grained sand and silt, tight, moist, poorly graded, light gray (10R 8/1).		
				SS	18/24	7, 18, 27, 33	45	(44') As above.		
45								(45') POORLY GRADED SAND (SP); very fine to fine grained sand, tight, moist, (10R 8/1).		
				SS	24/24	7, 18, 43, 47	61	(46') POORLY GRADED SAND (SP); fine to medium grained sand, loose, wet, interbedded gray to reddish orange (5YR 6/8) - seams 2cm.		
				SS	18/24	14, 17, 18, 7	35	(48') DIAMICTON (GW); mostly fine to coarse gravel and medium to coarse sand, saturated, very loose, well graded, (5YR 7/8).		
50				SS	24/24	12, 22, 36, 39	58	(50') WELL-GRADED SAND (SW); medium to coarse grained with fine gravel, saturated, loose.		
				SS	24/24	9, 11, 14, 18	25	(52') As above: (5YR 7/6).		
								(53') DIAMICTON (GW-SW); same as above, (5YR 6/8).		
				SS	24/24	19, 31, 53	84	(54') Same as above (SW).		
55								(55') WELL-GRADED GRAVEL and SAND (GW-SW); mostly fine to coarse grained gravel and fine to medium sand, loose, wet, light gray (10R 8/1), orangish tan chert nodules.		
				SS	24/24	7, 21, 14, 8	35	(57') As above: top 1' tan (5YR 6/8) bottom gray (10R 8/1), wet.		
				SS	24/24	6, 9, 11, 16	20	(58') POORLY GRADED SAND (SP); mostly very fine to fine grained sand, wet, loose, tan (7.5YR 8/4).		
60										

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G0f

Drilling Start Date:	**01/29/2021**	Boring Depth (ft):	**62**	Well Depth (ft):	**60**
Drilling End Date:	**01/29/2021**	Boring Diameter (in):	**f .25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**wolloS utem AVger**	DTW After Drilling (ft):		Riser Material:	**uch 70 P&C**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**353.86**	Screen Material:	**uch 70 P&C ulotted**
Driller:		Ground Elev. (ft):	**352.47**	Seal Material(s):	**GroVt H Bentonite**
Logged By:	**BA H CL**	Location (Lat/Long):	**37.21116, -88.8492**	Filter Pack:	**uand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
60				SS	24/24	32 48 38 8	86	(60') As above. (62') DIAMICTON (GW-SW); same as above.		
								(62') End of Boring.		
65										

NOTES:

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Drilling Start Date:	01/2E/2021	Boring Depth (ft):	86	Well Depth (ft):	8W
Drilling End Date:	01/28/2021	Boring Diameter (in):	Ef2W	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0f010
Drilling Method:	BolloH wtem ASger	DTW After Drilling (ft):		Riser Material:	wch u0 PVC
Drilling Equipment:	CM5 WWLC	Top of Casing Elev. (ft):	344.22	Screen Material:	wch u0 PVC wlotted
Driller:		Ground Elev. (ft):	341.72	Seal Material(s):	GroSt & 7 entonite
Logged By:	7 A	Location (Lat/Long):	37.20984, -88.85066	Filter Pack:	wand

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value / RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
0	SS		7, 3, 4, 6	7	(0') TOPSOIL. (0.25') WELL-GRADED SAND (SW); light brown/gray, loose, dry.	
2	SS		14, 11, 7, 6	18	(2') GRAVELLY SAND (GW-SW); loose, dry, mostly fine to coarse grained gravel and sand.	
4	SS		4, 3, 4, 4	7		
5					(5') SILT (ML); low plasticity, dark gray, dry, trace coarse gravel.	
6	SS		3, 2, 2, 4	4	(6') As above.	
8	SS		2, 2, 2, 2	4	(8') As above: trace fine gravel.	
10	SS		3, 4, 4, 4	8	(10') SILTY SAND (SM); dark gray, loose, dry, well-graded.	
12	SS		2, 2, 3, 3	5	(12') As above.	
14	SS		2, 3, 2, 4	5	(14') As above: clay seam at 15' (1-2").	
16	SS		2, 2, 2, 2	4	(16') POORLY GRADED SAND and CLAY (SP/CL); dark gray interbedded with dark gray, medium stiff, clay - 2" beds alternating.	
18	SS		1, 2, 1, 1	3		
20						

NOTES:

Geosyntec consultants	Client: Dynegy Project: GLP0821, Joppa Ash Pond Address: Unnamed Road, Metropolis, IL 62960	O 5LL LNG Oell . of G08 Page: 2 o4W

Drilling Start Date:	**01/2E/2021**	Boring Depth (ft):	**86**	Well Depth (ft):	**8W**
Drilling End Date:	**01/28/2021**	Boring Diameter (in):	**Ef2W**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0f010**
Drilling Method:	**BolloH wtem ASger**	DTW After Drilling (ft):		Riser Material:	**wch u0 PVC**
Drilling Equipment:	**CM5 WLC**	Top of Casing Elev. (ft):	**344.22**	Screen Material:	**wch u0 PVC wlotted**
Driller:		Ground Elev. (ft):	**341.72**	Seal Material(s):	**GroSt & 7 entonite**
Logged By:	**7 A**	Location (Lat/Long):	**37.20984, -88.85066**	Filter Pack:	**wand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
20	SS		1, 1, 1, 2	2	(20') CLAY (CH); high plasticity, soft, moist, gray to green.	
	SS		1, 1, 1, 1	2	(21.5') SILTY SAND (SM); wet, loose, gray to green. (22') As above.	
25	SS		3, 2, 2, 2	4	(24') SILT (ML); loose, dark gray, black clay seam - 2".	
	SS		2, 2, 1, 2	3	(26') CLAY (CH); gray to green, saturated, high plasticity. (27') SILT (ML); soft, moist, gray to green.	
	SS		1, 1, 1, 2	2	(28') SILTY SAND (SM-SP); light gray, firm, saturated, mostly poorly graded fine to medium grained sand and silt.	
30	SS		3, 2, 3, 4	5	(30') As above. (31') SILTY SAND (SM); tight, light gray, poorly graded, fine to medium grained sand.	
	SS		3, 3, 4, 4	7	(32') As above. (33') CLAY (CL); light gray, hard, low plasticity, dry.	
35	SS		4, 4, 3, 3	7	(35') As above: some fine grained sand.	
	SS		3, 4, 4, 5	8	(36') As above: gradually grades to fine to medium sand. (37') POORLY GRADED SAND (SP); fine to medium grained sand, tight, trace gravel, mottled with rusty red color.	
40	SS		3, 3, 3, 3	6	(38') As above.	

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Client: Dynegy		**O 5LL LNG**
Project: GLP0821, Joppa Ash Pond		**O ell . of** **G08**
Address: Unnamed Road, Metropolis, IL 62960		**Page:** **3 o4W**

Drilling Start Date:	**01/2E/2021**	Boring Depth (ft):	**86**	Well Depth (ft):	**8W**
Drilling End Date:	**01/28/2021**	Boring Diameter (in):	**Ef2W**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0f010**
Drilling Method:	**BolloH wtem ASger**	DTW After Drilling (ft):		Riser Material:	**wch u0 PVC**
Drilling Equipment:	**CM5 WWLC**	Top of Casing Elev. (ft):	**344.22**	Screen Material:	**wch u0 PVC wlotted**
Driller:		Ground Elev. (ft):	**341.72**	Seal Material(s):	**GroSt & 7entonite**
Logged By:	**7A**	Location (Lat/Long):	**37.20984, -88.85066**	Filter Pack:	**wand**

DEPTH (ft)	Sample Type	Blow Counts	N Value	SOIL/ROCK VISUAL DESCRIPTION
40	SS	5, 10, 12, 12	22	(40') POORLY GRADED SAND (SP); fine to medium grained, tight, light gray, mottled with rust color. (41') As above: saturated.
42	SS	3, 5, 8, 8	13	(42') As above: some fine to coarse gravel. (43.5') As above: nodule (red chert), saturated.
44	SS	3, 6, 7, 7	13	(44') As above: lots of fine to coarse gravel, yellow/orange/red, gravel/nodules.
46	SS	5, 7, 7, 11	14	(46') GRAVELLY SAND (GW-SW); mostly fine grained sand and fine to coarse gravel, light gray, gravel bits are red/yellow, saturated.
48	SS	1, 5, 5, 5	10	(48') As above: very loose.
50	SS	9, 9, 5, 14	14	(50') As above. (51.5') As above: some silt.
52	SS	3, 11, 11, 10	22	(52') WELL-GRADED SAND (SW); fine to coarse grained, trace fine gravel, tan, very loose.
54	SS	9, 14, 12, 10	26	(54') WELL-GRADED GRAVELLY SAND (GW-SW); tan, moist, coarse grained gravel, fine to coarse sand, very loose, wet. (55') As above: light gray.
56	SS	17, 19, 17, 17	36	(56') POORLY GRADED SAND (SP); fine to medium grained, wet, loose, dark tan. (57.5') WELL-GRADED GRAVELLY SAND (GW); dark tan, loose.
58	SS	6, 8, 11, 12	19	(58') As above. (59') WELL-GRADED SAND (SW); dark tan, wet, loose, trace fine gravel.

Column headings: DEPTH (ft); LITHOLOGY; WATER LEVEL; WELL COMPLETION; COLLECT: Sample Type, Recovery (in), Blow Counts, N Value RQD (%); SOIL/ROCK VISUAL DESCRIPTION; MEASURE: Lab Sample; DEPTH (ft). Depth scale: 40, 45, 50, 55, 60.

NOTES:

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Client: Dynegy

Project: GLP0821, Joppa Ash Pond

Address: Unnamed Road, Metropolis, IL 62960

O 5LL LNG

O ell . of G08

Page: u o4W

Drilling Start Date:	01/2E/2021	Boring Depth (ft):	86	Well Depth (ft):	8W
Drilling End Date:	01/28/2021	Boring Diameter (in):	Ef2W	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0f010
Drilling Method:	BolloH wtem ASger	DTW After Drilling (ft):		Riser Material:	wch u0 PVC
Drilling Equipment:	CM5 WLC	Top of Casing Elev. (ft):	344.22	Screen Material:	wch u0 PVC wlotted
Driller:		Ground Elev. (ft):	341.72	Seal Material(s):	GroSt & 7entonite
Logged By:	7A	Location (Lat/Long):	37.20984, -88.85066	Filter Pack:	wand

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
60	SS	24/24	14, 10, 14, 11	24	(60') As above.	
61					(61') GRAVELLY SAND (GW-SW); dark tan, well-graded, coarse chert nodules, wet, loose.	
62	SS	18/24	5, 3, 4, 5	7	(62') As above.	
64	SS	12/24	4, 8, 5, 8	13	(64') As above.	
66	SS	18/24	5, 8, 8, 7	16	(66') As above.	
68	SS	18/24	5, 7, 7, 8	14	(68') As above: saturated.	
70	SS	12/24	5, 6, 7, 7	13	(70') As above.	
72	SS	18/24	7, 9, 9, 11	18	(72') As above.	
74	SS	24/24	7, 7, 8, 9	15	(74') As above: mostly silt and gravel, (5YR 6/8).	
76	SS	18/24	10, 16, 17, 25	33	(76') WELL-GRADED SAND (SW); mostly medium to coarse grained sand, wet, loose, (5YR 6/8).	
78	SS	24/24	8, 15, 39, 42	54	(78') DIAMICTON (SW-SM); mostly coarse grained gravel, fine sand, silt, wet, medium density, (5YR 6/8).	
79					(79') Same fine to coarse gravel, more coarse gravel, (5YR 6/8). (GW-SW)	
80						

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Client: Dynegy		O 5LL LNG
Project: GLP0821, Joppa Ash Pond		Oell . of G08
Address: Unnamed Road, Metropolis, IL 62960		Page: Wo4W

Drilling Start Date: **01/2E/2021**	Boring Depth (ft): **86**	Well Depth (ft): **8W**
Drilling End Date: **01/28/2021**	Boring Diameter (in): **Ef2W**	Well Diameter (in): **2**
Drilling Company: **Geotechnology**	DTW During Drilling (ft):	Screen Slot (in): **0f010**
Drilling Method: **BolloH wtem ASger**	DTW After Drilling (ft):	Riser Material: **wch u0 PVC**
Drilling Equipment: **CM5 WWLC**	Top of Casing Elev. (ft): **344.22**	Screen Material: **wch u0 PVC wlotted**
Driller:	Ground Elev. (ft): **341.72**	Seal Material(s): **GroSt & 7entonite**
Logged By: **7A**	Location (Lat/Long): **37.20984, -88.85066**	Filter Pack: **wand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	Sample Type (COLLECT)	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample (MEASURE)	DEPTH (ft)
80				SS	18/24	6, 11, 12, 14	23	(80') As above. (SW)		
								(81.5') 1/2" seam - orangish sand, medium packing, moist, (7.5YR 8/6). (SP)		
				SS	24/24	7, 14, 19, 21	33	(82') Same as above. (SW)		
								(83') Same as above, top 3" (10R 6/6), tight, moist. (SP)		
				SS	12/24	19, 27, 15, 5	42	(84') As above.		
85								(85') 2cm seam of reddish/oxidized fine grained sand, dry.		
								(86') End of Boring.		
90										

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G09M

Drilling Start Date:	01/26/2021	Boring Depth (ft):	158	Well Depth (ft):	155
Drilling End Date:	01/28/2021	Boring Diameter (in):	4.25	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	Hollow Stem Auger	DTW After Drilling (ft):	51.93	Riser Material:	Sch 80 PVC
Drilling Equipment:	CME 55LC	Top of Casing Elev. (ft):	351.53	Screen Material:	Sch 80 PVC Slotted
Driller:		Ground Elev. (ft):	348.60	Seal Material(s):	Grout & Bentonite
Logged By:	SK & AT	Location (Lat/Long):	37.21040, -88.85422	Filter Pack:	Sand

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample (MEASURE)
0	SS	6/24	6, 4, 5, 6	9	(0') LEAN CLAY (CL); brown (7.5YR 5/3), stiff, dry, some reddish brown mottling, trace sand.	
2	SS	22/24	4, 5, 6, 4	11		
4	SS	24/24	2, 3, 3, 4	6	(4') FAT CLAY (CH); light brown (7.5YR 6/4), medium dense, moist.	
6	SS	24/24	0, 3, 3, 4	6	(6') As above: lean clay, moist. (CL)	
8	SS	24/24	2, 3, 5, 5	8	(8') As above: brown (7.5YR 5/4), some reddish brown mottling.	
10	SS	20/24	2, 3, 4, 5	7	(10') As above.	10-12 Chem
12	SS	22/24	2, 4, 5, 5	9	(12') CLAY (CL); gray to light brown (7.5YR 6/1) mottled, medium dense, dry, few sand.	
14	SS	21/24	2, 3, 5, 5	8	(14') As above: brown (7.5YR 5/4).	
16	SH	24/24			(16') As above: light brown (7.5YR 6/3).	16-18 Geotech
18	SS	23/24	2, 5, 6, 7	11	(18') CLAY (CL); gray to light brown (7.5YR 6/1) mottled, very stiff, moist, few sand.	
20						

NOTES: SBG09M- (16-18)-20210127: 20.6% moisture content, 950 mg/kg total organic carbon, 105.4 pcf dry unit weight, 2.666 specific gravity, 8.3x 10^{-8} cm/s vertical hydraulic conductivity, 39 LL, 16PL, 23PI, 0.0% gravel, 5.0% sand, 95.0% fines.

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Client:	Dynegy	**WELL LOG**	
Project:	GLP0821, Joppa Ash Pond	Well No.	G09M
Address:	Unnamed Road, Metropolis, IL 62960	Page:	2 of 8

Drilling Start Date:	01/26/2021	Boring Depth (ft):	158	Well Depth (ft):	155
Drilling End Date:	01/28/2021	Boring Diameter (in):	4.25	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	Hollow Stem Auger	DTW After Drilling (ft):	51.93	Riser Material:	Sch 80 PVC
Drilling Equipment:	CME 55LC	Top of Casing Elev. (ft):	351.53	Screen Material:	Sch 80 PVC Slotted
Driller:		Ground Elev. (ft):	348.60	Seal Material(s):	Grout & Bentonite
Logged By:	SK & AT	Location (Lat/Long):	37.21040, -88.85422	Filter Pack:	Sand

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value / RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
20	SS	24/24	2, 4, 7, 8	11	(20') CLAY (CL); light gray with brown (10YR 7/1) mottling, very stiff, moist, trace sand and silt.	20-22 Chem
22	SS	24/24	4, 6, 7, 8	13	(22') As above: (10YR 7/2).	
24	SS	24/24	2, 5, 7, 8	12	(24') As above: fewer brown mottling.	
26	SS	24/24	3, 3, 6, 7	9	(27-28') As above: increased reddish brown mottling.	
28	SS	24/24	4, 8, 8, 7	16	(28') SILT (ML); with few sand and clay, light gray (10YR 7/2) with some brown mottling, dry, stiff.	
30	SS	24/24	4, 8, 6, 8	14	(30') As above: moist.	
32	SS	24/24	4, 5, 6, 7	11	(32') As above.	
34	SS	24/24	2, 4, 4, 6	8	(34') SANDY CLAY (SC); light gray (10YR 7/2) with some brown mottling, moist. (34.5') SILT (ML); with some sand, few clay, stiff.	
36	SS	24/24	3, 4, 5, 8	9	(36') As above: trace black organics.	
38	SS	24/24	5, 20, 18, 17	38	(38') SANDY CLAY (SC); fine grained sand, few silt, gray (7.5YR 5/1), moist.	
40						

NOTES:

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G09M

Drilling Start Date:	**01/26/2021**	Boring Depth (ft):	**158**	Well Depth (ft):	**155**
Drilling End Date:	**01/28/2021**	Boring Diameter (in):	**4.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**51.93**	Riser Material:	**Sch 80 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**351.53**	Screen Material:	**Sch 80 PVC Slotted**
Driller:		Ground Elev. (ft):	**348.60**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**SK & AT**	Location (Lat/Long):	**37.21040, -88.85422**	Filter Pack:	**Sand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
40	SS	24/24	3, 6, 8, 7	14	(40') SILT WITH SAND (ML); few clay, gray (7.5YR 6/1), moist.	
42	SS	24/24	5, 3, 4, 5	7	(42') As above: some reddish brown mottling.	
44	SS	24/24	2, 3, 5, 6	8	(44') As above: fewer clay, more sand.	
46	SH	24/24				46-48 Geotech
48	SS	24/24	5, 8, 18, 12	26	(48') SILT WITH CLAY (ML); gradationally sandier, becomes moist, stiff to medium dense, gray (7.5YR 6/1).	48-50 Chem
50	SS	20/24	18, 8, 15, 23	23	(50') POORLY GRADED SAND (SP); light gray (7.5YR 7/1), moist, loose.	
52	SS	16/24	16, 22, 28, 32	50	(52') POORLY GRADED SAND (SP); fine grained, with gravel up to cobble size, light gray (10YR 7/1), medium dense to loose, moist.	
54	SS	20/24	25, 45, 49, 49	94	(54') POORLY GRADED SAND (SP); fine to medium grained, light gray (7.5YR 7/1), moist, loose. (55') As above: few coarse gravel, reddish yellow (7.5YR 7/6).	
56	SS	23/24	27, 33, 20, 20	53	(56') POORLY GRADED SAND (SP); fine to coarse grained, with coarse gravel, moist, gray (7.5YR 7/1) to reddish yellow (7.5YR 7/8).	
58	SS	18/24	8, 33, 47, 34	80	(58') As above: fine gray sand contains trace silt.	
60						

NOTES: SBG09M- (46-48)-20210127: 19.8% moisture content,105.4 pcf dry unit weight, 2.715 specific gravity, $3.5x\ 10^{-7}$ cm/s vertical hydraulic conductivity, 35 LL, 15 PL, 20 PI, 0.0% gravel, 17.2% sand, 82.8% fines.

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Client: Dynegy	**WELL LOG**	
Project: GLP0821, Joppa Ash Pond	**Well No.**	**G09M**
Address: Unnamed Road, Metropolis, IL 62960	**Page:**	**4 of 8**

Drilling Start Date:	**01/26/2021**	Boring Depth (ft):	**158**	Well Depth (ft):	**155**
Drilling End Date:	**01/28/2021**	Boring Diameter (in):	**4.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**51.93**	Riser Material:	**Sch 80 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**351.53**	Screen Material:	**Sch 80 PVC Slotted**
Driller:		Ground Elev. (ft):	**348.60**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**SK & AT**	Location (Lat/Long):	**37.21040, -88.85422**	Filter Pack:	**Sand**

DEPTH (ft)	COLLECT: Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample
60	SS	16/24	32, 35, 47, 21	82	(60') POORLY GRADED SAND (SP); coarse grained, reddish yellow (7.5YR 6/8), moist, loose.	
	SS	16/24	22, 50/5, 14	64	(62') POORLY GRADED SAND (SP); coarse grained, reddish yellow (7.5YR 6/8), medium dense, some coarse gravel pebble size.	
65	SS	13/24	17, 11, 12, 12	23	(64') As above: increasing fine to coarse gravel.	
	SS	12/24	15, 16, 15, 11	31	(66') As above.	
	SS	11/24	38, 50	50	(68') POORLY GRADED GRAVEL WITH SAND (GP); strong brown (7.5YR 5/6), loose, moist.	
70	SS	12/24	14, 17, 30, 32	47	(70') As above.	
	SS	12/24	25, 24, 15, 16	39	(72') As above: reddish yellow (7.5YR 6/8).	
75	SS	8/24	6, 25, 20, 12	45	(74') As above: sand disappears, wet.	
	SS	14/24	7, 7, 8, 7	15	(76') As above: strong brown (7.5YR 5/8).	
80	SS	16/24	11, 22, 14, 8	36	(78') As above: with some sand.	

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Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G09M

Drilling Start Date:	**01/26/2021**
Drilling End Date:	**01/28/2021**
Drilling Company:	**Geotechnology**
Drilling Method:	**Hollow Stem Auger**
Drilling Equipment:	**CME 55LC**
Driller:	
Logged By:	**SK & AT**
Boring Depth (ft):	**158**
Boring Diameter (in):	**4.25**
DTW During Drilling (ft):	
DTW After Drilling (ft):	**51.93**
Top of Casing Elev. (ft):	**351.53**
Ground Elev. (ft):	**348.60**
Location (Lat/Long):	**37.21040, -88.85422**
Well Depth (ft):	**155**
Well Diameter (in):	**2**
Screen Slot (in):	**0.010**
Riser Material:	**Sch 80 PVC**
Screen Material:	**Sch 80 PVC Slotted**
Seal Material(s):	**Grout & Bentonite**
Filter Pack:	**Sand**

DEPTH (ft)	COLLECT: Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample
80	SS	12/24	2, 17, 19, 12	36	(80') POORLY GRADED GRAVEL (GP); little sand, reddish yellow (7.5YR 6/8), very loose, wet.	80-82 Chem
82	SS	10/24	5, 18, 13, 14	31		82-84 Geotech
83.7					(83.7') POORLY GRADED SAND (SP); medium grained, trace gravel, reddish brown (7.5YR 6/8), loose, moist.	
84	SS	14/24		19		
85						
86	SS	14/24	12, 9, 10, 10	22	(86') WELL-GRADED GRAVEL (GW); few sand, trace clay, reddish brown (7.5YR 6/8), loose, wet.	
88	SS	14/24	25, 14, 8, 6	14	(88') As above: clay disappears.	
90	SS		4, 6, 8, 7			
91					(91') GRAVELLY LEAN CLAY (CL); very pale brown (10YR 8/2), moist, soft.	
92	SS		2, 3, 3, 4	6	(92') CLAY (CL); trace gravel, gray (7.5YR 6/1), medium dense.	
94	SS		2, 1, 3, 3	4	(94') As above: gray (10YR 5/1).	
95						
96	SS		1, 6, 23, 23	29	(96') POORLY GRADED SAND (SP); fine grained, strong brown (7.5YR 5/8), loose.	
98	SS		5, 14, 25, 23	39	(98') As above.	
100						

NOTES: SBG09M- (82-84)-20210127: 7.6% moisture content, 740 U mg/kg total organic carbon, 100.0 pcf dry unit weight, 2.686 specific gravity, 22.7% gravel, 75.4% sand, 1.9% fines.
*U = Analyte was not present in concentrations above method detection limit and is reported as the reporting limit

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Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G09M

Drilling Start Date:	01/26/2021	Boring Depth (ft):	158	Well Depth (ft):	155
Drilling End Date:	01/28/2021	Boring Diameter (in):	4.25	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	Hollow Stem Auger	DTW After Drilling (ft):	51.93	Riser Material:	Sch 80 PVC
Drilling Equipment:	CME 55LC	Top of Casing Elev. (ft):	351.53	Screen Material:	Sch 80 PVC Slotted
Driller:		Ground Elev. (ft):	348.60	Seal Material(s):	Grout & Bentonite
Logged By:	SK & AT	Location (Lat/Long):	37.21040, -88.85422	Filter Pack:	Sand

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
100	SS	14/24	14, 14, 13, 15	27	(100') CLAY (CL); (10YR 6/1), very soft, trace gravel.	
101					(101') CLAYEY GRAVEL (GC); (7.5YR 5/8), moist, loose.	
102	SS	15/24	14, 12, 8, 15	20	(102') As above: some sand, brown (7.5YR 4/4).	
104	SS	9/24	12, 12, 9, 14	21	(104') GRAVELLY CLAY (CL); light gray (2.5Y 7/2), stiff, moist.	
105						
106	SS	15/24	12, 12, 12, 20	24	(106') CLAYEY GRAVEL (GC); pinkish gray (7.5YR 7/2), medium dense, moist.	
108	SS	14/24	9, 28, 11, 11	39	(108') POORLY GRADED SAND (SP); fine grained, yellow (10YR 7/6) to white (10YR 8/1) at 109.8' bgs, moist, loose.	
110	SS	15/24	8, 12, 8, 12	20	(110') As above: light gray (10YR 7/1).	110-112 Chem
112	SH	8/24				112-114 Geotech
114	SS	13/24	10, 11, 9, 10	20	(114') As above: yellow (10YR 7/6), trace gravel.	
115						
116	SS	12/24	7, 9, 9, 12	18	(116') As above: light gray (10YR 7/2), no gravel.	116-118 Geotech (not tested)
118	SS	22/24	7, 1, 2, 3	3	(118') SILT WITH SAND (ML); gray (10YR 6/1) with some light brown mottling, soft, moist.	
119.5					(119.5') CLAY (CL); little silt, gray (10YR 6/1), stiff, moist.	
120						

NOTES: SBG09M- (110-112)-20210127: 25.5% moisture content, 760 U mg/kg total organic carbon, 87.0 pcf dry unit weight, 2.675 specific gravity, 0.7% gravel, 84.1% sand, 15.2% fines.
*U = Analyte was not present in concentrations above method detection limit and is reported as the reporting limit

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Drilling Start Date:	**01/26/2021**	Boring Depth (ft):	**158**	Well Depth (ft):	**155**
Drilling End Date:	**01/28/2021**	Boring Diameter (in):	**4.25**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**51.93**	Riser Material:	**Sch 80 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**351.53**	Screen Material:	**Sch 80 PVC Slotted**
Driller:		Ground Elev. (ft):	**348.60**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**SK & AT**	Location (Lat/Long):	**37.21040, -88.85422**	Filter Pack:	**Sand**

DEPTH (ft)	COLLECT: Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample
120	SS	21/24	2, 3, 4, 14	7	(120') SAND WITH SILT (SM); light gray (10YR 7/1), medium dense, moist. (121') As above: less silty. (SP-SM)	
	SS	16/24	7, 7, 22, 31	29	(123.5') As above: yellow (2.5Y 7/6). (SP)	
125	SS	11/24	13, 14, 16, 14	30	(124') POORLY GRADED SAND (SP); fine to medium grained, red (2.5YR 5/6), loose, dry.	
	SS	16/24	3, 5, 8, 10	13	(126') CLAY (CL); few silt and sand, light brownish gray (10YR 6/2), very stiff, dry.	
	SS	15/24	3, 8, 9, 13	17	(128') As above.	128-130 Chem
130	SS	15/24	8, 13, 17, 6	30	(130') Crushed SAPROLITE, dark yellowish brown (10YR 3/4) to black (10YR 2/1).	
	SS	16/24	6, 4, 6, 6	10	(132') CLAY (CL); few gravel, few sand, yellowish brown (10YR 5/4), moist, stiff.	132-134 Chem
135	SS	22/24	1, 2, 6, 7	8	(134') As above: light brownish gray (10YR 6/2), no sand.	
	SS	20/24	2, 5, 5, 6	10	(136') As above: very pale brown (10YR 7/3).	
140	SS	13/24	4, 8, 7, 21	15	(138') As above: light yellowish brown (5YR 6/4).	

NOTES:

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Client: Dynegy		**WELL LOG**
Project: GLP0821, Joppa Ash Pond		Well No. G09M
Address: Unnamed Road, Metropolis, IL 62960		Page: 8 of 8

Drilling Start Date:	01/26/2021	Boring Depth (ft):	158	Well Depth (ft):	155
Drilling End Date:	01/28/2021	Boring Diameter (in):	4.25	Well Diameter (in):	2
Drilling Company:	Geotechnology	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	Hollow Stem Auger	DTW After Drilling (ft):	51.93	Riser Material:	Sch 80 PVC
Drilling Equipment:	CME 55LC	Top of Casing Elev. (ft):	351.53	Screen Material:	Sch 80 PVC Slotted
Driller:		Ground Elev. (ft):	348.60	Seal Material(s):	Grout & Bentonite
Logged By:	SK & AT	Location (Lat/Long):	37.21040, -88.85422	Filter Pack:	Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
140				SS	6/24	70/1		(140') CALCARENITE, very pale brown (10YR 7/3), dry.	140-142 Chem	
145										
150										
155								(155') End of Boring.		
								(158') Redrilled to 158' due to well installation difficulties.		
160										

NOTES:

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Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG

Well No. G11

Drilling Start Date:	**01/19/2021**	Boring Depth (ft):	**66**	Well Depth (ft):	**66**
Drilling End Date:	**01/19/2021**	Boring Diameter (in):	**7.5**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**45.66**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**366.88**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**363.38**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**ZJF & AT**	Location (Lat/Long):	**37.21436, -88.85636**	Filter Pack:	**Sand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
0	SS	24/24	6, 4, 9, 7	13	(0') TOPSOIL. (0.2') ASH (ML) (0.8') LEAN SILT (ML); trace fine sand, stiff, moist, tan (2.5Y 7/4).	
	SS	17/24	1, 1, 2, 4	3	(2.7') LEAN CLAY (CL); some orange fine sand, soft, wet, brown (2.5Y 3/3).	
5	SS	16/24	5, 21, 50/6	71	(5.1') SILTY SAND (SM); fine to medium grained, with coal, some organics, very dense, gray (N3), moist, well-graded.	
	SS	17/24	5, 7, 5, 5	12	(7.0') LEAN CLAY (CL); stiff, moist, tan (5Y 7/2) with gray (N8) mottles.	
	SS	24/24	1, 3, 5, 6	8	(8') As above: becomes medium stiff, orange (10YR 7/12) mottles.	
10	SS	24/24	2, 5, 8, 6	13	(10') As above: becomes stiff, black inclusions, trace organics.	
	SS	23/24	2, 4, 5, 7	9	(12') As above.	
	SS	24/24	2, 5, 6, 8	11	(14') As above.	
15	SS	24/24	2, 4, 5, 6	9	(16') As above.	
	SS	24/24	3, 7, 9, 10	16	(18') LEAN SILT (ML); trace sand, stiff, moist, tan (5Y 7/2) with orange (10YR 7/12) and black mottling.	
20						

NOTES:

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Client: Dynegy	WELL LOG
Project: GLP0821, Joppa Ash Pond	Well No. G11
Address: Unnamed Road, Metropolis, IL 62960	Page: 2 of 4

Drilling Start Date:	**01/19/2021**	Boring Depth (ft):	**66**	Well Depth (ft):	**66**
Drilling End Date:	**01/19/2021**	Boring Diameter (in):	**7.5**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**45.66**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**366.88**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**363.38**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**ZJF & AT**	Location (Lat/Long):	**37.21436, -88.85636**	Filter Pack:	**Sand**

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample
20	SS	24/24	3, 6, 8, 8	14	(20.1') LEAN CLAY (CL); trace fine sand, stiff, moist, tannish orange (10YR 7/6) with gray (N8) mottles.	
22	SS	27/24	2, 4, 6, 7	10	(22') As above.	22-24 Chem
24	SS	27/24			(24') As above.	24-26 ST
26	SS	24/24	3, 4, 5, 7	9	(26') As above.	
28	SS	24/24	3, 4, 6, 7	10	(28') As above.	
30	SS	26/24	2, 4, 4, 6	8	(30') As above: with increased moisture.	
32	SS	24/24	2, 4, 4, 6	8	(32') As above.	
34	SS	25/24	4, 5, 8, 7	13	(34') As above: with fine sand.	
36	SS	26/24	2, 5, 5, 5	10	(36') As above: orange (10YR 7/12) inclusions, gray (N8) with tan orange (10YR 7/6) mottling.	
38	SS	25/24	2, 4, 6, 6	10	(38') As above: trace silt.	
40						

NOTES: SBG11-(24-26)-20210119: 18.5% moisture content, 415 U mg/kg total organic carbon, 109.1 pcf dry unit weight, 2.688 specific gravity, 5.6×10^{-8} cm/s vertical hydraulic conductivity, 36 LL, 15 PL, 21 PI, 0.0% gravel, 11.5% sand, 88.5% fines.
*U = Analyte was not present in concentrations above method detection limit and is reported as the reporting limit

Geosyntec consultants

engineers | scientists | innovators

Client: Dynegy		**WELL LOG**	
Project: GLP0821, Joppa Ash Pond		**Well No.**	**G11**
Address: Unnamed Road, Metropolis, IL 62960		**Page:**	**3 of 4**

Drilling Start Date:	**01/19/2021**	Boring Depth (ft):	**66**	Well Depth (ft):	**66**
Drilling End Date:	**01/19/2021**	Boring Diameter (in):	**7.5**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**45.66**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**366.88**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**363.38**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**ZJF & AT**	Location (Lat/Long):	**37.21436, -88.85636**	Filter Pack:	**Sand**

DEPTH (ft)	COLLECT: Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample
40	SS	25/24	2, 3, 4, 4	7	(40') As above: becomes medium stiff.	
42	SS	27/24	2, 4, 4, 6	8	(42') LEAN CLAY (CL); orange (10YR 7/6) silty fine sand seams, medium stiff, moist, gray (N8).	
44	SS	25/24	2, 4, 5, 6	9	(44') As above: stiff.	
46	SS	25/24	3, 6, 9, 10	15	(46') As above: seams are silt only.	
48	SS	24/24	3, 4, 5, 8	9	(48') As above: no seams, trace orange (10YR 7/6) silt, increased moisture.	
50	SS	27/24	1, 3, 0, 3	3	(50') As above: increased moisture.	
52	SS	27/24	2, 3, 3, 6	6	(52') As above: gray (N9) sand layer.	
53.2					(53.2') POORLY GRADED SAND (SP); fine to medium grained, trace silt, loose, gray (N9), wet.	
54	SS	27/24	3, 8, 26, 26	34	(54') As above: becomes dense, trace clay, trace orange (10YR 7/6) silt inclusions.	
56	SS	8/24			(56') As above.	56-58 Geotech
58	SS	24/24	7, 14, 16, 13	30	(58') As above: trace gravel, no silt, some orange (10YR 7/6) fine to medium sand.	58-60 Chem

NOTES: SBG11-(56-58)-20210119: 14.4% moisture content, 679 U mg/kg total organic carbon, 110.0 pcf dry unit weight, 2.661 specific gravity, 0.2% gravel, 87.7% sand, 12.1% fines.
*U = Analyte was not present in concentrations above method detection limit and is reported as the reporting limit

Geosyntec consultants
engineers | scientists | innovators

Client: Dynegy
Project: GLP0821, Joppa Ash Pond
Address: Unnamed Road, Metropolis, IL 62960

WELL LOG
Well No. G11

Drilling Start Date:	**01/19/2021**	Boring Depth (ft):	**66**	Well Depth (ft):	**66**
Drilling End Date:	**01/19/2021**	Boring Diameter (in):	**7.5**	Well Diameter (in):	**2**
Drilling Company:	**Geotechnology**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW After Drilling (ft):	**45.66**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 55LC**	Top of Casing Elev. (ft):	**366.88**	Screen Material:	**Sch 40 PVC Slotted**
Driller:		Ground Elev. (ft):	**363.38**	Seal Material(s):	**Grout & Bentonite**
Logged By:	**ZJF & AT**	Location (Lat/Long):	**37.21436, -88.85636**	Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
60				SS	20/24	6, 14, 15, 16	29	(60') As above: increased orange sand.		
				SS	14/24	0, 6, 11, 13	17	(62') WELL-GRADED SAND (SW); fine to medium grained, medium dense, wet, orangish tan (7.5YR 8/8) with some gray (N9) sand layers.		
65				SS	18/24	2, 10, 15, 11	25	(64') As above: with sandy gravel layer (~5" thick).		
								(66') End of Boring.		
70										

NOTES:

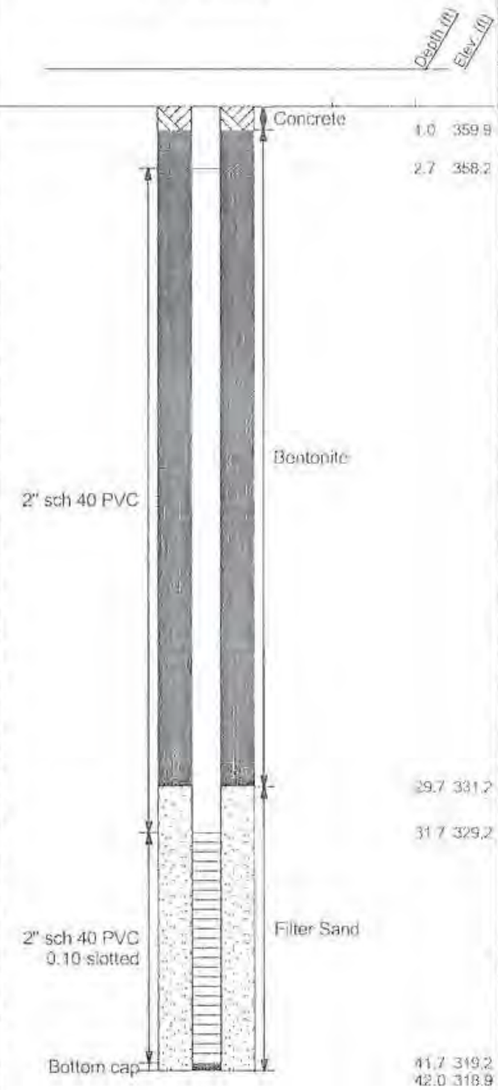
Surface Elevation: 360.9 Completion Date: 6/19/10

Datum: msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	GRAVEL			SS1
	Medium stiff to stiff, brown and gray, silty CLAY - (CL)		3-4-4-5	SS2
5			2-3-3-5	SS3
			3-3-4-4	SS4
	k = 1.6 x 10^{-8} cm/s		1-2-3-5	SS5
10			3-5-5-6	SS6
			2-4-5-6	SS7
15			2-3-4-5	SS8
	Medium stiff to stiff, brown and gray, silty CLAY, trace sand - CL		3-4-6-7	SS9
			3-4-6-6	SS10
20			3-5-7-8	SS11
			3-5-7-9	SS12
25			2-3-5-6	SS13
			3-5-7-6	SS14
			3-5-8-8	SS15
30			4-7-9-4	SS16
			4-4-6-7	SS17
35			2-4-3-5	SS18
	Medium stiff to very stiff, brown and gray, sandy CLAY with silt - CL		5-5-7-14	SS19
			13-13-10-8	SS20
40			2-4-6-7	SS21
	Boring terminated at 42 feet.			
45				
50				

WELL DIAGRAM

Flushmount



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 J017150.02ENV - EEI JOPPA.GPJ GTINC 0638301.GPJ 9/22/10

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER __ HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER BGF LOGGER

__ DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KA	Checked by: RBP	App'vd. by: RBP
Date: 7/14/10	Date: 9/20/10	Date: 9/20/10

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ash Pond Evaluation
EEI Facility
Joppa, Illinois

LOG OF BORING: G-151

Project No. J017150.02

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Joppa Power Station
Location: Joppa, Illinois
Project: 15E0030
DATES: Start: 8/17/2015
Finish: 8/18/2015
WEATHER: Partly cloudy, warm, mid-80s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4¼" HSA, split spoon sampler
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: G51D
Well ID: G51D
Surface Elev: 361.10 ft. MSL
Completion: 59.90 ft. BGS
Station: 200,430.10N
832,151.51E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Joppa
Township: 15S;3E
Section 14, **Tier** 15S; **Range** 3E

WATER LEVEL INFORMATION:
▼ = 39.50 - During Drilling
▼ = 34.91 - 8/18/15
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 *0%*	BD					2, 4			360, 358	
	0/60 *0%*	BD					6, 8, 10	Blind drill - see G151 boring log		356, 354, 352, 350	
	0/60 *0%*	BD					12, 14			348, 346	
	0/60 *0%*	BD					16, 18, 20			344, 342	

NOTE(S): G51D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Joppa Power Station
Location: Joppa, Illinois
Project: 15E0030
DATES: Start: 8/17/2015
Finish: 8/18/2015
WEATHER: Partly cloudy, warm, mid-80s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4¼" HSA, split spoon sampler
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: G51D
Well ID: G51D
Surface Elev: 361.10 ft. MSL
Completion: 59.90 ft. BGS
Station: 200,430.10N
832,151.51E

TOPOGRAPHIC MAP INFORMATION:
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WATER LEVEL INFORMATION:
▼ = 39.50 - During Drilling
▼ = 34.91 - 8/18/15
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 *0%*	BD					22			338	
	0/60 *0%*	BD					24–28			336, 334	
	0/60 *0%*	BD					30–34	Blind drill - see G151 boring log *[Continued from previous page]*		332, 330, 328	
	0/60 *0%*	BD					35–40			326, 324, 322	
9A	24/24 *100%*	SS	*6-7* *4-4* N=11	22		*1.50*	40–42	Yellowish brown (10YR5/8) with 20% gray (10YR5/1) mottles, moist, medium, CLAY with few silt and little very fine- to fine-grained sand.		320	

NOTE(S): G51D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Joppa Power Station
Location: Joppa, Illinois
Project: 15E0030
DATES: Start: 8/17/2015
Finish: 8/18/2015
WEATHER: Partly cloudy, warm, mid-80s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4¼" HSA, split spoon sampler
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: G51D
Well ID: G51D
Surface Elev: 361.10 ft. MSL
Completion: 59.90 ft. BGS
Station: 200,430.10N
832,151.51E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Joppa
Township: 15S;3E
Section 14, **Tier** 15S; **Range** 3E

WATER LEVEL INFORMATION:
▼ = 39.50 - During Drilling
▼ = 34.91 - 8/18/15
▽ =

Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
10A	24/24 100%	SS	1-2 4-5 N=6	20		1.50		Yellowish brown (10YR5/8) with 20% gray (10YR5/1) mottles, moist, medium, CLAY with few silt and little very fine- to fine-grained sand. *[Continued from previous page]*	318	
11A	24/24 100%	SS	3-4 4-4 N=8	16		0.25	44	Yellowish brown (10YR5/8) with 50% gray (10YR6/1) mottles, moist, soft, very fine- to medium-grained SAND with some silt and little clay.	316	
12A	24/24 100%	SS	5-7 10-11 N=17	13		1.50	46	Yellowish brown (10YR5/8) with 50% gray (10YR6/1) mottles, moist, stiff, very fine- to medium-grained SAND with some silt, little clay, and trace small gravel.	314	
13A	20/24 83%	SS	5-12 14-15 N=26	15		0.25	48	Yellowish brown (10YR5/8) with 20% gray (10YR6/1) mottles, wet, loose, very fine- to medium-grained SAND with trace silt, trace clay and trace small gravel.	312	
14A	23/24 96%	SS	5-15 19-21 N=34	15		1.25	50	Strong brown (7.5YR5/8), wet, loose, very fine- to medium-grained SAND with trace silt, trace clay, and trace small gravel.	310	
15A	22/24 92%	SS	3-12 14-7 N=26	15		1.50	52		308	
16A	24/24 100%	SS	1-5 6-11 N=11	17		0.00	54		306	
17A	24/24 100%	SS	2-7 8-11 N=15	19		0.00	56		304	
	0/23 0%	BD					58		302	Drilled past end of sample interval

End of boring = 59.9 feet

NOTE(S): G51D installed in borehole.

ATTACHMENT 2

RAMBOLL RESPONSE LETTER DATED NOVEMBER 6, 2023

RAMBOLL

ENVIRONMENT
& HEALTH

November 6, 2023

VIA E-MAIL
Lauren.Martin@epa.gov
EPA.CCR.PART845.COORDINATOR@ILLINOIS.GOV
EPA.CCR.Part845.Notify@Illinois.gov

Re: Joppa Power Plant East Ash Pond Alternative Source Demonstration Response to IEPA Comments

To Whom It May Concern:

This letter addresses the following requests for information from the Illinois Environmental Protection Agency (IEPA) provided on October 26, 2023 via email from Lauren Hunt regarding the Joppa Power Plant East Ash Pond alternative source demonstration (ASD) submitted on October 21, 2023:

1. Source characterization of the CCR at the East Ash Pond must include total solids sampling, analysis and reporting in accordance with SW846.
2. Hydraulic conductivities from laboratory or insitu testing must be collected, analyzed and presented with hydrogeologic characterization of all units including aquifers and confining units. Hydraulic conductivity data must include field and software analysis.
3. Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.

Background

Alternative source demonstrations use a multiple lines of evidence approach to support the conclusions that 1) the coal combustion residuals (CCR) unit is not the source of an exceedance, and 2) there is an alternative source of the exceedance. The multiple lines of evidence approach is consistent with the approach used in many areas of environmental analysis such as ecological risk assessment, monitored natural attenuation (MNA), and vapor intrusion (USEPA, 2016; USEPA, 1999; ITRC, 2007). The goal of a multiple lines of evidence approach is to provide robust support for a causal relationship based on many smaller individual qualitative or quantitative pieces of evidence (USEPA, 2016). Critically, no individual line of evidence will be completely conclusive, and each will have varying degrees of certainty. The final determination of a conclusion is based on the totality of the evidence provided.

ASDs based on a multiple lines of evidence approach are routinely prepared by environmental consultants to comply with federal CCR rules (Title 40 of the Code of Federal Regulations [40 C.F.R.] § 257) and State CCR rules (Title 35 of the Illinois Administrative Code [35 I.A.C.] § 845). In Georgia, where the CCR permitting authority has been delegated to the State, the Georgia Environmental Protection Division has approved ASDs using multiple lines of evidence to satisfy the requirements of federal CCR rule. An example of such approval is documented in the summary section (page 3) of the 2023 Annual Groundwater Monitoring and Corrective Action Report found in the publicly accessible files linked here: https://www.georgiapower.com/content/dam/georgia-power/pdfs/company-pdfs/plant-mcmanus/20230731_2023agwmcar_mcm_ap-1.pdf.

The East Ash Pond ASD was completed in conformance with the Electric Power Research Institute (EPRI) guidance for development of ASDs at CCR sites (EPRI, 2017). The EPRI document presents an approach for developing ASD lines of evidence that relies, where possible, on leachate samples collected from leachate wells, lysimeters, and/or leachate collection systems to provide samples that are representative of interstitial porewater. This direct approach for evaluating the potential for the East Ash Pond to impact groundwater is in contrast to the indirect approach implied by the IEPA request to characterize the CCR at the East Ash Pond using methods in accordance with SW-846 (specifically those used for waste characterization [*e.g.,* EP, TCLP, SPLP, LEAF[1]]), as discussed below.

Additionally, the lines of evidence as presented as section headings in the East Ash Pond ASD commonly contain multiple qualitative and quantitative pieces of information that contribute to the body of evidence that support the conclusion that the CCR surface impoundment (SI) is not the source of an exceedance.

Response to Request Number 1: SW-846 Characterization of CCR Material

The CCR porewater most accurately represents the mobile constituents associated with the waste management activity within the CCR SI (EPRI, 2017). The composition of CCR porewater accumulated at the base of the CCR unit, which is derived from, and represents contact with, CCR material above and around the well screen, is the truest representation of mobile constituents throughout the CCR SI. Leach tests presented in SW-846 (*e.g.*, TCLP, SPLP, LEAF 1313 - 1316) are inconsistent predictors or surrogates of *in situ* porewater chemical concentrations (EPRI, 2020; EPRI, 2021; and EPRI, 2022). Indeed, laboratory leach test effectiveness is determined by comparing results to porewater data (USEPA, 2014; EPRI, 2020; EPRI, 2021; and EPRI, 2022). These laboratory leach tests most accurately predict porewater concentrations when conditions in the test closely reflect conditions present in the field (USEPA, 2019). In many cases, the pH and/or redox potential of porewater is poorly represented by any laboratory leach test conditions. For these reasons, analysis of actual CCR porewater is more representative of potential contributions to groundwater observed in compliance monitoring wells than laboratory leach testing. The uncertainty in comparing the laboratory leach test results with the actual porewater concentrations means that the contribution of laboratory leach test data as a line of evidence to an ASD would be minimal.

Prior to performing hydrogeologic investigations in 2021, Ramboll completed a review of existing data to determine whether sufficient information existed to meet the requirements of 35 I.A.C. § 845. Based on the review, Ramboll developed an approach to fully characterize the CCR material as part of the 2021 investigation. Three locations for porewater wells were selected by evaluating the extent of ash through time on aerial photographs (**Figure 1**), identifying visible differences (color) in surficial materials, and capturing a representative spatial distribution. Porewater was encountered at an elevation of approximately 370 to 374 feet (Ramboll, 2021). For the purpose of visualization, **Figure 2** shows the areas within the SI that were not accessible for potential sampling and testing as illustrated by different colored portions of the East Ash Pond. Of the 122 acre unit, about 66%was accessible for safely installing porewater monitoring wells. A total of three porewater wells were installed in 2021.

[1] Extraction Procedure, Toxic Characteristic Leaching Procedure, Synthetic Precipitation Leaching Procedure, Leaching Environmental Assessment Framework

During installation of the porewater wells, the borings were logged, and solid samples were collected from six intervals for geotechnical and chemical analysis. Samples were analyzed for total metal concentrations via EPA Method 6010B and 6020A (SW-846) and results were summarized in the Hydrogeologic Site Characterization Report (Ramboll, 2021) and submitted in the 2021 Operating Permit (Burns and McDonnell, 2021).

As established above, testing porewater is a direct source term for evaluating potential influence on groundwater. SW-846 provides analytical methods for evaluating solid waste using leach tests that are designed to replicate potential *in situ* conditions (either current or future). The goal of these laboratory leach tests is to predict the potential concentration of chemicals under laboratory controlled conditions (*e.g.*, landfill leachate, synthetic precipitation, variable pH) which may or may not represent conditions observed in the field. The use of leach test results performed under variable conditions collected from any number of locations within the CCR SI to estimate a total potential for chemical leaching from CCR into groundwater under a variety of different conditions is irrelevant to an ASD. ASDs are prepared to evaluate the potential for actual porewater leaking from a CCR SI to be the cause of a detected exceedance observed in a compliance well.

Response to Request Number 2: Provide Hydraulic Conductivity Data

Responses to Request Number 2 are provided in the cover letter to this Attachment and in Attachment 1 to that cover letter.

Response to Request Number 3: Alternative Source Characterization

In the East Ash Pond ASD, the multiple lines of evidence approach is appropriate for identifying that a source other than the East Ash Pond caused the observed exceedance and that the East Ash Pond did not contribute to the cobalt exceedance at G05 or the low pH at G11 and G51D. Ramboll's investigation determined that release of naturally occurring cobalt from manganese oxides was the source of cobalt at G05. Results of solid sampling indicates the presence of cobalt in native materials from multiple locations at the site and naturally occurring cobalt was found to be associated with manganese throughout the site.

Mixing of oxidizing and reducing waters was identified as the source of the low pH at G11 and G51D. A distinct redox transition was identified, shifting from more reducing conditions in upgradient waters to more oxidizing conditions in downgradient wells, including the exceedance wells. The oxidation of dissolved iron to iron oxides is known to produce acidity (Hem and Cropper, 1959) and is believed to be the cause of the low pH at G11 and G51D.

When an exceedance is caused by natural variability driving geochemical reactions (*e.g.*, as by mixing of waters with different compositions), direct sampling of a "source" becomes challenging. The closest approximation of direct sampling would involve using collected materials in complex laboratory simulations which would attempt to replicate field conditions. Instead, site-specific hydrogeologic, groundwater composition, and solid phase data were analyzed using industry-standard geochemical and statistical methods to provide multiple lines of evidence which support the conclusions. As described above, a multiple lines of evidence approach allows for determination of robust conclusions when specific source data are inaccessible.

Conclusions

The combined strength of the lines of evidence in the East Ash Pond ASD demonstrates that the East Ash Pond is not the source of the cobalt exceedance at G05 or the low pH at G11 and G51D (and did not contribute to these exceedances) and that the likely source is natural variability in groundwater due to water-solid interactions and groundwater mixing, respectively. Ramboll does not believe that additional lines of evidence based on leach test data or testing of the alternative source would change the conclusion of the full body of evidence presented in the ASD that the East Ash Pond is not the source of the exceedances and did not contribute to the exceedances.

References

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Attachments

Figure 1 CCR Characterization
Figure 2 2022 Conditions

If you have any questions about this letter, please do not hesitate to contact Brian Hennings or Frances Ackerman, as referenced below.

Sincerely,

Brian G. Hennings, PG
Project Officer, Hydrogeology
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D +1 262 719 4512
brian.hennings@ramboll.com

A. Frances Ackerman, PE
Subject Matter Expert/Technical Manager 2
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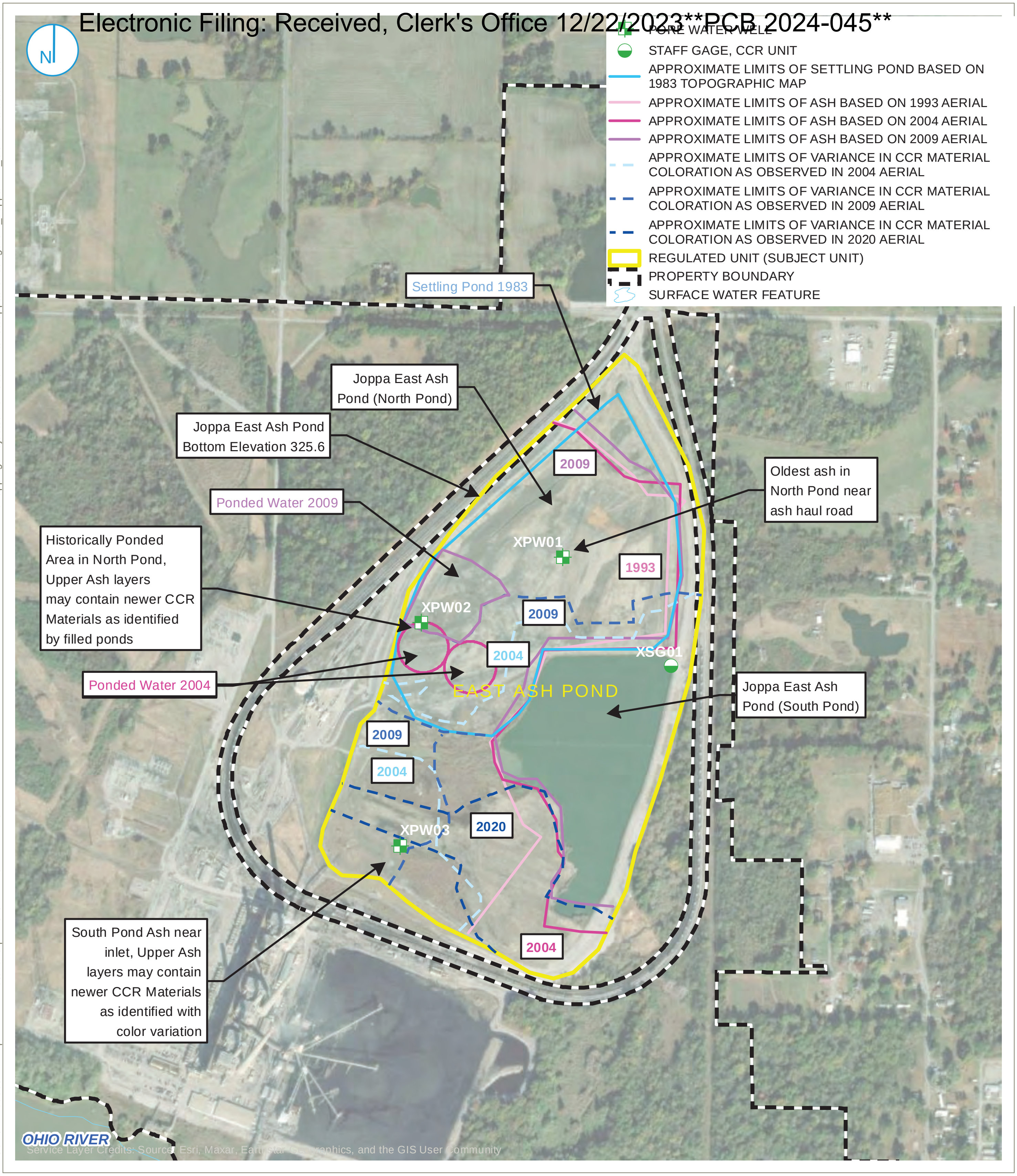
M +1 414 308 0811
frances.ackerman@ramboll.com



Y:\Mapping\Projects\22\2285\MXD\8845\Joppa\2023\Figure 1_JoppaEAP_CCR Characterization Plan.mxd

PROJECT: 169000XXXX | DATED: 11/3/2023 | DESIGNER: GALARNMC

CCR CHARACTERIZATION

FIGURE 1

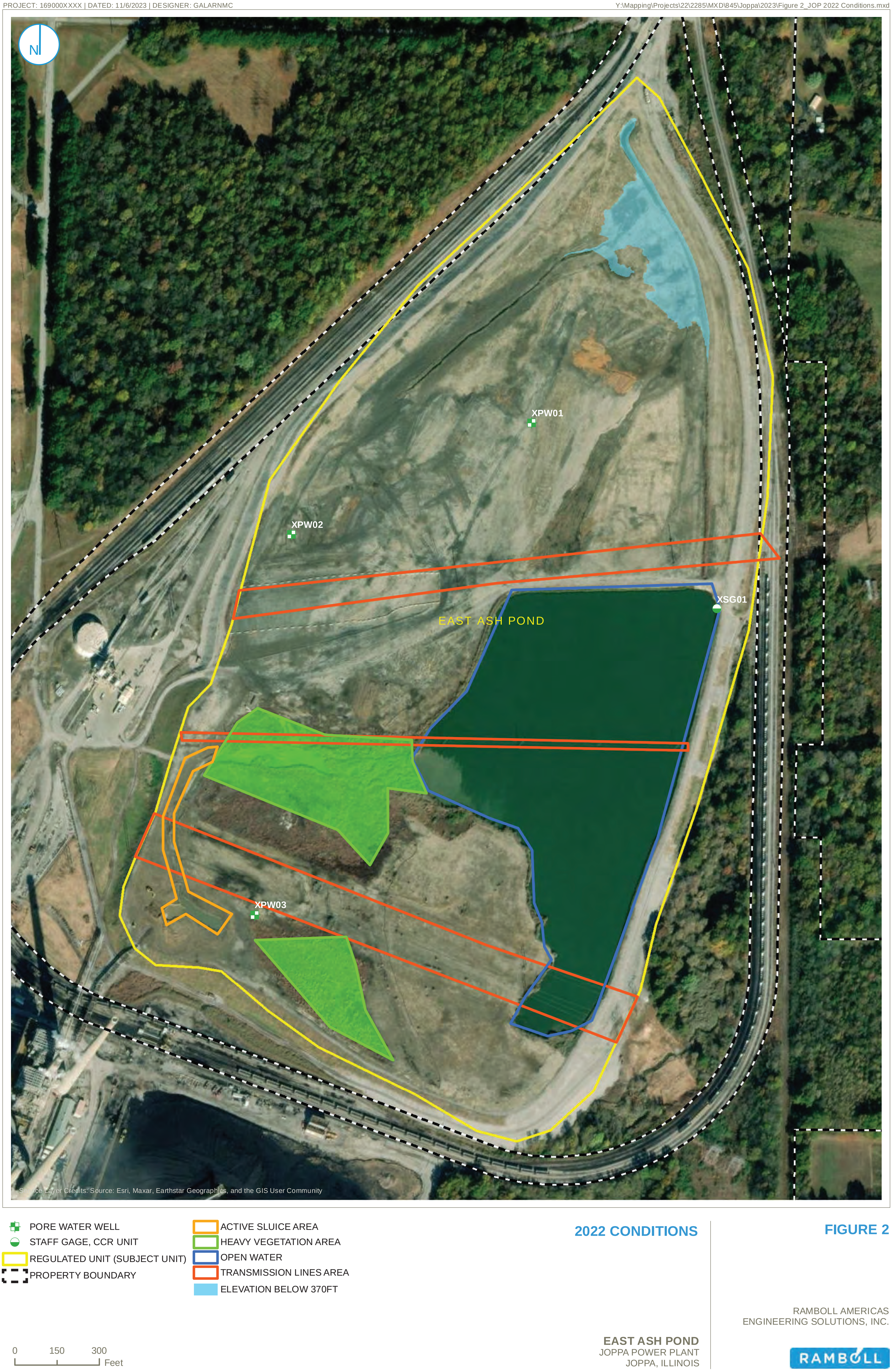
JOPPA POWER STATION
JOPPA, ILLINOIS

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 169000XXXX | DATED: 11/6/2023 | DESIGNER: GALARNMC

Y:\Mapping\Projects\22\2285\MXD\845\Joppa\2023\Figure 2_JOP 2022 Conditions.mxd



2022 CONDITIONS

EAST ASH POND
JOPPA POWER PLANT
JOPPA, ILLINOIS

FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Exhibit D

DECLARATION OF MELINDA W. HAHN, PhD

In support of Electric Energy Inc.'s Petition for Review of IEPA's Non-concurrence with the Joppa Alternative Source Demonstration and Request for Stay

I, Dr. Melinda W. Hahn, declare and state as follows:

1) I am an Environmental Engineer and Senior Managing Consultant with Ramboll Americas Engineering Solutions, Inc. Attached as Appendix A is a true and accurate copy of my Curriculum Vitae.

2) I hold a PhD in Environmental Engineering from Johns Hopkins University. The focus of my research for my PhD dissertation was contaminant transport in porous media (e.g., groundwater).

3) My practice over my 25-year career includes site investigation and remediation in multiple state and federal programs, such as voluntary remediation, Resource Conservation and Recovery Act (RCRA) corrective action, and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response action. My work in these programs includes contaminant fate and transport modelling, site investigation and remediation, and statistics and forensic

analysis of environmental contamination data. I have evaluated sites from many different industrial sectors with many different contaminants of concern, including volatile organic compounds (VOCs), which includes chlorinated volatile organic compounds (CVOCs), semivolatile organic compounds (SVOCs), metals, polychlorinated biphenyls (PCBs), and dioxins/furans.

4) To prepare this Declaration, I reviewed the Electric Energy Inc. (EEI) October 20, 2023 Alternative Source Demonstration (ASD) Report for the Joppa Power Plant East Ash Pond (EAP), the November 6, 2023 EEI letter to the IEPA with supplementary information on the ASD, the November 16, 2023 IEPA denial of the ASD, and supporting information for the ASD. I reviewed the documents submitted by EEI independently and was not personally involved in their preparation.

5) The ASD report addresses cobalt concentrations observed in groundwater in well G05 and pH observed in wells G11 and G51D above the Groundwater Protection Standards (GPS). It also identifies boron GPS exceedances at wells G06, G07, G08, G09 and G10 that will be assessed for corrective measures under Section 845.660 (the "corrective measures wells"). The ASD report relies on a multiple lines of evidence (MLE) approach that is standard practice in causal determinations in environmental forensic analysis, risk assessment, and site

investigation.[1,2,3,4,5] The MLE approach involves analysis of multiple independent sets of data to test whether an identified source can explain observed data. Information to consider can be site-specific, regional, or from the literature.[6,7] These independent lines of evidence are developed until sufficient confidence is achieved to either confirm or rule out a source.[8] For the Joppa ASD, the independent lines of evidence include hydrogeological data to establish the direction of groundwater flow (groundwater flows generally from west to east at the Joppa Power Plant), chemical porewater data from wells set at the base of the EAP CCR to characterize source concentrations, chemical groundwater data from upgradient and compliance wells, and multivariate analysis of chemical data to identify the geochemical processes that led to the pH exceedance at G11 and G51D and the cobalt exceedance at G05. The lines of evidence also rely on the principles of geochemistry and the fundamental

1 Miller, J. Methods and Advances in the Forensic Analysis of Contaminated Rivers, E3S Web of Conferences Vol. 125, 2019, p. 3.

2 U.S. EPA, U.S. Navy SPAWAR Systems Center, GeoChem Metrix Inc., and Battelle Memorial Institute, A Handbook for Determining the Sources of PCB Contamination in Sediments, Technical Report, TR-NAVFAC EXWC-EV-1302, October 2012, p. 13.

3 U.S. EPA, Office of the Science Advisor, Risk Assessment Forum, Weight of Evidence in Ecological Assessment, EPA/100/R-16/001, December 2016.

4 U.S. EPA, Office of Solid Waste and Emergency Response, OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor in Indoor Air, June 2015, pp. xv-xvii, 17-18, 38-40, 60-61, 117-123.

5 EPRI, Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites, 2017 Technical Report, p. viii.

6 U.S. EPA, Office of the Science Advisor, Risk Assessment Forum, Weight of Evidence in Ecological Assessment, EPA/100/R-16/001, December 2016, p. 20 et seq.

7 U.S. EPA, U.S. Navy SPAWAR Systems Center, GeoChem Metrix Inc., and Battelle Memorial Institute, A Handbook for Determining the Sources of PCB Contamination in Sediments, Technical Report, TR-NAVFAC EXWC-EV-1302, October 2012, p. 30.

8 Miller, J. Methods and Advances in the Forensic Analysis of Contaminated Rivers, E3S Web of Conferences Vol. 125, 2019, p. 3.

concept of contaminant migration: that contaminant concentrations decrease in the downgradient direction due to the successive dilution of dispersion and diffusion (i.e., downgradient concentrations cannot be higher than source concentrations). In a CCR surface impoundment release scenario, leachate is subject to physical processes that dilute solute concentrations including mixing, dispersion and dilution.[9]

6) The porewater well source concentrations in the EAP have been characterized through the collection of porewater samples. The source porewater data for the EAP are consistent with literature values for coal ash leachate,[10,11,12] and define the maximum concentrations for groundwater impact outside of the EAP.

Cobalt in G05

7) The three lines of evidence (LOEs) presented in the October 20, 2023 ASD report for cobalt are as follows:

a) LOE 1: Cobalt concentrations at G05 are consistent with cobalt mobilization from native soils due to reductive dissolution of manganese oxides;

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9 U.S. EPA Office of Solid Waste and Emergency Response, Solid Waste Disposal Criteria, Technical Manual, EPA530-R-93-017, p. 126.

10 U.S. EPA, Industrial Environmental Research Laboratory, Chemical and Biological Characterization of Leachates from Coal Solid Wastes, EPA-600/7-80-039, March 1980.

11 U.S. EPA and TVA, Effects of Coal-ash Leachate on Ground Water Quality, EPA-600/7-80-066, March 1980.

12 U.S. EPA, Office of Research and Development, Characterization of Coal Combustion Residues from Electric Utilities – Leaching and Characterization Data, EPA-600/R-09/151, December 2009.

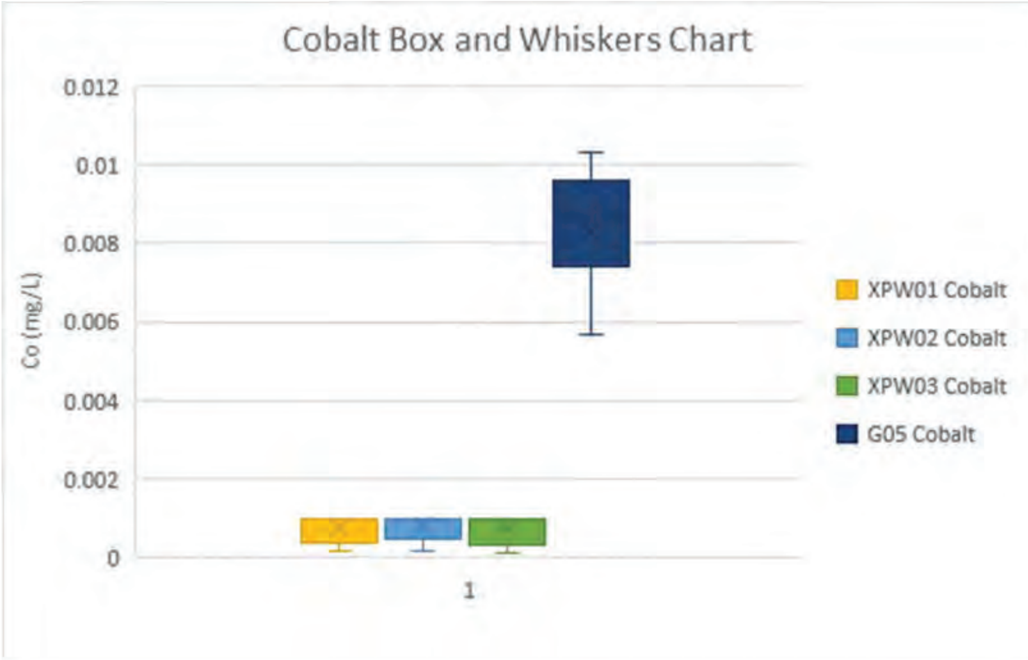
b) LOE 2: Cobalt concentrations at G05 are greater than source concentrations; and

c) LOE 3: Cobalt concentrations are not correlated with concentrations of CCR indicator parameters.

8) Cobalt is a naturally occurring element in soil. When mobilized in groundwater, cobalt does not behave like a conservative tracer as it sorbs strongly to solid phase manganese oxides, the presence of which are controlled by local redox conditions. Therefore, changes in redox conditions that affect manganese can cause cobalt to be released into solution from aquifer solids (thereby increasing observed concentrations), or removed from solution (decreasing observed concentrations). As a result, observed concentrations of cobalt in groundwater exhibit natural variation due to local geochemistry. The ASD demonstrated that the geochemical conditions near the EAP are thermodynamically favorable for reductive dissolution of manganese oxides, and that manganese and cobalt concentrations are positively correlated in both aquifer soil and groundwater samples.

9) The EAP is not a source of cobalt to well G05 because the porewater cobalt concentrations have been non-detect at a reporting limit of 0.001 mg/L or below this value in every sample collected. In contrast, cobalt concentrations in G05 are significantly higher than 0.001 mg/L. The following Box and Whiskers chart shows the cobalt concentration comparison.

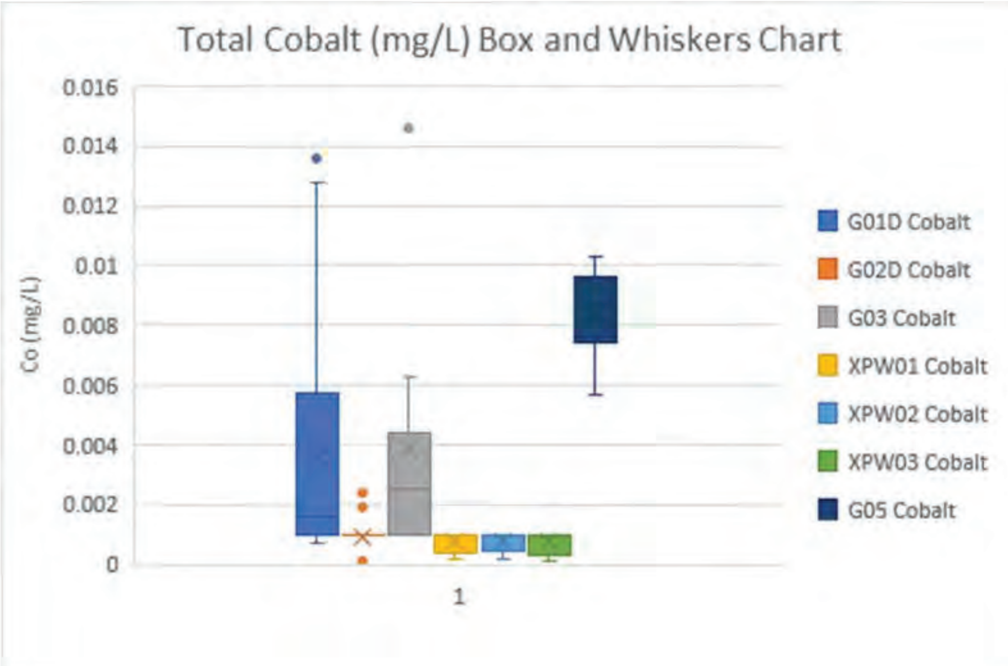
Figure 1: Cobalt Concentrations in Porewater Wells and G05[13]



The following chart shows the range of cobalt detected in exceedance well G05, background wells G01D and G02D, well G03 that is located at the north end (cross gradient) of the EAP and not impacted by porewater above GPS, and porewater wells XPW01, XPW02, and XPW03.

[13] Data presented are included in the October 20, 2023 ASD Report for the Joppa EAP, Appendix D-1. Non-detect values are replaced with the laboratory reporting limit.

Figure 2: Cobalt Concentrations Including Background Wells[14]



The relative absence of cobalt in porewater wells demonstrates that the EAP is not the source of cobalt observed in well G05. The ASD further demonstrated that the concentrations of cobalt observed in well G05 are not correlated with key CCR indicator parameters boron and cobalt as one would expect if they shared a common source. This in an independent line of evidence supporting the conclusion that the EAP is not the source of cobalt observed in well G05.

10) The three lines of evidence based on groundwater chemistry are sufficient to eliminate the EAP as the source of cobalt concentrations in well G05.

[14] Data presented are included in the October 20, 2023 ASD Report for the Joppa EAP, Appendix D-1. Non-detect values are replaced with the laboratory reporting limit.

The ASD identified the likely source as reductive dissolution of manganese minerals in the aquifer solids.

pH in G11 and G51D

11) The three lines of evidence (LOEs) presented in the October 20, 2023 ASD report for pH are as follows:

a) LOE 1: G11 and G51D are upgradient of the EAP.

b) LOE 2: Groundwater chemistry at G11 and G51D is aligned with the groundwater signature observed west of the monitoring wells; and

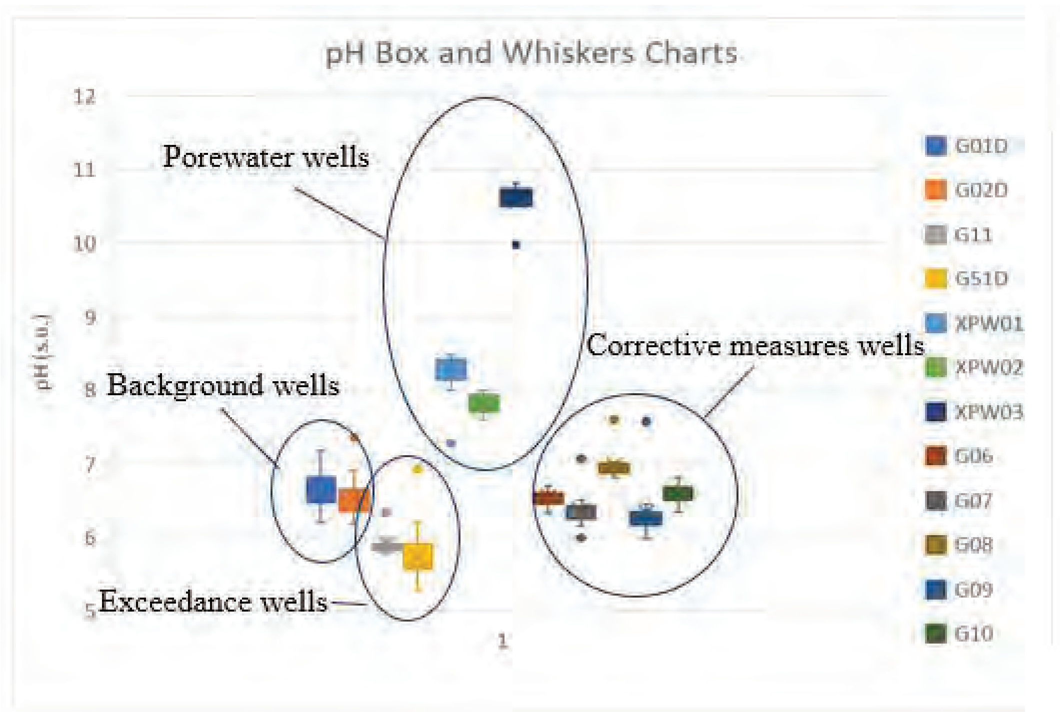
c) LOE 3: pH exceedances at G11 and G51D are consistent with iron oxidation.

12) Wells G11 and G51D are located on the western, or upgradient side of the EAP and, as such, are unlikely to be impacted by the EAP. In contrast, the corrective measures wells on the eastern, or downgradient side of the EAP (G06, G07, G08, G09 and G10) contained boron in excess of the GPS and are carried forward for assessment of corrective measures. Boron is considered by U.S. EPA to be the CCR indicator analyte with the fastest travel time and likely the first indicator analyte to be detected.[15]

[15] EPA Proposed Rule: Amendments to the National Minimum Criteria (Phase One for Disposal of Coal Combustion Residuals from Electric Utilities, FR Vol. 83, No. 51, March 15, 2018, p. 11588.

13) The pH exceedances at G11 and G51D are due to an observed pH that is more acidic (lower pH) than the GPS range. pH is a measure of the concentration of positively charged hydrogen ions in solution. The greater the concentration of hydrogen ions, the lower the pH. Like cobalt, acidity is also not a conservative solute like sodium or chloride, but rather it is variable and dependent on local geochemistry (i.e., acidity can be either neutralized or buffered in the subsurface depending on the nature of the aquifer solids and the redox chemistry of groundwater). The EAP is not a source of acidity to wells G11 and G51D as the leachate is alkaline (higher pH than background groundwater) and the pH in corrective measures wells downgradient of the EAP is not similarly depressed. The following figure displays the Box and Whiskers charts for pH in background wells, pH exceedance wells, porewater wells, and corrective measures wells. When EAP porewater mixes with groundwater, the pH is not below background levels as we see in G11 and G51D. This indicates a different geochemical process in the pH exceedance wells.

Figure 3: pH in EAP Wells[16]

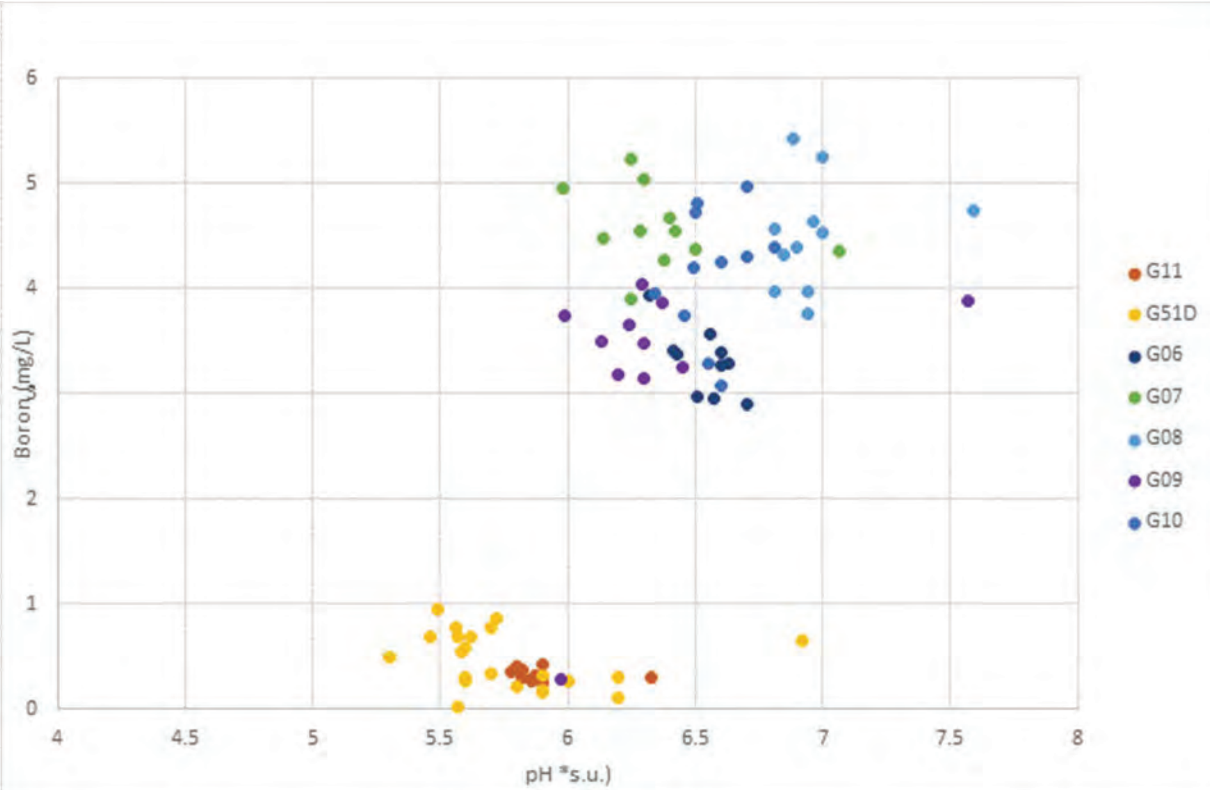


14) The pH in groundwater at G11 and G51D is driven by a redox gradient (a change in solution chemistry from reducing to oxidizing) in the upgradient direction that causes oxidation and precipitation of dissolved iron. That redox reaction results in a decrease in the observed iron concentration in groundwater samples and the net release of hydrogen ions, and therefore a decrease in pH. Well G11 and G51D samples have lower pH, boron (recall that boron is the first indicator parameter for CCR impact) and iron concentrations compared to samples from the

[16] Data presented are included in the October 20, 2023 ASD Report for the Joppa EAP, Appendix D-1. Non-detect values are replaced with the laboratory reporting limit.

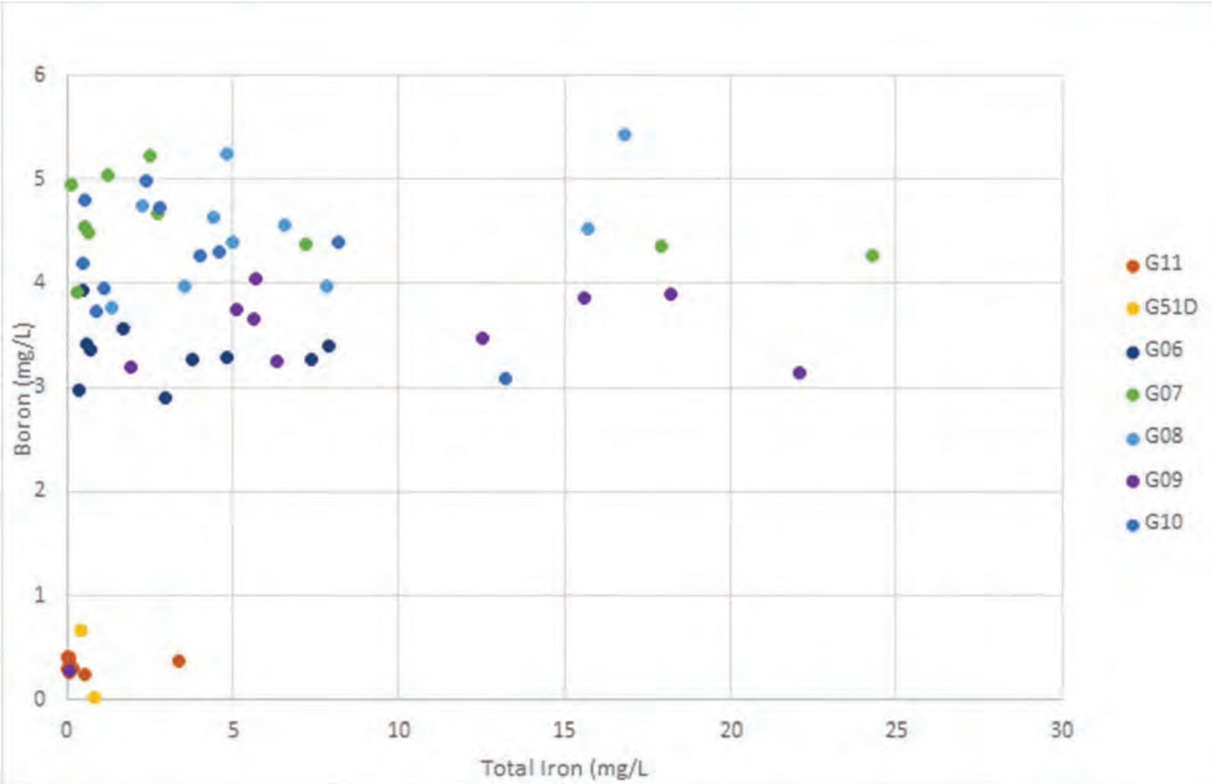
corrective measures wells (G06-G10). The following scatter charts display the differences in the sample chemistries.

Figure 4: pH vs. Boron in G11, G51D and Corrective Measures Wells[17]



[17] Data presented are included in the October 20, 2023 ASD Report for the Joppa EAP, Appendix D-1. Non-detect values are replaced with the laboratory reporting limit.

Figure 5: Iron vs, Boron in G11, G51D and Corrective Measures Wells[18]



These comparisons show that the groundwater chemistry at G11 and G51D is not consistent with CCR impact, but consistent with iron oxidation. The Principal Components Analysis (PCA) conducted in the ASD confirms that wells G11 and G51D are more consistent with upgradient groundwater chemistry compared to the porewater wells and the corrective action wells.

15) The three lines of evidence based on groundwater chemistry are sufficient to eliminate the EAP as the source of acidic pH in wells G11 and G51D

[18] Data presented are included in the October 20, 2023 ASD Report for the Joppa EAP, Appendix D-1. Non-detect values are replaced with the laboratory reporting limit.

as the EAP does not contribute acidity to these wells or create acidic conditions in the uppermost aquifer. The ASD identified the likely source as iron oxidation and associated pH decrease. The CCR and groundwater conditions near the EAP are sufficiently characterized to make this determination.

16) In its November 16, 2023 letter, the IEPA denied the ASD due to perceived "data gaps" that included the following:

a) Source characterization of the CCR at the East Ash Pond must include total solids sampling in accordance with SW846.

b) Characterization to include sample and analysis in accordance with 35 IAC 845.640 of alternative source must be provided with the ASD.

17) The CCR source characterization request is vague and inappropriate for the lines of evidence presented in the ASD. However, if the IEPA is requesting "total" constituent analysis of CCR in mg/kg (mass of constituent per mass of CCR on a dry weight basis), that information would not be more appropriate for a source impact analysis than the porewater data used for the ASD. In a land disposal scenario, groundwater would be impacted if leachate (or porewater) from the solid waste (rather than the solid waste itself) travels to and mixes with (and is diluted by) groundwater, then the impacted groundwater travels downgradient where dispersion and diffusion processes further dilute solid waste component concentrations. The most critical data needed for a groundwater impact analysis is the leachate quality, not the total amount of constituent in a solid sample of CCR,

because leachate is the material that potentially mixes with groundwater. Similarly, if the IEPA is requesting laboratory leach testing of solid CCR samples either by TCLP, SPLP, or LEAF, that information would also not be more appropriate for a source impact analysis than the actual porewater data collected from the CCR presented in the Joppa ASD. All of the synthetic laboratory leach tests on a solid sample aim to simulate a landfill environment in order to predict leachate quality from a solid sample. Synthetic leach test results are compared to actual field leachate data for fly ash and slag in order to evaluate the representativeness of their results, i.e., field verification.[19] U.S. EPA advises that these "batch" one-day laboratory tests on a relatively small sample do not account for the long-term climatic and meteorological influences on a full-scale landfill operation.[20] These tests often yield high initial concentrations that are not typical of a full-scale operation.[21] Other researchers evaluating the utility of the synthetic precipitation leaching procedure (SPLP) to assess the risk of groundwater contamination posed by the land application of granular solid waste report that the use of a total pollutant concentration (mg/kg) in conjunction with SPLP concentrations (mg/L) to estimate pore water concentration was unreliable as this method underestimates the

[19] Tiwari, M.K., et al, Suitability of Leaching Test Methods for Fly Ash and Slag: A Review, Journal of Radiation Research and Applied Sciences, Vol.8, 2015. pp. 523-537.

[20] U.S. EPA Office of Solid Waste and Emergency Response, Solid Waste Disposal Criteria, Technical Manual, EPA530-R-93-017, p. 125.

[21] *Ibid.*

measured porewater concentrations.[22] Clearly, directly measuring CCR analyte concentrations and pH in actual porewater samples from the actual disposal environment is a more accurate basis for an impact analysis than using laboratory predictions of those values. As stated above, the EAP CCR and adjacent groundwater quality has been adequately characterized for performing an alternative source demonstration. Data from the 24 EAP porewater samples relied upon in the Alternative Source Demonstration Report[23] are sufficient to define the strength and variability of source water. Collection of additional CCR source characterization data referenced in IEPA's November 16 letter is not required for the ASD by Part 845 or Part 257 and would not change the conclusion of the ASD. The collection of alternate source samples is not required for the ASD and development of such information would not change the conclusion of the ASD. Parts 845 and 257 do not even require identification of the alternate source – only that a source other than the CCR is causing the cobalt and pH exceedances and that the CCR is not contributing to the exceedances. At the Joppa EAP, the identified source of the exceedances is not a physical source area with a conservative solute that can be sampled, but certain geochemical conditions that promote chemical reactions that change the groundwater chemistry. Geochemical parameters that are

[22] Townsend, T, et al, Interpretation of Synthetic Precipitation Leaching Procedure (SPLP) Results for Assessing Risk to Groundwater from Land-Applied Granular Waste, Environmental Engineering Science, Vol. 23, No. 1, 2005.

[23] Ramboll, Alternative Source Demonstration Report for Joppa EAP, October 20, 2023. Appendix C.

critical to understanding the cobalt and pH exceedances such as oxidation-reduction potential (ORP) and iron or manganese concentrations are not discussed at all in Part 845. As such, the "alternate source" cannot be characterized with groundwater samples under Part 845.640 or by physical sampling and analysis for total or leachable analytes according to SW846. For pH, an accurate laboratory simulation of mixing and transport of groundwater with different redox potentials to demonstrate the impact of iron oxidation at a field scale with site-specific chemistry is likely not possible, and definitely not practical and is beyond the scope of both SW846 and Part 845. For cobalt, no physical source other than the aquifer solids are available for testing. In this case, supporting information could be collected from aquifer solids with geochemical analysis; however, existing LOEs are sufficient to make the alternative source determination and additional data would not change the conclusion. Regardless, source characterization in this case in accordance with 845.640 is infeasible.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: December 22, 2023

Melinda W. Hahn

Melinda W. Hahn, PhD

APPENDIX A

Curriculum Vitae of Melinda Hahn, PhD

RAMBOLL

ENVIRONMENT
& HEALTH

MELINDA W. HAHN, PH.D.

Senior Managing Consultant

Dr. Hahn's practice areas include site investigation and remediation, contaminant fate and transport modelling, statistics of environmental data, forensic analysis, and litigation support, including primarily environmental liability and cost allocation. Regulatory areas include RCRA, CERCLA, TSCA, and Voluntary Cleanup/Risk-Based Corrective Action. Dr. Hahn has experience in the following industry categories: energy (electric utilities, petroleum dispensing, pipeline operations, former manufactured gas plant sites), industrial equipment manufacturing, metal working and metal recycling, automobile manufacturing, ink and chemical manufacturing, wood treating, mining, cement manufacturing, milling and smelting operations, secondary aluminum production, and dry cleaning.

EDUCATION

1995
PhD, Environmental Engineering
The Johns Hopkins University

1990
BS, Physics
The University of Texas at Austin

1990
BS, Mathematics
The University of Texas at Austin

ACADEMIC HONORS

1992-1995
Graduate Fellow, National Science Foundation

1995
Most Distinguished Environmental Engineering Dissertation, Association of Environmental Engineering Professors

CAREER

1998-Present
Senior Managing Consultant, ENVIRON/Ramboll

1997-1998
Consultant, Roy Ball, PC

1995-1997
Senior Project Engineer, Environmental Resources Management-North Central, Inc.

CONTACT INFORMATION

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Suite 211
Austin, TX 78759
United States of America

PROJECTS

- Provided technical litigation support for over 50 matters regarding extent, severity, timing, and source of soil and ground water contamination and vapor intrusion, necessity for and costs of remediation, human health risk assessment, toxic tort liability, Superfund cost allocation (including consistency with the NCP), insurance cost recovery, and the siting and monitoring of a hazardous waste landfill. The regulatory frameworks included Illinois Voluntary Cleanup Program, Illinois Leaking Underground Storage Tank Program, RCRA, CERCLA, TSCA, NCP, and California Proposition 65. Completed projects in more than twenty states, with a focus in the Midwest.
- Provided expert testimony in matters involving Superfund cost allocation, statistics of environmental data, and contaminant fate and transport.
- Retained as an expert witness and provided litigation/mediation support for a number of cost allocation cases involving remediation of contaminated soil, groundwater, and sediment.
- Provided litigation support for environmental liability/cost allocation mediation and litigation at several large sediment sites. Evaluated historical information on industrial processes and discharges, and conducted forensic/statistical analysis to estimate the relative contribution of contaminants to sediments.
- Provided litigation support for a number of insurance cost recovery projects, including a former wood treating facility, a jewelry manufacturer, metal plating facility, machine shop and dry cleaner. Tasks included the identification of likely sources and timing of contamination.
- Evaluated claims of residents living near a scrap metal facility of transport and deposition of lead-containing particles in their homes using statistical analysis of plaintiffs' chemical data. Provided expert testimony based on this analysis.
- Evaluated the hydrogeological setting of a proposed petroleum pipeline pumping station and estimated the likelihood of a release and groundwater contamination. Provided expert testimony based on this analysis.
- Provided expert testimony on proposed coal ash impoundment closure regulations and proposed new state groundwater standards in Illinois.
- Conducted environmental forensic evaluations to determine sources of observed environmental contamination in soil, groundwater, sediment and sub-slab/indoor air for sites in litigation and pre-litigation phases.
- Performed multivariate statistical analyses of data for forensic analysis, for contaminant ecological impact analysis, to determine appropriate remedial objectives, and as part of human health and ecological risk assessments.
- Lead RCRA Corrective Action at a former manufacturing facility.
- Directed and assisted in the closure of a number of sites in the Illinois Voluntary Cleanup Program and the Illinois Leaking Underground Storage Tank Program.
- Evaluated the potential contribution of urban industrial sources of heavy metals to urban soil and sediments using both simple data comparisons and multivariate statistical techniques.
- Performed ground water and contaminant fate and transport modeling using MODFLOW and MT3D for use as a Superfund cost allocation tool in support of expert testimony. Relative mass of TCE entering the Superfund Site from sources on two PRP's properties was used as a basis for cost allocation. A Monte Carlo analysis was also performed to evaluate the sensitivity of the proposed allocation to changes in key variables.

- Performed Monte Carlo analysis of risk to ground water posed by a proposed petroleum pipeline in support of expert testimony. The analysis examined the likelihood of the exceedance of the Illinois Class I ground water standard for benzene per mile of proposed pipeline.
- Performed Monte Carlo cost allocation among four PRPs for a Superfund Site in support of expert testimony. Total volume, volume of hazardous substances, and volume of drummed materials were considered.
- Utilized 3-D geostatistical interpolation techniques to visualize environmental data, to estimate excavation volumes for remediation, and to identify and distinguish source areas and potential preferential pathways of migration for a number of contaminated sites.
- Performed research and analysis of remedial activities and associated costs to determine compliance with the NCP for cost recovery matters for a number of sites.

PUBLICATIONS AND PRESENTATIONS

1993
Stochastic Models of Particle Deposition in Porous Media
Paper presented at the 1993 Midwest Regional Conference on Environmental Chemistry, University of Notre Dame
Authors: Hahn, M.W., and C. F. O'Melia

1994
Deposition and Reentrainment of Particles in Porous Media
Poster presented at the 1994 Gordon Research Conference on Environmental Science, Water, New Hampshire
Authors: Hahn, M.W., D. Abadzic, and C. R. O'Melia

1994
Colloid Transport in Groundwaters: Filtration of Fine Particles at Low Filtration Rates
Presented at the 1994 ASCE National Conference, Boulder, Colorado
Authors: Hahn, M.W., D. Abadzic, and C. R. O'Melia

1995
Deposition and Reentrainment of Brownian Particles under Unfavorable Chemical Conditions
Presented at the 1995 ACE National Conference, Environmental Chemistry Division
Authors: Hahn, M.W., D. Abadzic, and C. R. O'Melia

1995
Deposition and Reentrainment of Brownian Particles under Unfavorable Chemical Conditions
Doctoral Dissertation, Johns Hopkins University
Author: Hahn, M.W.

1997
Some Effects of Particles Size in Separation Processes Involving Colloids
Wat. Sci. Tech. Vol. 36, No. 4 pp. 119–126
Authors: O'Melia, C.R., M.W. Hahn, and C. Chen

1997
Literature Review 1997: Storage, Disposal, Remediation, and Closure
Water Environment Research, Vol. 69, No. 4, pp 6389-719
Authors: Millano E.F. and M.W. Hahn

1998
The Statistics of Small Data Sets
Accepted for publication, Superfund Risk Assessment in Soil Contamination Studies: Third Volume, ASTM STP 1338, K.B. Hoddinott Ed., American Society for Testing and Materials
Authors: Ball, R.O., and M.W. Hahn

1998
RBCA Compliance for Small Data Sets
Battelle Conference Proceedings, Remediation of Chlorinated and Recalcitrant Compounds: Risk, Resource and Regulatory Issues
The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, pp. 73-78
Authors: Hahn, M.W., A.E. Sevcik, and R.O.Ball

1998
Contaminant Plume and using 3D Geostatistics
Battelle Conference Proceedings, Remediation of Chlorinated and Recalcitrant Compounds: Risk, Resource and Regulatory Issues
The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, pp. 85-90
Authors: Ball, R.O., M.W. Hahn, and A.E. Sevcik1998
RBCA Closure at DNAPL Sites
Battelle Conference Proceedings, Remediation of Chlorinated and Recalcitrant Compounds: Risk, Resource and Regulatory Issues
The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, pp.181-186
Authors: Sheahan, J.W., R.O. Ball, and M.W. Hahn

1998
RBCA Closure at DNAPL Sites, Ground Water Monitoring and Research
Authors: Sheahan, J.W., R.O. Ball, and M.W. Hahn

2004
Deposition and Reentrainment of Brownian Particles in Porous Media under Unfavorable Chemical Conditions: Some Concepts and Applications
Environmental Science & Technology, Vol. 38, pp 210-220
Authors: Hahn, M.W. and C.R. O'Melia

2010
Making the Case for Causation in Toxic Tort Cases: Superfund Rules Don't Apply
Environmental Law Reporter, News & Analysis, July 2010, pp. 10638-10641
Authors: More, J.R. and M.W. Hahn

Exhibit E

DECLARATION OF CYNTHIA VODOPIVEC
ON BEHALF OF ELECTRIC ENERGY INC.

I, Cynthia Vodopivec, affirm and declare as follows:

1. I present this Declaration on behalf of Electric Energy Inc. (hereinafter "EEI"). I am Senior Vice President, Environmental Health and Safety at Vistra Corp., the indirect corporate parent of EEI. As part of my duties, I oversee permitting, regulatory development, compliance (air, water, and waste issues), and health and safety at the Company, including EEI's Joppa Power Plant in Massac County, Illinois. I received a Bachelor's Degree in Engineering from Dartmouth College in 1998 and an MBA from Rensselaer in 2009. I state the following in support of EEI's Petition for Review of Illinois Environmental Protection Agency's Non-Concurrence with Alternative Source Demonstration under 35 Ill. Adm. Code Part 845 and Motion for Stay ("Petition").

2. EEI received IEPA's November 16, 2023 letter notifying EEI of IEPA's nonconcurrence with the Joppa East Ash Pond Alternative Source Demonstration via U.S. Mail on November 20, 2023. This letter is attached as Exhibit A of the Petition.

3. Following EEI's submittal of an Alternative Source Demonstration for the Joppa East Ash Pond on October 21, 2023, EEI Representatives communicated with IEPA multiple times between October 19 and October 31, 2023. Those communications occurred via telephone and email and included a discussion of (1) source characterization of the Primary Ash Pond using total solids sampling in accordance with SW846 methods; (2) hydraulic conductivities and hydrogeologic characterization; and (3) a complete characterization of the alternative source in accordance with 35 Ill. Adm. Code § 845.640.

4. Performing source characterization of the CCR at the Joppa East Ash Pond using total solids sampling techniques under SW846 would require drilling within the Joppa East Ash Pond with up to 8 borings using specialized equipment to collect 20 samples. It would further require complete laboratory analyses, data evaluation and reporting for those samples. Assuming a driller is readily available, which is not always the case, this process would likely take approximately 21-42 weeks to complete, and would likely cost approximately $325,000 - $680,000.

5. Conducting a characterization of the identified alternative sources for cobalt and pH in accordance with 35 Ill Admin. Code 845.640 is not practical given that they are the result of localized geology and geochemistry that varies significantly laterally and vertically in the uppermost aquifer at the Joppa East Ash Pond. Further characterization of the source of the cobalt exceedance at Joppa East Ash Pond could possibly occur by sampling and analyzing a soil sample adjacent to the exceedance well, and then conducting a geochemical evaluation based on that sample. Assuming a driller is readily available, which is not always the case, this process would take approximately 10-15 weeks and would cost approximately $55,000. There is no feasible solution to sample the source of pH exceedances because they are a result of chemical reactions within the aquifer. Any attempt to collect materials for evaluation of reactions in a laboratory would alter the geochemical conditions and provide unrepresentative results. Additional evidence for the geochemical reactions would require additional aqueous iron and iron speciation data from

select wells. To the extent this process was undertaken, the data collection and reporting would take 10-12 weeks and would likely cost $35,000 to $40,000.

6. Completing an assessment of corrective measures for cobalt and pH exceedances at the Joppa East Ash Pond in accordance with the requirements and deadlines of 35 Ill. Adm. Code § 845.660 would likely cost approximately $35,000. Completing the requirements of 35 Ill. Adm. Code § 845.670, including determining nature and extent, conducting a monitored natural attenuation evaluation, preparing and submitting the semi-annual reports, a construction permit application and a corrective action plan, for cobalt and pH exceedances at the Joppa East Ash Pond would likely cost approximately $400,000. Undertaking the steps required in Sections 845.660 and 845.670 is a considerable undertaking that requires the dedication of many resources. For example, the corrective measures assessment may require development of groundwater models specific to cobalt and pH, and could result in the development of potential engineered remedies. The Corrective Action Plan may require a 30 percent design for the selected remedy, a groundwater monitoring plan, a new Construction Permit Application, and attendance at a public meeting. Significant personnel time and resources will be necessary to dedicate specifically to this work.

FURTHER, the Declarant sayeth not.

Dated: December 22, 2023

Cynthia E. Vodopivec